Peasants, Potatoes and Pesticides

Heterogeneity in the Context of Agricultural Modernization in the Highland Andes of Ecuador

Myriam Paredes

Propositions

Accompanying the doctoral dissertation

Peasants, Potatoes and Pesticides:
Heterogeneity in the Context of Agricultural Modernization in the Highland Andes of Ecuador

Myriam Paredes

1. Development is intrinsic to farming practice, as it requires continuous moulding of complex socio-technical realities. In contrast to being a feature of backwardness, heterogeneity is the expression of a dynamic sector of activity where farmers exercise their agency for putting in motion their perceptions of "good farming". (this thesis)

2. Policy is not a force that determines rural development; it is, instead, an ambiguous and fragmented process that creates or restricts new spaces for knowledge development. As a result, different assemblages of farming practices arise that go beyond the dualism of the "modern" and the "traditional". (this thesis)

3. Western scientific knowledge is not determinant in changing the agrarian landscape; the reconfiguration of knowledge that occurs at the interface of farming practice is decisive.

4. The study of heterogeneity is central to legitimizing the voices of the silent – i.e., those people lying outside officialdom. Thus, it deepens and broadens democracy.

5. Farming styles, as the study of farming heterogeneity, allows seeing farmers as citizens, permanently engaged in the transformation of policy and geographies through their everyday practice.

6. If peasants were treated as respected artisans, their food would be valued for more than its weight.

6 December 2010

Thesis Committee

Thesis supervisor

Prof. dr. ir. Jan Douwe van der Ploeg
Professor of Transition Processes in Europe, Wageningen University

Thesis co-supervisor

Dr. P.G.M. Hebinck
Associate Professor, Rural Development Sociology Group, Wageningen University

Dr. D. Cole
Associate Professor, Dalla Lana School of Public Health, University of Toronto,

Other members

Prof. dr. ir. C. Leeuwis, Wageningen University

Prof. dr. Enrique Mayer, Yale University, USA

Prof. Karl Zimmerer, Pennsylvania State University, USA

Prof. dr. ir. Patrick Van Damme, Ghent University, Belgium

This research was conducted under the auspices of the Wageningen School of Social Sciences

Peasants, Potatoes and Pesticides

Heterogeneity in the Context of Agricultural Modernization in the Highland Andes of Ecuador

Myriam Paredes

Thesis
submitted in fulfillment of the requirements for the degree of doctor
at Wageningen University
by the authority of the Rector Magnificus
Prof. dr. M.J. Kropff
in the presence of the
Thesis Committee appointed by the Academic Board
to be defended in public
on Monday 6 December 2010
at 4 p.m. in de Aula.

Paredes, Myriam (2010)

Peasants, Potatoes and Pesticides: Heterogeneity in the Context of Agricultural Modernization in the Highland Andes of Ecuador

With summaries in English, Spanish and Dutch

ISBN 978-90-8585-810-2

I dedicate this thesis to Steve and Nina.

Acknowledgements

I dedicate this dissertation to my husband, Steve Sherwood, for his untiring efforts in helping me through this ambitious project and to our lovely, rambunctious infant daughter, Nina Micaela, for being an incredible source of energy, inspiration, and plain fun. While my entire family has supported me at different moments in this journey, my mother, Carmen Chauca Amaguaya, merits special mention, as she continues to find creative ways of helping me in career, family, and life. Most recently, following the birth of Nina, Mom -- an endlessly energetic octogenarian -- moved in with us on our farm near Quito, in order to help out in child rearing and to pass on her considerable knowledge of Andean agriculture. Somehow, we can always find available produce in her fields for dinner or to fill the weekly *Canastas*. And, it's been wonderful for Nina to be able to spend early mornings with her grandmother, learning how to milk a cow and feed the guinea pigs.

The final stage of this thesis has been marked by an accelerated pace of learning. In addition to the struggles of finding conceptual clarity in my research, I have been on a steep learning curve on the practicalities of motherhood. Both have been equally challenging and rewarding.

Countless people in Carchi contributed to this research, in particular the people of San Francisco de Libertad, Santa Martha de Cuba, San Pedro de Piartal, and Mariscal Sucre. Thanks to the hospitality and welcoming of the different families with whom I lived in these communities, I was able to learn from their different dreams and motivations, which provided insights into my own hopes and aspirations in life. I hope this thesis honours my friendship with these families and that it somehow contributes to a growing body of research arguing for a more enlightened agricultural policy, such as the recent ban on highly toxic pesticides in Ecuador. Moreover I wish all a better future in farming. After the last year, when Steve and I have been apart, I now more personally appreciate the many difficulties they face when members of the family have to migrate to secure employment and assure a family's livelihood. We must continue to struggle to make family farming a more viable, dignified vocation.

I also am grateful for the support of the many friends and colleagues. I give special thanks to Juan Carlos Landázuri for allowing Steve and I (as well as our research team) to use his farm as a base of operations and for making our time in Carchi so much more rewarding. I am indebted to my friend Catrin Meir for her important revisions and comments on many versions of this thesis, and to Tim, Finn and Merryn for welcoming us with a home in the U.K. Similarly, the Buitelaar family has kindly adopted us at many moments in The Netherlands, and I express my appreciation to my friend Jeanette and her son Ben as well as Marjo, Ellen, and Jan for their kindness and hospitality. In addition, I am grateful to Niels Roling and Janice Jiggins, especially during the last year in which they became Steve's *local parentis* in The Netherlands I appreciate their attention to his health and spirit, through countless weekends of wonderful exercise, food and other forms of nourishment at their lovely home. I also wish to recognize Conny Almekinders for inviting me to become part of the TAO-PAU program. Over the years, Conny has proven a generous friend, full of endless encouragement.

I wish to thank all my friends from the Humanist Movement and in particular to its founder, Mario Rodríguez Cobos or Silo, for sharing his tremendous insights and encouraging a global search for greater meaning and coherence in life. In particular, I am grateful to Jose Salcedo, a truly old soul, for his advice at a critical moment to focus my energies on completing this ambitious project and to Guiomar Bastidas, for her gentle spirit and endless goodwill and availability for conversation. I hope this dissertation reflects part of what I have learned through the Movement. For me, this experience has been a search for understanding human intentionality in the construction of farmers' own personal and social histories.

My promoters, Jan Douwe van der Ploeg, Paul Hebinck and Donald Cole were generous with their time, wisdom and insights. Jan Douwe contributed with his experience in identifying technical and social intentionality behind everyday practices, while Paul Hebinck, who somehow always found time for me in countless ways, to tighten form and content in my research as well as the ever-important administrative matters associated with PhD study in a far-off land. I want to thank them for their patience and welcoming. In the process of carefully reviewing the different drafts, Donald Cole expressed his intense appreciation and knowledge for social studies from the health point of view. Steve and I have greatly benefited from Donald's enthusiasm and friendship over the last decade. The foresight and patience of my promoters allowed me to learn at my own pace and successfully arrive at this dissertation. I am eternally thankful and indebted to each.

I wish to thank Charles Crissman, from the International Potato Center, for inviting me to join the interdisciplinary research in Carchi in 1999. Thereafter, I worked with the Eco*Salud* team, which helped me to identify families for my study and am grateful for the efforts of Luis Escudero, Jovanny Suquillo, Fernando Chamorro, Lilián Basantes, Mariana Pérez, and others. Graham Thiele provided important comments on this study, and Manuel Pumisacho of the National Program on Andean Roots and Tubers allowed me interactions with his colleagues in numerous workshops along the way. Susan Poats and others at the Carchi Consortium and Randi-Randi were helpful at many points. Fabián Muñoz was generous in sharing his time and tremendous wealth of knowledge in statistics, and I appreciate Donald Cole and Fadya Orozco for financing that activity through Eco*Salud* II. The memory of Veronica Mera, my colleague and friend who tragically died at the onset of this research, inspired me throughout the long road of this research, reminding me of the influence people can have well beyond their earthly lives.

I am grateful for my many good friends in Ecuador, especially Cinthya, Yolanda, Free, Orazio among others. I am pleased that we have been able to maintain our close ties, despite our being absent for so many events during the course of our PhD study. Thank you for your endless warmth and open hearts. We enjoyed the time when Irene, Bernardo, Antonia and Matea "illegally" shared a house in the Netherlands and are particularly grateful for their help with Nina. Similarly, Euler and Elena did the same in Ecuador for two very difficult months as I finished up the dissertation.

I wish to express my gratitude to the many people who reviewed different chapters and versions of my thesis, in particular: Craig Thomsen and Paula Samuelsen, Erika Schelly, Kristy Allen, Jessica Ingvalson, Rebecka Daye, and, of course, Steve. Tom Edwards, Irene Torres and Horacio Narváez-Mena ably edited the volume. José Jimenez kindly contributed final graphic support and layout. Surviving errors or mistakes are mine.

I am grateful to a number of organisations that provided financial support for this research, including: Wageningen University, the Rockefeller Foundation, and The Eco*salud* project, financed by the Canadian International Development Research Centre.

Table of Contents

Tables

Figures

Boxes

Appendixes

Chapter 1

Discovering Farming Heterogeneity in Carchi

The Province of Carchi in the highland Andes of northern Ecuador has been the focus of extensive research on the dynamics of health, environment and productivity since the early nineties. A collection of multi-disciplinary research, summarized in Crissman *et al.* (1998) and updated in Yanggen *et al.* (2003a), describes an intensive potato-pasture system that is highly productive (2-3 times the national average in terms of yield per area), but one that generates serious health and environmental problems. Research has found that the use of pesticides leads to chronic toxicity, which affects approximately two-thirds of the rural population. The introduction of mechanized tillage and the disk plough has resulted in the degradation of soils at an annual rate of between 80 and 120 tonnes per hectare. Price fluctuations result in farmers losing money on about 36 percent of their crops. The research shows that although potato production can be economically profitable, the extensive use of pesticides undermines the overall contribution of this crop to the development of peasant agriculture. The adverse effects on human health and the environmental degradation associated with modern production practices, combined with market uncertainties and the growing problem of pests, has led researchers to question the sustainability of the potato-pasture system and to encourage further research on alternatives.

Initially, I conducted a study of peasant heterogeneity in Carchi between 1999 and 2001, in order to examine different peasant farmers' responses to a project that was aimed at reducing pesticide use in potato production (Paredes 2001). The study shed light on the many ways that the intervention influenced farmers' daily practices in terms of pesticide use and management. It also produced interesting insights into the integration of crop management practices in the field. The study raised serious questions about the common belief that the peasant sector is disappearing in Ecuador due to its inability to keep up with modernization processes and increasingly competitive markets. Contrary to such assumptions, I found that the peasant sector was not only highly dynamic and diverse but was also determined to create its own space within the broader agricultural sector.

Between 2002 and 2009, I conducted detailed follow-up research on the strategies used by peasant farmers with regard to pesticide application and associated effects of this in the context of deepening agricultural modernization. In accordance with my interest in policies that encourage sustainable production, this second phase of research encompasses a larger population of people than my first study. In addition, it took into account a more diverse sample of communities so that a broader range of potato production practices could be considered.

The second phase was conducted in the context of 'dollarization', an extraordinary policy that centred around converting the national currency, the Sucre, to the US dollar. In addition, the government sought to shift the emphasis of production from the local to the international market by establishing 'free trade agreements' with foreign countries, in particular the United States.

Introduction to farming styles

My research adopts the view that agricultural modernization is a negotiated process that is continuously transformed through peasant farming practices and social networking. It begins with a study of the historical process of agrarian reform by means of an examination of the life experiences of local actors. It goes on to explore how traditional practices have given way to agricultural modernization, a change that has been attended by significant consequences for human health. Qualitative and quantitative data collection and analysis are used in order to understand farmers' perspectives and their patterns of agricultural practice. These patterns have been summarized by van der Ploeg (1993b, 1994, 2003) and referred to as "farming styles."

In summary, this thesis emerges from two phases of in-depth research over a decade that explores the subtle relationships between farming practice and markets, technology, and the structuring of labour. Due to the central role of farming styles in this study, it is useful at this point to briefly summarise the resulting style categories: *Tradicionales*, *Seguros*, *Arriesgados* and *Experimentadores* (summarized in Table 1.1).

Tradicionales: strategically mixing tradition with modern practices

The style of the *Tradicionales* (traditional farmers) is relatively intensive. It requires a lot of labour and produces high yields and benefits. *Tradicionales* call themselves *traditional* since they are proud of producing potatoes with "old" practices such as *wachu rozado*. This cropping system reduces soil erosion and functions as a source of green manure (Sherwood 1998) but demands more labour time than full tillage. In order to reduce labour costs, *Tradicionales* contract organized labourers (teams of workers or *cuadrillas*) who are specialized in *wachu rozado*. The *Tradicionales* style also depends on decades of community resource management, which gives farmers access to areas of forest and *páramo* (wet highlands) that are suited to *wachu rozado* farming methods. The *Tradicionales* style differs from the other styles in its emphasis on the continuous monitoring of crop and weather conditions. It also often involves frequent applications of agrochemicals.

Seguros: "friends are more valuable than money"

The *Seguros* (literally, 'secure ones') is an extensive style that emphasizes the use of large quantities of seed in order to compensate for low quality land that only allows for relatively low yields and benefits. *Seguros* are averse to monetary risk: they do not take loans from banks and limit investment in potato production according to their available resources. For this reason, *Seguros* are locally considered "*poor.*" *Seguros*, however, characterize themselves as 'independents' because they do not work as labourers and are not as vulnerable to market fluctuations as are other farmers. After decades of full tillage on steep terrain, *Seguros* tend to have degraded fields and thus make most of their limited investments in fertilizers and pesticides. Other production factors are largely facilitated through non-commoditized arrangements, such as labour exchanges and sharecropping arrangements with families and community members. These arrangements provide access to land, seed and machinery, with little or no monetary exchange. This is why *Seguros* assert that "land is more important than capital" and that "friends are more valuable than money."

Arriesgados: betting it all

The style of the *Arriesgados* (risk takers) is also an extensive style, but one characterized by high levels of mechanization and heavy fertilizer application. Due to the poor quality of land that follows decades of mechanization, the practice of this style produces low yields and benefits. The label *Arriesgados* refers mainly to farmers who make large investments in potato production on the basis of bank loans and who use the "modern" hacienda system of production as a model. This style is associated with values of wealth accumulation. Farmers who practice it are seen as "pure potato producers" (*paperos puros*) or "complete" (*completos*) because they invest everything in a crop that is considered a "lottery". The motivation to continue producing in this way comes from the many examples of *Arriesgados* who have had the "good luck" to earn high incomes and to improve their economic status. This allows them to acquire vehicles, for example, and to construct relatively expensive buildings and educate their children in the capital city, Quito. This is one reason why people refer to *Arriesgados* as “rich farmers.” However, the *Arriesgados* farming style is generally in crisis because of its ever-decreasing yields and benefits per hectare. The majority of farmers in this group had negative net benefits (total production minus total costs) in 2004.

<u>*Experimentadores*: finding the way through experimentation</u>

The style of the *Experimentadores* (experimental farmers) is characterized by the high use of foliar fertilizer and the use of cheap, highly toxic pesticides. Both inputs are meant to compensate, to some extent, for the reduced use of more expensive soil fertilizers and pesticides. With this strategy, *Experimentadores* achieve high yields and benefits and follow quite an intensive style of farming. *Experimentadores* are mostly part-time farmers. The name is derived from the farmers’ need to experiment in order to keep producing for the market, while using as little money as possible and utilizing very small pieces of land. For this reason, colleagues often referred to farmers who practice this style as “playing with the land” and “not true farmers.” *Experimentadores* mostly farm by sharecropping with other small landholders from their extended families. This arrangement usually facilitates sufficient access to seed, oxen, and agrochemicals and allows the farmers to meet the majority of their labour needs. According to *Experimentadores*, their families put more “care” than paid labourers into tasks such as soil preparation, seed selection, planting and hilling-up. Farmers from this group consider family labour as “the capital of the poor.”

I found through an in-depth study of the farming styles in Carchi that the structuring of labour, technology and market relations of peasant agriculture does not follow a single pathway of increasing levels of commoditization (the process of assigning an exchange value to objects and relationships), as suggested by certain modernization theories. Farmers in Carchi are not a homogeneous group constrained by market forces. Rather they employ heterogeneous economic strategies involving complex commoditized and non-commoditized relations. This is illustrated by the manner in which farmers organize labour in response to diverse ecological and market considerations and to complex community social conditions that are characterized by family values and different perceptions of “good farming” and economic priorities.

Table 1.1. Characteristics of potato farming styles

Criteria	*Tradicionales*	*Seguros*	*Arriesgados*	*Experimentadores*
Identity markers	Proud to keep traditions	Being “independent” from markets Not taking risks	Being true potato producers (paperos puros) Taking all the risks needed	Experimenting for a “better life”
Rationality of production	High investment and high return Conserving resources for high yields	Low investment and low return Having enough without being “too ambitious”	High investment and highly variable return Playing the “lottery game”	Low investment and high return Non-commoditized labour as the main “capital”
The driving ‘model’ of production	Combination of “traditional” and “modern” technologies	Against the “old” hacienda way of production Especially tries to avoid owner-employee relationships	The “modern” hacienda mode of production Tries to limit labour demand	Technology replacement with less costly options through experimentation
Main decision making base	Continuous monitoring of the crop	Cost reduction	Recommendations by technicians from commercial shops	Experimentation and close monitoring of the crop
Relevant technologies for potato production	The use of the *wachu rozado* planting system Numerous pesticides and fertilizer applications	The use of manual and mechanized full tillage Fewer pesticide applications High potato seed per hectare.	The use of mechanized full tillage High quantities of fertilizer and pesticide spend in few applications	The use of rotations and organic matter incorporation High use of foliar fertilizer and cheap pesticides
Kind of market used	Local cooperative	Organized consumers in big city (Canastas)	Market in big cities	Market in small and big cities
Labour arrangements	*Cuadrillas* and individuals monitored by family members	Family paid in kind and sharecropping	Paid individuals	Extended family in sharecropping

The identification of different farming styles allows the portrayal of farmers as actors who adjust their farming strategies in response to particular socio-economic and ecological conditions. The study shows, moreover, that a community's historical decisions regarding resource management significantly influence present farming conditions. The study of farming styles in Carchi also illustrates the way in which farmers integrate production activities, social relations and decisions regarding their environment in largely unpredictable ways. These ways are often at odds with theories of modernization, which view development, either explicitly or implicitly, as occurring in linear and evolutionary stages.

Purpose of the research

The dominant view of peasant farming in Ecuador rests on preconceptions about peasant poverty and the consequent transformation of peasantry into an industrial labour force. In this thesis, peasant farming refers to modes of production that combine diverse forms of commoditized and non-commoditized relations of production. Peasant farms are organized by families that live on the farms themselves, rather than by entrepreneurs or commercial organizations that are based elsewhere. The family is usually the primary source of labour, but not always the only source. Different production techniques may be used on the farm. Some or all of the produce might be sold in the markets. Different degrees of farmer autonomy co-exist. This way of conceptualizing peasant farming opposes notions based mainly on the quantity of resources (chiefly land size) available to a family or some other production unit, which equate peasants with subsistence farming.

Studies that explore social mobility of peasants and the dynamic development of peasant farms are exceptional or limited (Barsky 1984, Martínez 1992, 2000). Agricultural policies continue to follow the predominant interpretation of agricultural dynamics rather than the implications of specific empirical studies. The main purpose of this study is to show that peasant agriculture is heterogeneous in nature, despite the modernization policies that attempt to consolidate family farms into fully integrated and marketable 'entrepreneurial units'. The other aim is to examine the important role that peasant farming plays in Ecuadorian rural development and its vulnerability when confronting the processes of "modern" marketing and technology. Finally, I aim to report on the opportunities and limitations of rural development from the perspective of peasant farmers whose farming styles are motivated by a sense of autonomy and pride. A peasant farmer once commented:

> We peasants survive not only by producing food for everybody but we produce work for our family and neighbours and future opportunities for our children so that they can stand on their own feet. Our pride is not the money in our pocket but the food on our table. We want to keep doing what we know how to do. We don't want the government's charity or people from the city feeling pity for us. We don't want to be like those sick cows that produce pity instead of milk[1], we want to do our job.

With this study I hope to contribute to four aspects of the debate surrounding modernization policies in Ecuador. Firstly, by describing the variation in farming styles, I will demonstrate that the peasantry should not be categorized as a subsistence-farming group or as a group that is disappearing. I will argue that the peasantry is a dynamic, diverse segment of the population. Furthermore, this group consists of farmers who are continuously adapting to and overcoming limitations in creative ways.

The second aspect I address is the impact of higher commoditization levels promoted by modernization policies. This study shows that higher commoditization levels do not stimulate development in practice. Instead they tend to increase farm vulnerability.

Thirdly, I assess the technological strategies of modernization policies and their consequences after 50 years of intensive application. I describe how specific patterns of pesticide use are embedded in labour processes and demonstrate that farmers are active decision-makers, and even generators, of technologies and experimental techniques.

Lastly, I explore the assertion that policy and project interventions related to rural development should draw on the lessons learned from the evidence of heterogeneity in the field. I use actor-oriented and farming styles methodologies to understand dynamics at the farm level. I argue that it is critical to study actual farmers' practices and their influence on other domains before designing policies that aim to have an impact in national or international spheres.

Study context

Agrarian reform was the starting point for the modernization policies that were first implemented in Ecuador in the early 1960s. The idea supporting these policies was that agricultural development would benefit from orienting agricultural production towards national and international markets (Martínez 1983; Barsky 1984; Acosta 1998). The land market, created by

[1]In Spanish the farmer used the saying "vacas que producen lástima en lugar de producir leche".

land redistribution in the 1960s, allowed peasant farmers to buy and sell land and connected them increasingly to markets of capital, inputs, labour and natural resources.

Following agrarian reform in the 1960s and 1970s, the haciendas in Carchi became geographically limited to the fertile valleys. Former labourers, who had become organized into cooperatives, were granted individual landholding rights and cultivated the surrounding mountainsides. Because the cooperatives were indebted to the State, the new landholders received credit offered by the national development bank (*Banco Nacional de Fomento*) to develop production systems linked to commercial markets. In the following years, peasant farmers in Carchi rapidly transformed the earlier hacienda-based production system of wheat and barley into a cash crop, potato, as a means of more effectively competing in growing national and international markets. Due to its uniquely favourable conditions for agriculture and trade (evenly distributed rainfall throughout the year, fertile soils, proximity to Ecuadorian and Colombian markets and a large literate rural population), Carchi was one of the few places in Ecuador where many peasant farmers could afford to apply the export-based, external, input-intensive technological packages (pesticides, fertilizers and mechanized tillage) associated with the "green revolution" (Barsky 1984, Llovet *et al.* 1986). Today, the peasant system combines potato production with pastures for dairy cattle (Crissman *et al.* 1998, Herrera *et al.* 1999).

Pesticides are central to the potato production system that developed in Carchi. The Andean weevil (*Premnotrypes vorax*) locally known as *gusano blanco* became a significant pest in the potato monocroping system of Carchi, which is characterized by little rotation with other crops. In its larval stage, this pest affects 20 to 50 percent of potato tubers causing considerable economic loss to farmers who mostly rely on insecticide spraying for its control (Pumisacho and Sherwood 2002: 30). Other minor pests have become important under the commercial system of production in Carchi and are increasingly controlled with insecticides as well. In addition, late blight —a fungal disease caused by *Phytophthora infestans*–can devastate a potato crop in a matter of days, especially when susceptible varieties are planted (usually the most commercial ones). Under most conditions in Carchi, the disease is only controlled with frequent spraying of fungicides.

According to research conducted in the 1990s, pesticide use was associated with negative effects on family health. In 1990, Carchi had the highest rate of passively reported pesticide poisonings in Ecuador (22 cases per 100 000 population, Carpio 1990). Several studies show that exposure to the insecticides used in Carchi such as carbamates and organophosphates have measurable effects on peripheral nerve functions while continuous contact with fungicides such as dithiocarbamates can be linked to skin diseases like chronic dermatitis (Cole *et al.* 1997b and 1998a). These effects reduce work capacity and adversely affect farmers' decision making capabilities over time, which calls into question the overall contribution of pesticides to production (Antle *et al.* 1997, 1998; Crissman *et al.* 1994, 1998: 12; Cole *et al.* 1998a: 229). Cole *et al.* (2000) finds that expenditures in medication and lost labour associated with an acute poisoning are an average of $18 (based on 1991 currency values), representing a financial burden of about six working days (Cole *et al.* 2000).

Mera-Orcés (2000) found that small children under five years of age accounted for the majority of cases of pesticide-related toxicity in a regional hospital. Pesticide toxicity was the second most common cause of death for women and men. Analyzing the trade-offs between productivity and healthy alternatives, the researchers postulated that policies designed to limit the use of pesticides through taxation would result in a reduced area of potato cultivation and a decrease in yield per area. Higher input costs, combined with reduced employment opportunities, would have a double (negative) impact on poorer populations. A policy option was proposed, therefore, that included the substitution of red label products for less toxic alternatives in conjunction with integrated pest management and the reduction of pesticide exposure through education programs (Cole *et al.* 1997a, 1998a).

Notwithstanding the above policy measures, my 2001 study found that the average farmer in Carchi tended to use pesticides in higher quantities than recommended (Paredes 2001). The pesticide application techniques were not uniform but varied according to the different styles of farming.

Problem definition and main questions

Modernization policies in Ecuador treat peasant farmers as part of a homogeneous group. They are regarded as incapable of competing in global markets due to their limited scale of production. As a result, peasant farmers are supposedly left with little alternative but to work as wage labourers in the growing industrial sector. Nevertheless, the last national agricultural survey (see INEC 2000) found that the number of small (less than 2 hectares) and medium (2 to 10 hectares) size farms that were run by peasant families had increased since the agricultural survey of 1974 (Otáñez 2005). On the basis of land size, the survey of 2000 categorized 58 percent of the total units of production in Ecuador (842,882 farms) as 'subsistence' farms (Morales *et al.* 2005). Otáñez (2005) explain that farm size correlates closely with income distribution, the main measure of socio-economic development. More critical analysis reveals, however, that peasant families practice a variety of forms of production besides subsistence farming.

The agricultural modernization model considers "green revolution" technologies, applied in standard form, as the principal means of increasing production for the market. According to modernization theory, therefore, the degree to which "modern" technology is utilized corresponds to the level of farm development. However, studies in Carchi show that there is no standard way or single model that peasant farmers follow in their application of modern technologies in potato production. Moreover, the application of "modern" technologies does not always stimulate development. It might also have negative consequences. For instance, farmers use pesticides and fungicides in ways that are not technically recommended (Crissman *et al.* 1998; Yanggen *et al.* 2003a, Paredes 2001), leading to the exposure of their family and community members to dangerous chemicals (Mera-Orcés 2000).

The multiple rationalities underlying peasant farmer production are highly relevant to understanding local development patterns and local strategies for managing vulnerabilities. Insight into these patterns and strategies is critical for the identification of more appropriate and effective rural development policies. Yet most studies that inform policy or interventions tend to rely on a generalized view of peasant production as homogeneous and constrained by markets and risks. This thesis, on the other hand, takes the heterogeneity of peasant farming as its central focus. This allows it to provide a trenchant explanation of the multitude of health, productivity and environmental consequences that are associated with modern agricultural technology in general, and with the use of pesticides in particular.

The chief research questions of this thesis can be summarized as follows:

1. What emerge as the main strategies of potato production in Carchi when a broad sample of farms and a variety of production systems is considered?
2. Given the fact that pesticides have been promoted in standardized ways, with clear and detailed instructions, is pesticide use across farming styles a homogeneous or heterogeneous phenomenon?
3. How do farmers utilize pesticides and manage the risks associated with their use?
4. What insights are provided by a study of heterogeneity that could inform new policies that aim to promote healthier and more sustainable agricultural production?

Theoretical and methodological perspectives

This study employs an actor-oriented perspective to argue that the adverse effects of pesticide use on human health among peasant farmers can be explained by differentiated social processes that are rooted in farming practice. Consequently, the research aims to illustrate how the practices of peasant farmers produce, reproduce, consolidate and transform such processes. What others describe as structures (such as 'pesticide markets') that determine people's practices (see for instance the international code of conduct for the distribution and use of pesticides, from the Food and Agriculture Organization 2003), the actor-oriented perspective sees them as the dynamic co-constructions of actors. As Giddens (1976: 121) explains, structures are constituted by human agency and are the very medium of this constitution. The actor-oriented approach, then, develops a theory of agency based on the capacity of actors to process and act on one another's experiences in differentiated ways, in accordance with their competing priorities, purposes and circumstances (Long 2001: 49).

> Agency implies both a certain knowledgeability, whereby experiences and desires are reflexively interpreted and internalized (consciously or otherwise), and the capability to command relevant skills, access to material and non-material resources and engage in particular organizing practices (Ibid: 49).

The richly varied practices of farmers –as an expression of agency– can be understood in terms of different 'styles of farming' (see van der Ploeg 2003). These cannot be reduced to individual farming strategies. As farming takes place in unique domains (i.e., family, community, markets etc), van der Ploeg views farming styles as the result of complex interrelational networks, involving both human and non-human components.

In this study, agricultural heterogeneity is positioned in a debate that distinguishes between notions of modernization and modernity. Modernization theory was developed in the last century. It depends on a fixed notion of progress and the idea that modernization can be implemented through public policies. The concept of modernity, however, views agricultural development as the result of heterogeneous patterns based on cultural notions of progress. These notions are the product of actors who have to navigate between competing interests in their pursuit, and co-construction, of what is "modern" (Arce and Long 2000). Policy, in the context of this study, refers to the technical and administrative measures that are implemented in the agricultural sector by the state with the involvement of various actors at different times and in different places.

In order to examine the co-construction of modernity at a time when modernization policy is being implemented in Ecuador this study employs elements of Actor-Network Theory (ANT). In the first instance, it uses the 'extended translation' model to look at how actors define a problem and attempt to make themselves and their proposed solutions indispensable. Secondly, the study analyses how actors make the solution interesting for specific stakeholders and create ways of involving others in the application of such solutions. Finally, it seeks to understand the means whereby actors mobilize people and resources in order to implement the proposed solutions (summarized from Callon 1995). Translation analysis is used as a tool to study modernization policy in order to determine the extent to which proposed solutions are transformed or translated in the process of implementation. It also helps to chart the ways in which the meaning of human and non-human elements change and also the quality and level of involvement of the different actors.

Although this study focuses chiefly on policy interpretation and application at farm level, the translation analysis of modernization policy also allows for the wider historical context to be viewed in a dynamic way. It shows how policy changes occur during the process of implementation instead of simply presenting an account of final outcomes. The study of the local dynamics of agricultural production emerges as critical to achieving an understanding of the agency involved in the use of technology. The thesis views farming styles as an expression of novel translations of modernity.

Extended translation theory assumes that the construction of networks that support a given policy (as a mode of structures) will occur, and sets up a methodology to study the different steps of this process. An actor-oriented approach, however, does not take the existence of these networks (or the steps to build them) for granted. Instead it employs the concepts of agency and interface in order to understand the ways in which actors transform policy through their everyday life practices, which may or may not include the conscious construction of networks. While noting the differences between the two approaches, I was also able to exploit important areas of convergence between them.

By means of this analytical framework, I address concerns about the links between apparent dualities: the micro and macro, global and local, actor and structure, and nature and society. As Long (2001) asserts:

> Rather than seeing the 'local' as shaped by the 'global' or the 'global' as an aggregation to the 'local', an actor perspective aims to elucidate the precise sets of interlocking relationships, actors 'projects' and social practices that interpenetrate various social, symbolic and geographical spaces… Thus the

> major challenge is to delineate the contours and contents of diverse social forms, explain their genesis and trace out their implications for strategic action and modes of consciousness. That is, we need to understand how these forms take shape under specific conditions and in relation to past configurations, with a view to examining their viability, self-generating capacities and wider ramifications. (Long 2001: 49-50)

Linkages between theory and empirical data

In chapter two, I draw on translation analysis to explain how the promotion of pesticide technology became part of an authoritative, strategic intervention in the context of broader agrarian reform and agricultural modernization. The empirical data in this chapter shows how pesticides have become integral to a sociotechnical regime that consistently promotes their use. While the adverse effects of pesticides on human health have become a problematic part of peasant agricultural production, the ways in which pesticides are used and the ways in which peasant farmers manage the risks that are associated with them vary. The resulting differentiation can be seen as an important window into endogenous alternatives to worrisome "modern" technologies.

Question 1: *What emerge as the main strategies of potato production in Carchi when a broad sample of farms and a variety of production systems is considered?*

I study the heterogeneity of farming practice through the lens of farming styles, an approach that guides social analysis by studying the farm labour process as well as the links between markets and technologies. The identification and description of farming styles incorporates factor and cluster analysis of potato production figures. The analysis is based on in-depth studies of daily farming practice.

This thesis examines a wider population of farmers and a greater variety of production systems than my previous study did. That study was limited to farmers who participated in a single project intervention (Paredes 2001).

Question 2: *Given the fact that pesticides have been promoted in standardized ways, with clear and detailed directions, is pesticide use across farming styles a homogeneous or heterogeneous phenomenon?*

Building on the response to the first question, I relate different patterns of pesticide use to farmers' structuring of the labour process and their sociotechnical distance from markets and technology.

Question 3: *How do farmers utilize pesticides and manage the risks associated with their use?*

I address this question by examining how farmers who practice particular styles offer different rationales to explain their methods of pesticide use and its adverse consequences. I suggest that patterns of pesticide use cannot be analyzed as independent practices. They need, rather, to be understood as part of a system of rationality that is integral to the sociotechnical network involved in the generation of a farming style.

Question 4: *What insights are provided by a study of heterogeneity that could inform new policies that aim to promote healthier and more sustainable agricultural production?*

To address this question, I draw on innovations in farming styles to argue that these are the best way in which to learn about peasant strategies that are conducive to human health and sustainable agricultural production.

Thesis outline

In this first chapter I have summarized the research background, purpose and context of the study and have also set out the problem definition and the main questions addressed by the thesis. In addition, I have provided a brief explanation of the methodological and theoretical approaches employed in my thesis. Chapter Two introduces and explains the historical context of modernization in Ecuador, associated with the arrival of pesticide technology in Carchi and its ensuing incorporation into rural life. Chapter Three presents the conceptual framework and the methodology that I have used to understand peasant heterogeneity through farming styles. Chapter Four describes the different styles of farming revealed by a qualitative examination. Chapter Five presents quantitative analyses of a large sample of potato producers and also explores the relevant factors that distinguish each style. Chapter Six focuses on different approaches to pesticide use and perceptions among those practicing the different farming styles. Finally, Chapter Seven presents the main conclusions of the study.

Chapter 2

Historical Introduction: Modernization as Translation

This chapter sets out the historical context of agricultural modernization in Ecuador, with particular emphasis on the introduction of pesticides. Drawing on translation analysis, two historical processes are explored: 1) the adoption of agricultural modernization as a policy and 2) the controversy surrounding the adverse effects of pesticides on human health. This application of the translation model contributes two notable insights to the analysis of modernization policy. It reveals the characteristics of the networks that form in reaction to policies, and it provides a guided but flexible means of examining how policy or project propositions are continuously transformed (i.e., "translated"). This implies that intervention principles are not simply accepted or rejected. Rather, each is negotiated, allowing intervention activities to proceed more efficiently. Translation, therefore, is a process rather than a final outcome (Callon 1986: 196).

I draw on translation analysis to examine the differences between the concepts of modernity and of modernization and, in particular, to examine the impact of the arrival of agrichemicals and other industrial era technological resources. The last section of this chapter illustrates how peasant families, after 50 years of agricultural modernization, exhibit diverse patterns of practice, with important implications for family health and economic and social status. In Chapter Three I will more closely examine localized expressions of modernity and modernization, as manifested through farming styles.

I draw on historical data from available literature, discussions and debates in farmers' workshops, as well as peoples' accounts of, and reflections on, historical living conditions, production practices and lifestyles, in order to discuss agriculture in the pre-modern and modern periods. I go on to use my own records as an active participant to analyse the activities of researchers that were aimed at promoting the banning of highly toxic pesticides in Ecuador.

Theoretical considerations

Preston (1996) explains how western notions of change and progress are embedded in the hypothesis that development can be brought about through the application of externally based knowledge and technology. This "authoritative intervention" is based on the idea that the application of science can enable humankind to effectively manipulate its social environment. According to this, a form of "expert" knowledge, strategically applied, lies at the core of successful interventions (Preston 1996: 159-160).

In keeping with Latour's (1999b) critical perspective on science in practice, I argue that modernization, as a compelling authoritative intervention, does not have an essential authority or power. Instead it represents an attempt to give a particular 'culture' a political advantage over others. In order to give a fresh perspective on agricultural modernization in Carchi, I utilize translation analysis to examine how actors strategically employ different activities and forms of organization in order to influence policy processes.

According to Callon (1995: 50), *translation* refers to the operations that link technical devices (e.g., agrochemicals), statements (principles written as policies) and human beings (farmers). The relationship between these different elements is established by means of inscriptions that refer to "all graphic displays." These may include newspaper publications, tables of data, brief reports and articles or books (Latour 1987). Callon (1995: 53) explains how the progression from an inscription to a statement (e.g., for a report to become a policy baseline) and from one statement to another, requires embodied skills (such as those of experts) and technical devices (pesticides).

Translation analysis views technologies as part of social networks. A network is understood as a set of aligned heterogeneous elements, both human and non-human, which together has a specific function (Callon 1986, 1999; Latour 1987). The meaning and function of pesticides, for instance, is dependent on the networks of which they form a part. Some of these networks promote a view of pesticides as poisonous and a cause of illness, while other networks encourage a view of them as an indispensable technology and a facilitator of wealth. When understood as the product of continual processes of negotiation and translation within competing networks, pesticides can no longer be viewed as tangible, portable artefacts whose movements can be controlled through policy. As Sherwood (2009) argues: a pesticide in Ecuador is not simply a liquid in a bottle but also a social construction and a political device.

In this thesis I use translation to explain two historical processes in Ecuador:

1) The positioning of agricultural modernization as a policy for social progress.

2) The resulting controversy about the adverse effects of pesticides on human health in Carchi and the attempts of a group of researchers to lobby for a national policy to ban highly toxic products.

In both cases I will describe the following critical moments of translation (adapted from Callon 1986: 196):

1) *Problematization, or how to become indispensable. Problematization* of translation refers to the ways in which particular actors define a problem and their suggestions for resolving the problem. Callon (1986: 196) describes the solutions proposed as "obligatory passage points," since the actors "seek to become indispensable in the drama by defining the problems."

2) *Interessement, or the identification and shaping of allies. Interessement* refers to the ways in which the actors defining a problem establish linkages with the individuals or populations concerned with that particular problem. In order to obtain economic or legal support, for instance, researchers studying the adverse effects of pesticides continually aim to establish linkages between their studies and various groups or stakeholders who have a vested interest in the outcomes of these studies. Examples include the groups and institutions mobilized against the sale of highly toxic products, scientists interested in occupational health and the government ministries that design and implement related policies. In pursuing a particular objective, a stakeholder group may argue, for example: "We want what you want, so ally yourselves with us by endorsing our research, and you will have a greater chance of obtaining what you want" (Callon 1980; 1995: 52). To understand *interessment* involves a study of the stakeholders under consideration and the roles that they play.

3) *Enrolment, or the strategies used to define and interrelate the roles of different stakeholders*. Callon (1995: 211) explains that the internal processes of coercion and collusion associated with alliance building are not explained by *interessment*. Instead, this process of "enrolment" involves "the group of multilateral negotiations, trials of strength and tricks that accompany the *interessment* and enable them to succeed."

4) *Mobilization, or the methods of intervention used to ensure that the various collectivities are represented*. The term "mobilization" involves displacement – the making of previously static entities mobile (Callon 1995: 217). Through the designation of farmer representatives, for instance, and the implementation of a series of activities that are of interest to them, actors are first displaced (both physically and in terms of their roles) and then assembled later at an appointed place.

The study of the processes of translation aims to provide insights into how these translations are connected and how they result in the temporary establishment of the stabilized relations known as *translation networks*. Callon (1995: 52) explains that a translation network refers to a "compound reality in which inscriptions (statements in particular), technical devices and human actors (including researchers, technicians, industrialists, charitable organizations, and politicians) are brought together and interact with each other." The study of the "force" of a modernization network is of particular interest. This refers to its internal ability to be convincing and is determined by the heterogeneity of its components (technical devices, statements, inscriptions, embodied skills and social groups). This characteristic of the network is important because when networks are strong (*forceful*) "any attempt to question the network is rapidly confronted with a cohesive body of translations that all support one another" (Callon 1995: 56).

Positioning of agricultural modernization as policy

The following analysis aims to clarify how different actors translate the modernization policies of agrarian reform and technology transfer. The analysis of the pre-modernization and modernization periods is contextualized by some of the data.

The traditional hacienda[2] system and the precarista[3] pressure

The ecological diversity of Ecuador is a result of its location in the Northern Andes and on the equator, and of the diverse mountain environments of the Andean ridge and the highland valleys that run from north to south, and separate the Amazonian region from the Coastal region. Carchi, which borders on Colombia, is the northernmost province in the highlands. Five centuries ago, European colonizers described the province as a "cold, gross, mountainous land" (Balboa, cited in Ibarra 2005: 37).

---

[2] The term hacienda refers to a large estate or farm. In Ecuador haciendas were given to Spanish colonizers as payment for service to the Spanish crown. Indigenous people were the original owners of the hacienda land although the idea of ownership was not for them the same as in the colonial times in which they became indentured servants on the haciendas.

[3] *Precaristas* were *hacienda* servants. They were part of a number of different systems of non-commoditized relationships that existed between workers and hacienda owners (*hacendados*). The *precaristas* were given access to a small piece of land in exchange for labour and other services on the *hacienda*. Some of these arrangements included *wasipungos* (lending of a piece of land in exchange for labour), rent and sharecropping (Acosta 1998: 24).

Sherwood (2009) explains that the Spanish colonizers focussed on agriculture as a source of income due to limited mining opportunities in the region. Carchi thus acquired importance as a province with good soils and well distributed rainfall. A few very extensive haciendas were established. These relied on the labour of the native population, which was mobilised through feudal systems such as slavery, tributes and indentures[4]. These haciendas initially produced textiles such as wool and later grains as well, which were exported to Europe. An ex-hacienda servant explained:

> I educated myself (*me formé*) in agriculture as a labourer in one of the haciendas since I was 15 years old. I practically grew up taking care of about 700 cattle and other animals, and I worked with a hoe for 30 years. I was a hacienda servant[5] for eight years and eight months. At that time there was calamity and poverty so every time we needed something we would run to the patron's house so that he could give us the *suplido*. The *suplido* was a certain quantity of grains and vegetables that we bought in the hacienda and they would discount that from our work as labourers (Field notes 20 May 2004).

Following independence from the Spanish crown in 1830, Ecuador had difficulty establishing itself as a nation-state due to the fact that its geographical boundaries had been arbitrarily determined to suit the interests of the governors of what would become the territories of Peru, Colombia and Ecuador. It proved impossible to maintain unity within Ecuador since the three regions had closer relations with areas in neighbouring countries than between themselves (Acosta 1998: 22). Nevertheless, a process of developmentalism[6] was initiated. To encourage the principles of "independence" and "civilization" various governments promoted changes to the institution of the hacienda. Most of the changes that succeeded

---

[4] Indenture is defined as "a contract committing an apprentice or servant to serve a master for a specific period of time" (Encarta dictionary: English (UK) 2007). The indentures of the hacienda system involved a stipulated number of days which had to be worked in return for each kind of resource the servant required (land, irrigation channels, habitation, grasslands, etc.). Because these resources were essential to the peasant families' livelihoods, indentures commonly involved servants still being indebted at the end of each year of contract. Thus the indentures were renewed each year and the servants were obliged to work in perpetuity.

[5] The difference between labourers and servants is not completely clear in the historical records, but the term "servant" mostly refers to people who lived in the main hacienda house and had contracts (indentures) that obliged them to work continuously for the same hacienda owner. The term "Labourer", on the other hand, usually refers to the people who did not have contracts with the hacienda but who worked for a salary on a weekly basis.

[6] 'Developmentalism' was a discourse that was common among the elites of the newly independent nation states. Political and social stability and new patterns of authority were pursued as the basis for development (Preston 1996: 158-59).

afforded little benefit to the *precaristas*. After a period of struggle between competing regional interests, most of the benefits went to the hacienda owners who controlled the government[7] (Marchán 1986).

From the beginning of the 20th century, in the context of events such as the Russian Revolution of 1917, many intellectuals were influenced by socialist ideology and wrote about the need for reforms in favour of the *precaristas* (Costales and Costales 1971: 10). The struggle of urban workers for the creation of a legal working code influenced indigenous labourers in the haciendas, resulting in numerous hacienda uprisings that protested against the peasants' unsatisfactory living and working conditions. It was only after the Second World War, however, that financial and political pressure[8] from the United States and from various national interests led to agrarian reform becoming the central strategy of agricultural modernization.

Beginning of the modernization period

The beginning of the modernization period in Ecuador cannot be ascribed a specific date, but the approval of agrarian reform undoubtedly marks the moment when strategies for creating a modernized state began to gain momentum. Successive Ecuadorian governments, from the mid 1950s until the late 1970s, were the champions of modernization through agrarian reform and technology "transfer" (the latter is based on the idea that the technologies developed in one place could be implemented in other parts of the world with similar results). The US government and the United Nations led this process, especially by means of the *Comisión Económica para America Latina y el Caribe* (CEPAL)[9] (Barsky 1984: 25).

---

[7] For instance, Marchán (1986) shows that the abolition of slavery in 1851 was the result of the coastal landowners pressurizing the congress to advance their economic interests as opposed to those of landowners in the highlands. Costales and Costales (1971) also mention that many of the reforms that congress made to the hacienda system merely resulted in changing the nomenclature of the conditions, while the same indentured service systems continued exploiting the native population. The term *concertajes,* for example, was substituted for *wasipungos*. Both terms refer to work by a peasant family on a hacienda in exchange for a piece of land to cultivate through the year (Costales and Costales 1971: 8, 94).

[8] In order to combat the influence of the USSR in the Third World, as epitomized by the Cuban revolution, the US Department of State proposed taking steps towards ordering the global economic system by creating an international economic centre in the USA. This led to the creation of the International Monetary Fund (IMF) and the World Bank, which would control trade between countries and finance the changes demanded by the USA in Latin America (Ibid: 56-7).

[9] CEPAL is the Economic Commission for Latin America and the Caribbean. It is one of the five economic commissions of the United Nations (www.eclac.org, 2007).

Problematisation: "agriculture's backwardness"

In 1954, CEPAL released a report that characterized Ecuadorian agriculture as "the most backward of Latin America." Reasons put forward to explain this state of affairs included the extensive use of labour, the haciendas' monopoly of land as the primary source of power and social prestige, and the precarious relations that existed between the different elements of production (Martínez 2000). In translation analysis terms, the CEPAL report claimed that modernization of the State was the "obligatory passage point." Modernization was understood as a group of policies that promoted the transfer of technology and the application of agrarian reforms that would destroy the material base of the hacienda system and promote an "economic take-off" (Solo de Zaldívar 2008: 586). In CEPAL's view this would encourage the development of production and the progressive consolidation of paid-labour relations. This would only be possible, however, with the support of international experts and the development of national expertise in the use of modern technologies and strategies (e.g., credit, agrochemicals, machinery etc) (Barksy 1984: 25).

Successive Ecuadorian governments took the CEPAL report as a starting point and recognized that the popularity of agrarian reform amongst peasants and intellectuals was a source of potential electoral support for its development policy. It was only in 1964, however, that an agrarian reform law was signed. This law aimed to eliminate the traditional feudal institutions and to expand the internal market to prepare the way for industrial development through "technological improvements" such as the introduction of pesticides, fertilizers, mechanization and "improved" seeds.

Interessement: defining "progress"

The stakeholders who were involved in the promotion of agrarian reform and technology transfer included Ecuadorian politicians and decision makers[10], farm workers, expert organizations, elite intellectuals, the Catholic

[10] President Galo Plaza Lasso (president from 1948 to 1952) was one of these decision-makers. As a hacienda owner he also represented a particular group of *hacendados* (hacienda owners) who have historically been seen as "progressive". Another decision-maker was Galo Plaza Lasso's vice-president. He was instrumental in the creation of the National Institute of Intellectual Groups, which consisted of a new generation of professionals that emerged from different schools of literature, as well as sociologists from the first school of sociology, which was founded by the Central University of Ecuador in 1914. The new sociologists were in charge of writing proposals for social policies related to *precaristas*. Writers began to publish books and daily newspaper articles on the *precaristas'* situation, which was relatively unknown in the cities (Costales and Costales 1971: 69).

Church and a group of hacienda owners regarded as "progressive." The modern artefacts promoted included pesticides, fertilizers, machinery and improved seeds[11].

"Progressive" *hacendados* (hacienda owners) commonly shifted to dairy or meat production, investing in various technologies such as mechanical milking and utilizing improved cattle breeds and grass seeds. These strategies lowered the demand for labour considerably and employment opportunities were consequently reduced on these haciendas, prompting labourers to start pressing for land in order to facilitate the survival of their own families. In order to alleviate the pressure for land from farm workers, "progressive" *hacendados* supported both the use of new technologies and the implementation of agrarian reform (Marchán 1986). By promoting agrarian reform "progressive" *hacendados* could determine, with relatively little opposition, which sections of land would be given to labourers and servants as well as the prices that would be paid for them. Some *hacendados* even assigned land to *wasipungueros* years before the agrarian reform law was approved. This attitude paved the way for agrarian reform to be viewed as a principle of social justice rather than as a communist measure (Costales and Costales 1971: 69). A former hacienda owner from this group in San Gabriel explains:

> Agrarian reform was needed in order to promote modernization because there were huge extensions of fallow land, and the pressure by the [*precarista*] population was increasing. It [agrarian reform] was mostly implemented in El Angel with the influence of the Church. Here [in San Gabriel] the haciendas were not as big as in other places, and the exploitation [of people] was not that strong because we had resources and the haciendas were producing well (Field notes 18 December 2003).

A farmer also describes this process

> The owner of the biggest hacienda here was Don Almeida, who was a senator, and we were sure that he would never accept the agrarian reform. In the 1960s the president, Rodríguez Lara, created articles 34 and 36 of the constitution. These articles stated that *montes* (highlands), rivers and *páramos* (wet highlands) belonged to the State. In our fight we referred to these articles and although the land was not given to us for free at least we could buy the land in the hillsides close to the *páramos*. (Field notes 16 June 2003).

[11] "Improved seeds" refers to new varieties resulting from a systematic selection made by researchers, usually combining native and introduced plant materials. As summarised in Pumisacho and Sherwood (2002:37) the process commonly involves: clones selection, hybridization, selection of parental lines and field-level breeding, followed by the release of a new variety.

Wasipungueros are the largest group of stakeholders represented in political and academic writing even though they constituted only one part of the *precarista* group. They used a piece of the hacienda's land –called *wasipungo*– in exchange for labour. It is often claimed that *wasipungueros* preferred to earn a salary instead of working in exchange for land. But according to the ethnographies of the time, *wasipungueros* generally demanded a salary in addition to land because they did not consider land alone to be sufficient compensation for their labour (Guerrero 1983: 120-122; Marchán 1986: 49). A farmer from San Francisco explains:

> In the hacienda time I only cared for money because my wife and I served a very rich hacienda owner who gave us food and the yearly "contribution" of grains, potatoes and guinea pigs commonly given to servants, but we needed money for other things that were only sold [i.e. available through commercial outlets in exchange for cash] (Field notes 14 June 2003).

New organizations of experts had to be created in order to implement the social, economic, technical and administrative aspects of the policies that modernized agriculture, including:

- The Ecuadorian Institute of Geography and Anthropology (IEAG), tasked with making descriptive and statistical analyses of the reality in the haciendas.
- The Rural Itinerant Cultural Extension Service (SAREG), representing formal education in rural areas.
- The Ecuadorian Institute of Agrarian reform (IERAG), in charge of land expropriation and distribution.
- The National Institute of Agricultural Research (INIAP), for the generation and adaptation of agricultural technology.
- The Ministry of Agriculture (MAG), for the promotion of INIAP based technology.
- The National Development Bank *(Banco Nacional de Fomento)*, for the provision of credit to facilitate the transition towards modern agriculture.

These institutes were linked to formal education at technical high schools and universities, which were created for the express purpose of the "formation of experts" and the development of "modern technology." The students of the first School of Sociology founded by the Central University of Ecuador in 1914 (Costales and Costales 1971), was the first group to write about the precarious living conditions of hacienda servants. The objective of the school was to initiate empirical research on the hacienda system and to contribute to the design of social policies that would improve productive relations on haciendas. A group of independent writers also followed this trend and wrote extensively in daily newspapers, magazines and books, pressing for better living conditions for the *precaristas*.

The faction of the Catholic Church that promoted liberation theology[12] was an important actor that supported the *precaristas,* not only in their opposition to the large landowners but in important matters such as education, organization, leadership and the promotion of ethnic pride and identity (Solo de Zaldívar 2008: 589). This gave *precarista organizations* the appearance of greater strength and gave their claims more exposure. Hacienda owners lost the historical support of the church at the same time. The Ecuadorian Episcopate finally approved the agrarian reform (Ibid: 81).

Synthetic pesticides, fertilizers, tractors and improved seed varieties were the representative artefacts of modernization and wealth. They were always associated with successful haciendas. A farmer from Mariscal, a community close to the Colombian border, explains his view:

> The first tractor that came here was the caterpillar… but only rich hacienda owners used it and they did not rent it to others. The same with fertilizers, sprayers and pesticides, we knew them from working on the haciendas but you needed to be rich and have contacts for bringing them illegally from Colombia where everything was more modern than here (Field notes 2 May 2005).

Enrolment by expert advice, loans and change of identities

Numerous national and international organizations (CEPAL, World Bank, etc.) urged the government to integrate Ecuador's economy with the international trade system at the time during which agrarian reform was approved. Pressure was applied, partly by offering loans and expert advice. Haciendas owned by *progressive hacendados* were used as examples of the "benefits" of agrarian reform and the utilization of new technologies. These haciendas became known as *agribusinesses.* Family farms were categorized as either subsistence operations or as entrepreneurial production units fully integrated into the market. The first national agricultural survey changed the name of family farms from *chakras* –the traditional name used in Kichwa–

[12] Liberation theology has its roots in dependency theory. The former was developed by ecclesiastical circles in the Catholic Church that argued that the church had an important role to play in changing the relationship of dependence of the 'poor' on the 'rich' through "a process of breaking away and liberation" (Boff and Boff 2010). Only this faction of the church supported land redistribution and the peasantry in the struggle for the land because the church itself was a big landowner (Solo de Zaldíbar 2008: 588)

to "Agricultural Production Units" (the Spanish acronym was UPA) (Sherwood 2009). The national expert organizations, INIAP and MAG, were in close contact with *progressive* haciendas. Technological research was coordinated with these haciendas. IEAG, SAREG and IERAG worked with ex-hacienda farm workers to demonstrate the state's interest in solving their problems. These organizations instructed farm workers about new forms of organization and production and set up agricultural technical high schools in various rural towns. A technician from one of these schools explains:

> I wanted to study medicine but my father pressed me to take over the farm, so I don't remember what he did, but I ended up studying agriculture. When I came back [from finishing university] my father respected everything I did on the farm, since he was so proud that I was an engineer. Even though we made a loss three years in a row growing potatoes due to the drought, and we lost the car (Field notes 22 January 2004).

The Banco Nacional de Fomento offered credit to those farmers who demonstrated entrepreneurship and were able to repay loans. According to the bank, the success of these farmers was directly related to the utilization of technology in order to increase production for the market (Barsky 1986). A farmer explains how some peasants experienced this policy:

> We thought we had become rich overnight because for the first time we had lots of money in our pockets; we even didn't know how to spend it, and of course we bought all the products that only the rich could buy before. And then…we realized that we were as indebted to the bank and to the government as we were before to the hacienda owners, and then we couldn't sleep well anymore. We did not understand what the deal was all about (Field notes 22 January 2004).

The faction of the Catholic Church that favoured agrarian reform was represented by bishops such as Monsignor Leonidas Proaño who, against the interests of many hacienda owners within the church, helped to organize the hacienda labourers around issues of literacy, housing and land claims" (Solo de Zaldívar 2008:588-9).

In sum, the *Enrolment* of different actors in the modernization project hinged on the purported "backwardness" and "injustice" of traditional systems, which by definition were not based on high-input technologies and paid labour. Bank loans that made the acquisition of agrochemicals and machinery possible were seen as an "obligatory passage point" for peasants and hacienda owners who wanted to become entrepreneurs. Name changes, such as "haciendas" to "agribusinesses" or "*chakras*" to "UPAS", signalled changes to the mechanisms of production.

Mobilization through encounters with the expert system

There were numerous conferences and meetings in which government representatives from Latin America set objectives for modernization and made commitments to eliminate “traditional” production relations. These meetings included the Indigenous Conference of Cuzco (*Congreso Indígena de Cuzco*) in 1947 that facilitated the formation of the Councils for Indigenous and Peasant Affairs (*Juntas de Cuestiones Indígenas y Campesinas*) (Costales and Costales 1971), and the meeting of the Inter-American Economic and Social Council of the Organization of American States. This resulted in the adoption of the “Alliance for Progress” Development Programme from the USA (Sherwood 2009).

Expert organizations such as INIAP and MAG were linked to universities in the United States. These universities granted scholarships to Ecuadorian professionals so that they could learn about and adopt new technologies. INIAP was in charge of producing “improved seeds” and “validating” the use of agrochemicals and agricultural machinery in coordination with the industries that imported these products. Research and promotion consisted mainly of developing standardized packages of “improved varieties” of pesticides, fertilizers and mechanization. The efficacy of these artefacts was proven in experimental stations and displayed to agricultural entrepreneurs in order to encourage their adoption. An effective package was defined as a specific combination of technologies that increased the production per area and reduced costs, particularly labour costs.

Large landowners commonly became the representatives of agrochemical industries and distributed agrochemicals in small towns. They began by importing agrochemicals and later began processing them as well.[13] A technician working for one company relates:

> When I started working for them [an agrochemical company] they impressed me; I never had to handle so much money in my life, and never had a car for myself [before]. They gave me all that because at first nobody wanted to buy their products or even take them for free, so I went to convince farmers and became the company’s best salesman for three years in a row (Field notes 22 May 2004).

[13] Ecuadorian companies, as intermediaries, bought the active ingredients of pesticides and fertilizers, and themselves created different pesticide formulations (e.g. powders, liquids, etc.) for the Ecuadorian market.

Translation: agrarian reform and "modern" technology

The diagnosis of the agrarian problem as one of "backwardness" and the consequent promotion of the modernization model by CEPAL and other organizations proved effective in enrolling important groups in Ecuador. Progressive hacienda owners (wanting to reduce the social pressure of *precaristas* for land and work) and successive Ecuadorian governments aligned themselves with this proposal, as agrarian reform was widely supported by the public. Public opinion had been influenced by decades of abundant written material that described and criticized the precarious living and working conditions of *precaristas*. All these circumstances resulted in the approval of agrarian reform in 1964 and the development of expert organizations to modernize the agricultural sector.

There were important interest groups, however, that were opposed to agrarian reform and technological measures. Yet, they were influential in the application of agrarian reform. Some of these groups included:

a) Hacienda owners who depended on the extensive use of labour. They were not interested in technological investments or in the elimination of feudal institutions such as the *wasipungo* system. Pro-agrarian reform actors labelled these hacienda owners as "traditional."

b) The *precaristas* who, though interested in access to land, were not a homogeneous group represented by *wasipungueros*. Most *precaristas* were not interested in abolishing non-commoditized relationships with the haciendas but instead were chiefly interested in receiving supplementary payments while maintaining access to grasslands, irrigation or other services that were associated with the hacienda system.

Once the IERAG representatives in charge of land expropriation and redistribution began to implement the reforms, "traditional" hacienda owners adopted multiple strategies to reduce their effectiveness. They became organized nationwide and pressured the government via the congress. This resulted in several policy shifts. These included:

a) The focus changed from agrarian reform to the colonization of remote or "abandoned" land, mainly in the Amazonian region.[14]

[14] Martínez mentions that between 1964 and 1981, 72.1 percent of the land distributed to peasants was assigned through colonization and only 27.9 percent through agrarian reform (CONADE 1982, cited in Martínez 1983:43).

b) Only a few wasipungos were assigned to precaristas, mostly in unproductive and highly vulnerable places such as mountain ridges or the fragile páramo (high wetlands).
c) It was accepted that the poor living conditions of precaristas would not be improved just by breaking up the hacienda. The solution was to provide them with new technology and expert assistance.

Precaristas who legally acquired their *wasipungos* lost the rights to other hacienda services and resources. These had been central to their livelihoods (for example access to grasslands, irrigation channels, etc.) and the result was a reduction in their quality of life (Marchán 1986). Some *precaristas* organized themselves into cooperatives with the help of opportunists in search of land or with socialists. IEAG and SAREG were eliminated from the government and only a restructured IERAG continued to operate after the agrarian reform law was modified. INIAP and MAG now became prominent, especially after production had significantly increased in some of the entrepreneurial haciendas, and the role of technology and agricultural experts in the modernization of agriculture was increasingly recognized by different sectors. Peasant farmers who had recently acquired marginal land, however, could not achieve the same yields and maintain their bank payments. The Banco Nacional de Fomento terminated its credit line to small landholders in most parts of the country (Barsky 1984).

The expert organizations were successful in creating a stable network of users for the standardized technological package they were promoting. New technology seemed a logical element of development when its introduction increased production on hacienda enterprises during the first decade after agrarian reform (1970s). Various governments invested in the import of technology and financed the expert organizations that were involved with technology. Agricultural practices that did not use modern technology, or that had not been fully integrated into markets, were dismissed as "backward." "traditional", "native" or "primitive". The assumption was that agriculture had to become "modern" for Ecuador to integrate into the international market.

The modernization policies had two main outcomes: 1) the transformation of the agrarian reform law, and, 2) the establishment of imported technologies as the favoured means of modernizing the agricultural sector. Agrarian reform initially had multiple proponents, representing different interests. They cooperated in order for the reforms to be signed into law by the Ecuadorian congress:

d) The US government considered agrarian reform as a strategy to reduce the pressure of social movements and discourage socialist or communist revolutions such as the one in Cuba.
e) Influential politicians in Ecuador saw agrarian reform as a way of reducing public pressure on feudal institutions.
f) Some politicians acted as representatives of a "progressive" group of hacienda owners who envisioned the haciendas becoming "enterprises" through the process of agrarian reform.
g) Expert organizations viewed themselves as facilitators and distributors of modern knowledge and technology.
h) *Precaristas* viewed agrarian reform as a means of safeguarding their land. Nonetheless they did not expect to lose the other benefits of their non-commoditized arrangements with the haciendas.

After agrarian reform became law, the differing interests of its various proponents became apparent. There proved to be no single strategy for implementing the reform measures. General approval of agrarian reform was an important goal of the government. It could not afford to exclude opponents of reform ("traditional" hacienda owners, other *precarista* groups, etc.). As a result most hacienda land could not be re-distributed, and technology was seen as a logical component of agricultural development. Even the opponents of agrarian reform recognized technology's immediate benefits and endorsed it as the modern way of farming. In contrast to agrarian reform, which had multiple opponents, the introduction of technology led to the creation of a more or less stable and convincing (*forceful*) network of policy promoters, importers, retailers, researchers, students and farmers, who sought access to "modern" artefacts and 'expert' advice. As a farmer says:

> When we first saw a carterpillar in the hacienda we all wished to have one or at least be able to rent one. We also wanted to send our children to technical schools because we did not know how to use pesticides and fertilizers (Field notes 14 May 2004).

The technology network that was formed can be explained by Law's description of relatively stable translation networks:

1. A relatively stable network is one "embodied in and performed by a range of durable materials (e.g., books, which tend to be more durable than speech and thoughts)" (Law 1992: 4).
2. It involves "materials and processes of communication that allow for acting at a distance and that create the possibility of transmitting "immutable mobiles" (e.g., letters of credit, military orders, etc.)" (Ibid).

3. The responses and reactions of the materials to be translated can be anticipated. "Innovations, under the appropriate relational circumstances therefore have important calculable consequences, which in turn increase network robustness" (Law 1992: 5).
4. It is possible to attribute generalized strategies of translation to networks, which then ramify and reproduce themselves in a range of network instances or locations (Ibid).

The proponents of modern technology could support their arguments by pointing to the benefits associated with durable materials such as tractors, pesticides, fertilizers and improved seeds. Modern technology was embodied in machines and artefacts. Networks could buy or sell them in remote places. It was predicted that these embodied technologies would boost production, and indeed their impact could be seen immediately at experimental stations and entrepreneurial haciendas. Technologies that performed as predicted were then "validated" Experiments did not take place on *wasipungos*, since the primary objective of technology was to transform haciendas into agribusinesses. Nonetheless, the networks of technology-users multiplied in various locations. In this case, all the strategies of translation worked in favour of the introduction of modern technology. Such strategies were generated though centre/periphery asymmetries and hierarchies based on the division between "modern" and "traditional" agriculture.

Law (1992) argues that the characteristics of the materials that embody a network are the result of interactions. The effects of materials thus change when they are located in a new network of relations (Law 1992: 4). Pesticides, for example, emerge as a representative artefact of "progress" when seen from the perspective of the network promoting the modernization of agriculture (agricultural research centres, universities and agrochemical dealers). But they are viewed as agrochemical compounds with different toxicity levels and impacts on human health by occupational health researchers.

The effects of modernization policy in Carchi

Haciendas traditionally produced potatoes for the market. Peasant farmers, on the other hand, planted potatoes mainly for their own consumption using so-called "traditional" technologies. As a farmer from San Francisco, a community formed mainly by ex-hacienda workers, explains:

> We did not just plant potatoes but also *mellocos, quinua, chochos, cebada, mashua,* [Andean grains and tubers] and many different varieties of each. The potatoes

> we planted in *wachu rozado* and the main tool was the *cute*[15]. We only used sheep manure mixed with cattle manure. Three persons planted potatoes: one made the holes; the other put in the potatoes and the last threw on the manure. We had *lancha* [late blight] but it was not a serious problem as we only planted 20 to 30 *quintals* each time. We did not know about the *gusano blanco* (Andean weevil) so we did not use pesticides. People who did not like to use much labour used oxen to prepare the land, to hill up, to weed and to harvest. The person with the best crop harvested 80 for 1 (80 quintals for each quintal of seed) but the normal was 60 for 1. We planted about 20 different varieties and sometimes they were all mixed up in the same field. People were more serious than [they are] now: once they had arranged a price they kept their word (Notes from a farmers' workshop, 20 November 2003).

Sherwood (2009) identified two ways in which land was distributed to *precaristas* in Carchi. One was through land purchased from "progressive" hacienda owners some decades before the onset of agrarian reform. Good relations between labourers and hacienda owners were the rule in this case. Farmers were assigned land near a central living area and an additional piece of land on a mountain ridge, which was distributed by lottery. The second form of land distribution was the purchase of land from the State during the period of agrarian reform. This process began when *precaristas* organized themselves into groups with the help of opportunistic leaders (who wanted to profit from selling the land distributed to them) and/or socialists, and invaded the hacienda land, usually in the mountain ridges. They clashed with the police who had protected the haciendas for many years. IERAC later expropriated land from hacienda owners and distributed it to *precaristas* by lottery. Many of the recipients (including the "opportunists") sold their land to their neighbours and relocated to the cities after agrarian reform. The farmers that remained were indebted to the State and thus felt compelled to produce for the market.

Increasingly, pesticides and fertilizers were imported for sale in rural areas. Agrochemical dealerships flourished in towns where production for markets was increasing and economic growth was evident. In exceptional cases, such as various towns in Carchi, the peasant farmers transformed a subsistence crop, such as potatoes, into a commercial product for Ecuadorian and Colombian consumer markets. Potato farmers from Carchi were also the only peasant farmers to receive credit from the Banco Nacional de Fomento after it had discontinued lines of credit to peasants in other provinces (Barsky 1984). According to the farmers this was due to technology "improvements" in Carchi:

---

[15] The *cute* is a plain wooden tool which sometimes has a metal point to cut into the earth.

> Since we had to pay for the land and what we had purchased on credit we needed to speed up the production, and potatoes fetched a higher price than other products. We started planting 50 to 100 quintals per family. So the potato planting system changed to full tillage, for which we usually rented a tractor that saved a full week of working with labourers. We also changed the "cute" for the hoe and when we sold the potatoes we brought chemical fertilizer from Colombia.
>
> The salespeople in the agrochemicals shop advised us to use more or less one quintal [of fertilizer] per 10 quintals of potato seed; that is, one tablespoon per potato plant. At first we applied fertilizer at any time [in the crop cycle] because we did not know that there were specific times when the plant needed more. *Lancha* [late blight] became a problem and according to the advice from the salespeople we started spraying Manzate Dupont [brand name for the active ingredient of the fungicide Manzate] two or three times in one cycle. By that time we were preparing the mixtures in cooking pots and spraying it with bush branches because the few people who could afford to buy a pump did not want to rent it out to others because it was almost impossible to get them fixed once they were broken. We had not yet heard of the *gusano blanco* [Andean weevil]. We planted about ten potato varieties that had a good price; the most common were the *curipamba* and *martina*, which easily produced 60 and 70 [quintals of potato] for one [quintal of seed]. With these improvements the production remained high for about five to 10 years and the prices were good (Notes from a farmers' workshop 15th September 2003).

During the 1970s, most farmers from Carchi maintained high levels of production per unit area and increased the total area cultivated by utilizing mechanized or semi-mechanized land preparation techniques. Tractors were usually rented from wealthier people in the main towns or from farmers who had earned enough money in potato production to purchase one themselves. Agrochemicals were often sold in their original packaging, but they were also often divided and repackaged in plastic bags or bottles. Improved seeds were provided by INIAP and MAG, but peasant farmers usually complained that these organizations only made such seed available to big landowners.

The peasant production system became one of simple rotation in most municipalities[16] in Carchi: potato-potato-pasture. Men generally managed the revenue derived from the potato crop, while the women's source of daily income tended to come from dairy cattle. Potatoes usually gave higher returns but required more capital due to the increasing agrochemical

[16] Ecuador is politically organized by provinces and cantones, the later of wich is roughly equivalent to a municipality in American and Dutch/European political systems.

requirement per unit area. Although traditional arrangements (meaning non-commoditized relations) were central to the success of potato production for the market, such arrangements became less common, especially those arrangements related to labour contracts. Traditional fertilization systems using animal manure practically disappeared as most farmers had to sell their animals in order to make their first payment on the land. Planting systems based on minimum tillage (such as *wachu rozado*) became largely confined to those hillside areas inaccessible to tractors. Potato varieties were selected for their market price and popularity. The change from "traditional" to "modern" farming encouraged the rise of a style of farming locally referred to as the *Arriesgados* (risk takers) or *paperos puros* (pure potato farmers –usually a self-styled term) (Paredes 2001; Sherwood 2009). A farmer who considers himself a *papero puro* explains this process:

> My father used to plant up to 100 quintals of potato, but I started renting land and planting up to 500 quintals at once. He planted potatoes to maintain the family, but I planted to earn money, though sometimes I had to sell everything to pay my debts and my wife has threatened to leave me many times. Planting potatoes became a drug for me: once I had planted, it all depended on my luck. I made big investments in fertilizers: initially I used one quintal of fertilizer for three quintals of seed, and now I use one for one. In the years since I started [growing potatoes] not only has the *gusano blanco* [Andean weevil] become a problem but [now there are] also the flies and bugs so that first I applied [pesticide] three times [in one growing cycle] and then I increased this to five times, and now sometimes I apply 12 times per cycle, not including three or four soil disinfections (Field notes 22 January 2004).

Sherwood (2009) describes how this trend of production in Carchi drove farmers to what he calls the "production of decline." In the 1980s, potato production per unit area started to decrease (from 40 quintals of potatoes per quintal of seed to 20-30 quintals per quintal of seed) and the variation in prices increased. During the 1990s, production per unit area decreased further (to less than 20 quintals per quintal of seed) and prices fluctuated by as much as 500 percent. In addition, soil erosion was found to be taking place at an annual rate of one ton per hectare. Various organisms became pests after years of potato mono cropping. Only four varieties of potato were marketable in the main cities (Sherwood 2009). Farmers described different elements of this process during a workshop:

> *Lancha* [late blight] started to have a significant effect some 40 years ago. The *gusano blanco* [Andean weevil] borer only appeared 30 years ago, and people said that it was because the soils were tired. Then farmers started to cut down the forest because it was still possible to achieve good rates of production on land that had just been deforested. Three years ago the potato tuber moth

> appeared. It came in the seed from Colombia and it is impossible to control it in dry areas; it does not matter what poison [pesticide] you apply to them.
>
> Before, we were depressed because there was too much rain, and now we lack water in our crops because the weather has changed. Then we have to apply [agrochemicals] for *lancha*, for the leaf miner [*Epitrix* sp.], for *gusano blanco*, for *desarrollo* [growing], for *engrose* [tuber formation], for flowering[17]. We don't want to know how much we have invested in each field anymore. We do all this only to get 15 to maximum 20 quintals per quintal of seed, and some farmers only get seven or eight for one.
>
> Many times when we achieve the maximum [yield] we lose out because of the low price. Prices vary as much as the middlemen want: you get one price in Ibarra, another in Quito, and you never know which will be the best tomorrow. Eventually we ended up growing just two or three varieties because they were sellable in the markets. The most important variety was "chola," and later it was "improved" by INIAP and became the "super chola,"[18] but still we never get the high yields we had before, while we are indebted to the bank or to the *chulqueros*[19] (Notes from a farmers' workshop, 20th November 2003).

The policies of "structural adjustment" that the International Monetary Fund pressurized Ecuador to adopt, and which resulted in Latin American countries reducing public investment, further added to the difficulties experienced by farmers. As a result, the Ministry of Agriculture was transformed into a regulatory organization, and public funds for research in INIAP were reduced considerably (Sherwood 2009). The National Development Bank finally terminated all credit lines in Carchi. In the late 1990s and early 2000s the potato system in Carchi was in crisis, mainly due to inflation and the dramatic devaluation of the *Sucre*, the national currency, and the subsequent shift to the US dollar in 2000. The dollarization of the economy resulted in inflated input and labour costs since the attainment of parity with the external dollar required a very substantial increase in domestic prices. Domestic prices rose 96.1 percent in 2000, and continued to rise in 2001 (Beckerman and Cortés-Douglas 2002: 102). As a result, potato prices increased during 2000 and 2002 (Sherwood 2009: 105), which made potatoes from Ecuador expensive relative to those from other countries. Potatoes were imported into Ecuador from Peru and Colombia where rates for labour and inputs were cheaper. Agrochemical prices rose

---

[17] Growing, tuber formation and flowering are the different crop stages, and some farmers feel that foliar fertilizers should be applied at each of these stages.

[18] *Super Chola* was actually a locally bred variety, that was subsequently "cleaned-up" and nationally distributed by INIAP (Pumisacho and Sherwood, 2002).

[19] *Chulqueros* are local informal moneylenders who charge very high (and illegal) interest rates.

and producer profits dropped below the cost of production for longer periods than ever before.[20] A farmer who stopped producing potatoes in the community of San Francisco describes this period as follows:

> After dollarization we were out of business for many years, and some of us still are. The problem is that the government allowed potato imports from Colombia and Peru because they were cheaper, and it was a convenient measure for the crisis in the cities, but then we were completely ruined. Many people left the potatoes where they were in the fields because the prices were so low that we could not even pay the labourers to harvest them, and some other people paid the labourers with quintals of potatoes instead of money. It was a very hard period and many families sent a son or a daughter to work in Spain. That was the last thing we wanted to happen to our children (Notes from a farmers' workshop, 20th November 2003).

Several studies of the impact of pesticides on human health in Carchi (Crissman *et al.* 1998) showed that potato production was still profitable even though the use of modern pesticides was undermining the overall contribution of this crop to the livelihood of peasants. It had long been known, from passive medical surveillance, that Carchi had the highest reported rates of pesticide toxicity in the country[21] (Carpio 1990), but later research based on active medical surveillance confirmed an even higher rate than previously reported[22] (Crissman *et al.* 1998).

A plea for the banning of highly toxic pesticides – counter translation

In 1998, a group of researchers from the International Potato Center in Ecuador, concerned about the adverse effects of the pesticides used in potato production, initiated a project to train farmers to reduce their use of pesticides. The project had the additional aim of raising public awareness and concern. Its long-term goal was to get highly toxic pesticides banned. The following sections present this process as a form of translation.

Problematization: The adverse effects of pesticides on human health

Researchers have framed the problem as follows: pesticides are of central importance to the potato production system which has developed in Carchi, but according to research published in 1998 the negative impacts of pesticide use on family health make their overall contribution questionable

---

[20] Sherwood (2009) notes that between 1995 and 2004 relative potato prices increased with inflation for wholesalers and consumers, but real prices for producers dropped by about 30 percent (Sherwood 2009: 105)

[21] This refers to medical surveillance of intoxication in the national public health sites.

[22] This refers to medical surveillance of intoxications in the communities studied.

(Crissman *et al.* 1998: 12; Cole *et al.* 1998a: 229). Pesticide toxicity has a significant economic impact on families. Each case of acute poisoning costs an average of $18 in medical bills and lost work time, which is financially equivalent to the value of about six working days. Furthermore, most farmers experience chronic dermatitis and effects on the nervous system, which together reduce their work capacity and long-term decision making abilities (Crissman *et al.* 1998).

Carchi has a higher rate of pesticide poisoning, as reported through active medical surveillance (171 cases per 100,000 head of population) (Ibid), than any other province in Ecuador. Several studies show that exposure to pesticides such as dithiocarbamates, carbamates, and organophosphates have measurable effects in terms of peripheral nerve functioning and skin diseases (Cole *et al.* 1997b and 1998a). All of the abovementioned pesticides are regularly used in potato production in Carchi. Farmers applying pesticides experience chronic exposure to these chemicals. Their families also suffer exposure, although to a lesser extent. Mera-Orcés (2000) found that the most common cases of pesticide-related toxicity in a Carchi regional hospital were those of small children under five. The second most common cause of death for women and men in the same area was pesticide toxicity. Other studies (Espinosa *et al.* 2000) show that the conditions under which peasants farm in Carchi make it difficult to handle highly toxic pesticides safely. There are numerous contamination pathways in the farmers' homes. Pesticides are often stored inside the home, for example, or in animal corrals for safekeeping (Paredes 2001).

An analysis of the trade-off between productivity and the impact of pesticides on health found that policies designed to limit the use of pesticides through taxation would result in a reduction in the area cultivated and an overall decrease in yield. The higher input prices combined with the reduced employment opportunities would have a double impact on the poorer sections of the population. An alternative policy would be to substitute less toxic products for more toxic ones while implementing Integrated Pest Management (IPM) and programmes to educate farmers about the safe use of pesticides (Crissman *et al.* 1998a). The obligatory passage point of this *problematization*, as the researchers framed it, was a farmer-training programme and the development of a strategy to promote a ban on the use of highly toxic pesticides, especially carbofuran and metamidofos, which together accounted for 90 percent of the insecticides applied in Carchi (CIP 2000).

<u>Interessement: The intervention</u>

In 1999, a group of researchers from CIP, in collaboration with the National Agricultural Research Institute (INIAP), initiated the Ecosalud[23] Project with the general objective of "improving the health and well-being of rural people through pesticide monitoring and the promotion of Integrated Crop Management (ICM)" (CIP 2000). The project involved three rural communities in Carchi: San Francisco de La Libertad, Santa Martha de Cuba and San Pedro de Piartal. The training programme was based on the methodology of Farmer Field Schools (FFS), defined as:

> A field-based learning experience for a group of about 25 farmers; it lasts for a full cropping season with sequential weekly or bi-weekly meetings of approximately four to five hours. Each meeting consists of a set pattern of activities: agroecosystem field observation, analysis, and presentations; special topics; and group dynamics (Gallagher 1999).

The Ecosalud project proposed to reduce the number of pesticide applications, by either replacing the highly toxic pesticides (principally carbofuran, metamidophos and mancozeb) with less toxic products, or by introducing techniques that utilized no chemicals at all. It was hoped that farmers, extension officers and researchers would reinforce the support for the banning of the toxic products once they had gained experience of these new products and techniques.

The project leader was the head of the FFS at CIP (referred to in this thesis as the CIP representative). He coordinated the CIP research team and international collaborators (University of Toronto, Wageningen University) during the collection of agricultural, health and environmental data, both before and after the farmers were trained. He enrolled the head of an IPM programme from INIAP (referred to in this thesis as the INIAP representative) to assist with the project. Both the CIP and the INIAP representatives worked in the research station of the International Potato Centre in Quito and coordinated their activities with a team based in Carchi, sharing resources such as transport, personnel, expertise and finances.

The Ecosalud team consisted of an agronomist from INIAP who was in charge of implementing the Farmer Field Schools [24](FFS) programme, a

[23] Ecosalud would be translated as "Ecohealth" in English. The name implies that the focus of the International Development Research Centre from Canada (IDRC, the main donor for this project) is research and development related to ecology and health.

[24] Farmer Field Schools are an approach developed by the Food and Agriculture Organization of the United Nations in order to help farmers learn about IPM through practical involvement over the course of a full crop cycle (Pumisacho and Sherwood 2005,

nurse contracted by CIP to collect data on health, and a gender specialist who was both the project administrator and in charge of working with women and children. This team set up FFS in three communities in the province of Carchi. The communities were selected on the basis of the levels of interest they showed during initial meetings. Each group of farmers chose a council of representatives who would coordinate the training and any other public activities that required group representation. Contacts were made later with the primary schools of each community and with representatives of the public health system in order to inform health workers, teachers, and children and their parents about the effects of pesticides on the health of farmers and their families.

The Ecosalud team focussed its efforts on training community members without having a written strategy that would have helped them identify the mechanisms to enable field interventions to lead to policy changes. The roles of the actors at this stage of the project were not clearly defined.

Enrolment and Farmer Field Schools

FFS methodology promotes an innovative way to utilize the expertise of technicians, researchers and farmers. Farmers are actively involved in designing training curricula so that only material relevant to them is included in the training programmes. Once a week, farmers meet as a group in a communal field to work on cultivating potatoes. They work together for the duration of a complete cropping cycle, from planting through harvesting and marketing. The field is divided into a "conventional" section (where farmers use common practices) and an "IPM" field (where farmers implement the IPM practices recommended by the technicians).

Alongside these two main fields are four or five smaller fields in which farmers experiment with ideas they consider relevant (usually they try new potato varieties or defoliation experiments). Once the initial work required on the crops is completed,[25] farmers monitor the different fields, counting insects and observing pest and disease attacks. They work in groups and record their observations in notebooks. Each group of farmers then presents their findings to the other groups, comparing the "conventional" and the "IPM" fields. The groups as a whole discuss the implications of the findings and possible strategies and decisions regarding pest control. A special study theme relevant to the curriculum is chosen for each meeting.

Sherwood *et al.* 2000)

[25] Different tasks have to be performed every week according to the development of the crop (weeding, hilling-up, fertilizing, etc.).

Several social problems emerged during the first cycle of FFS. About 30 to 40 farmers attended the first meetings, but the numbers had declined to ten or twelve by the end of the training cycle. Farmers were reluctant to pool investments and work together on a potato field. Socio-economic disparities caused difficulties when financial investments had to be made.

The FFS produced interesting results despite these problems. It emerged that the techniques employed on the IPM fields had the potential to reduce costs while maintaining production. Unfortunately, a severe drop in the market price of potatoes at the time the FFS fields were harvested meant that many farmers lost the motivation to continue experimenting with IPM. Although many farmers found the FFS training interesting, most preferred the short and concise recommendations of pesticide sellers that continuously visited them. The communities or families of the farmers who attended FFS training criticized them for wasting time. In addition, the pesticide companies organized social gatherings (such as parties, sporting events or brief demonstrations) and provided pesticides or pesticide application equipment as prizes during the event.

Two cycles of FFS training were implemented in three communities over the course of two years (1999-2000). At the end of these two cycles, the Ecosalud project team organized public presentations of the research results that were relevant to health in different locations in the province of Carchi. FFS trained farmers were asked to present their findings regarding the practices and technologies with which they had become familiar. These presentations were enhanced by the inclusion of power point displays, videos of pesticide tracers[26], photographs, role-plays and field visits. The objective of these presentations was to raise public awareness and concern and thus to put pressure for getting highly toxic pesticides banned.

A documentary about the use of pesticides in Carchi was shown on national television. This influenced urban audiences to support the banning of certain pesticides. This video was not always well received by the farmers themselves, however, as they did not like to be portrayed as "irrational users of pesticides."

While most urban audiences were convinced of the dangers of highly toxic products, few farmers believed what the FFS graduates said about the

[26] The pesticide tracer was a specific chemical that could be identified under UV light and was included in the pesticide mixture that farmers were spraying. The pesticide contamination pathways were traced after the application process. UV light could harmlessly detect traces of the pesticide on human bodies and on buildings, furniture, cooking implements etc.

feasibility of reducing the use of pesticides. Farmers did not accept that pesticides could be replaced by simple technologies such as the use of cardboard traps[27] to control the Andean weevil. A FFS graduate remarked:

> Here we [farmers] are accustomed to hear things with words that we don't understand – [and] then we think that the person that talks is highly qualified. When people see us [Farmer Field School graduates] they even leave the room because they don't believe that we could have found something better than pesticides. Moreover, why would they want to change when the highly toxics (sic) are also highly cheap? (Field notes 23 January 2004).

In 2001, the CIP representative organized a national conference in Quito, in coordination with the research team and the INIAP representative, to present the research findings and the FFS results. Representatives were invited from the following organizations:

1. Political and public health organizations from Carchi
2. The Ecuadorian Service for Agricultural Safety (SESA)
3. The Ministry of Agriculture (MAG)
4. The Ministry of Health (MSP)
5. The Ecuadorian representatives of CropLife Ecuador. (A subsidiary of CropLife International, a worldwide network of agrochemical companies that manufacture and commercialize agrochemical and biotechnology products and services in 91 countries (http://www.croplifela.org 2010)
6. Various media representatives

The representative from SESA failed to attend. The Ministry of Agriculture sent someone less influential than the minister. The only government department that was properly represented was the Ministry of Health. By contrast, CropLife representatives from Latin America, based in Miami, actually asked to be invited.

The presentations utilized videos, power point displays and photographs. The research results were presented by the international team members while the benefits of the IPM technologies were outlined by FFS graduates. After the meeting representatives from CropLife Latin America approached the CIP research team and offered to collaborate with them on reducing the negative impact of pesticides. They also offered to provide funding for FFS.

---

[27] Although the use of cardboard traps has been promoted together with insecticidal spot application onto the foliage of trap plants, this farmer as well as a few others did not use insecticides in trapping. Instead, he took home the captured adult beetles for feeding his chicken. Other variants in the use of Andean weevil traps are explained in Paredes (2001).

The extent of translation: Sales of highly toxic pesticides increased.

The framing of the problem (*problematization*) of the effects of pesticides on human health and the need for farmer training and for the banning of the more toxic pesticides resulted in the collaboration of various actors in a number of projects. Researchers, technicians and some farmers were involved. However, many of those who participated did so for short-term benefit such as access to resources for research and access to new potato seeds. While the FFS were effective in bringing together actors with different concerns, not many of these actors actually supported the idea of banning highly toxic pesticides. I describe how the different actors influenced the outcomes of this intervention in the following section.

Farmers

Many farmers who participated in FFS were motivated to continue doing research on their own land after the completion of their FFS studies. Some went so far as to finance their own FFS in their communities[28]. Nevertheless, the methodology was not of interest to most farmers in Carchi since it was too much at odds with the well-established system of quick and easy recommendations by technicians. Farmers also questioned why INIAP extensionists were now talking against the same pesticides that they had actively encouraged a few decades before. As one farmer put it:

> I don't believe it is possible to produce potatoes without carbofuran. It was possible before, when our grandparents did not grow large areas [of potatoes] but now, impossible! We would lose the entire harvest. I don't understand why technicians contradict themselves (Notes from a farmers' workshop 20 November 2003).

Moreover, some farmers became FFS facilitators. However, several people refused to participate in these FFS because they did not accept that a fellow farmer was qualified to teach them. For example, one disgruntled farmer argued: "How could they [the farmer FFS trainers] know more than the rest of us?" Farmers felt that those who sold pesticides were usually technicians who had been to university and understood the latest technological advances, especially those related to agrochemicals. A woman farmer told

[28] Farmers financed new Farmer Field Schools by contributing land, seed and time. A part of the harvest was given to the farmer trainer as payment. Farmers were trained as trainers in a Training of Trainers course organized by CIP and INIAP. These farmers were usually drawn from among those who performed best in the initial Farmer Field Schools or who were inspired to become facilitators. The farmers who organized new groups for training in their communities were supported with information and visits from INIAP technicians.

me: "If *you* tell me that I should apply a given product [pesticide] in this field, I will try to do it right away." I asked her why and she said: "Because I know that you come from Quito and that you have studied."

Farmers who were trained in FFS were thus not really representative of the farming community in Carchi as a whole. Those who participated in the FFS belonged to a specific group who practiced a particular style of farming: These farmers referred to themselves as *seguros* (those who practised "safe farming"), as opposed to the more widely practised *Arriesgado* ("risk-taking") style of farming. *Seguros* had not completely commoditized their production relations and usually tried to reduce monetary investments in agrochemicals (Paredes 2001).

CropLife and INIAP representatives

The CropLife representatives from Miami asked the researchers from CIP and INIAP if they could visit Carchi. The request was accepted in the hope of exposing the CropLife representatives to public opinion in Carchi. The researchers from CIP and INIAP then organized a meeting at the INIAP office, with the participation of farmer representatives, consumers and politicians. Various participants requested that the CropLife representatives take action to reduce pesticide poisonings in the province. As a result, CropLife offered to finance a new cycle of FFS coordinated by INIAP. However, the INIAP team leader from Carchi was concerned that CropLife would co-opt the work of INIAP and consequently turned down the CropLife proposal. Nonetheless, a few months after the flow of funds for the Ecosalud project had ended, the INIAP representative in Quito began to work with CropLife in order to secure continued financing.

Researchers from the Ecosalud project

The team of researchers from Ecosalud did not manage to influence policy in a way that led to the banning of highly toxic pesticides. They recognized, therefore, that there was a need to reach a wider target group than the one they had with the Ecosalud project. It was particularly important to influence a group that could put pressure on the government (the ministries of health and agriculture, the congress, etc.). This led the researchers to decide that the outcomes of the FFS training and the associated research results should be used to inform the wider population, including residents of cities such as Quito, about the dangers of highly toxic pesticides. This objective was not part of the original Ecosalud project (Sherwood 2009).

Limitations and consequences of the translation

Research findings did not lead directly to the adoption of new policies. Moreover, a range of different issues arose and evolved as follows:

1) CropLife had been financing part of the work of SESA, the pesticide regulating body of the State that was supposed to represent public interests rather than those of private companies. Such financial linkage was legitimate because the Ecuadorian Government demanded the co-financing of its activities by private sector parties with vested interests[29].
2) The FFS coordinated by INIAP and financed by CropLife transformed the curricula to emphasize training on the Safe Use of Pesticides (SUP). It later extended this into a programme to train school children in the safe use of carbofuran (a highly toxic pesticide).
3) Three years after the National Conference organized by the CIP representative in Quito, with the objective of urging the government to ban highly toxic pesticides, carbofuran sales in Carchi had doubled. This was because the companies importing this pesticide had managed to keep their prices below those of less toxic alternatives.
4) In two municipalitiess in Carchi the environmental units[30]in charge of regulating pesticide use at local level (and representing public interest before private companies) were partly financed by CropLife; and
5) The only county to have formulated a local decree prohibiting the sales of highly toxic pesticide had insufficient funds to practically apply it.

It was clear that CropLife was using the information gathered through the FFS to formulate strategies to *prevent* the banning of highly toxic pesticides and promote SUP[31]. Once CropLife had implemented their first FFS, these training programmes were presented to local governments and the public as CropLife's contribution to solving the problem of pesticide toxicity. The team of researchers focused, therefore, on trying to disengage CropLife from their research and training activities.

---

[29] This way of working with the industry has been common in other parts of the world (e.g. IFAD and CropLife 2001).

[30] Since the Ministry of the Environment de-centralized its activities, each county municipality in Carchi had an "environmental unit," which was in charge of controlling the activities that affected the natural environment in each county.

[31] Ecosalud researchers found that many years of training courses run about SUP by the pesticide industry in Carchi did not prevent pesticide toxicity. Rather the frequency of toxicity was increasing.

The sociotechnical regime and black boxing of pesticides

I now turn to an analysis of the structural effects of the modernization networks mentioned by Callon (1995: 59), including:

1) *Irreversibility:* The consolidation of the network so that further translations are foreseeable and inevitable, leading to a development that ultimately follows "a perfectly determined sociotechnical path that progressively reduces the room for manoeuvre of the *actants* involved."[32]
2) *Lengthening* through "black-boxing": The number of diverse *actants* that the network enrols. "In [black boxes]…entire chains of translation are folded up and embodied in sentences, technical devices, substances or skills. They contribute to the production of ever more statements, themselves doomed to pursue their existence silently in the bodies or machines that ensure the enterprise's continuity."
3) *Variety*: The presence of diverse and disconnected networks. "When networks are strongly interconnected to form a system, the level of diversity is low."

In the case of Carchi, modernization as the promotion of "modern" technologies reached a level of irreversibility. This occurred once stable sociotechnical networks (of human and material elements) had formed. These networks enrolled numerous and diverse *actants*. Most organizations and individuals believed unquestioningly that technical devices such as pesticides, fertilizers, machines or crop varieties embodied "modernization". The belief was that modernization did not need to be explained but could simply be 'achieved' through the use of "modern" artefacts.

As Hamilton (to appear: 10) argues, phenomena involving pesticides illustrate that, powerful processes of selecting and classifying technologies as "modern" (while other options were considered "backward") determine what is accepted as genuine "technology." This privileges certain practices and de-values others. Technical devices, such as pesticide use in the sociotechnical networks of Carchi, can be described in terms of the properties mentioned by Law (1992) as durable, mobile and representative of the entire network. Farmers do not fully understand the mechanisms by which pesticides control pests and diseases or affect human health, but most farmers do not see this as a problem since pesticides are effective. The

[32] Theorists of *translation analysis*, such as Michel Callon, Bruno Latour and John Law, propose that researchers apply the principle of *free association* to their analyses. This involves "the abandonment of all *a priori* distinctions between the natural and the social" (Callon 1986: 196-9). This is expressed by their replacement of the notion of 'actor' (used for humans) by that of the *actant*: 'any entity endowed with ability to act' (Callon 1995: 53).

stage when the use of technology is no longer questioned is also called "black boxing" (Callon 1995). In the context of Carchi, many actors such as technicians and farmers consider black boxing to be an inevitable and reassuring aspect of modern technology. They also trust the researchers and professionals who appear to understand such technology. A farmer who participated in a workshop explained his view:

> When we saw that the insects were dead immediately after pesticide application, we did not know how it had happened, but it was like a God's blessing for us… If a pesticide does not work properly it is usually because it has gone out of date or because we don't know how to use it in the right way, but pesticides mostly work. How could so many years of research and studies not work? (Notes from a farmers' workshop, November 20, 2003).

Many farmers come to regard the use of sophisticated and "black box" technologies as their right. As one farmer said:

> It is not like in the times of the hacienda when only the hacienda owners had access to tractors, sprayer pumps or pesticides. When we visit indigenous towns we remember those times of oppression: see, they don't have any rights, even the pesticide sellers do not visit them, though they come here (Notes from a farmers' workshop 20 November 2003).

While the effectiveness of pesticides for killing insects is clear to most farmers, the adverse effects of these technologies on human health are more difficult to recognize. The need for alternative technologies, therefore, is not a priority for most farmers:

> By using pesticides farmers don't lose an arm or a leg, thus they don't see the effects as clear in their own health (sic) (Ecosalud Nurse, in a BBC interview).

> Farmers are accustomed to seeing that the insects fall dead right after pesticide applications, so other technologies [which do not kill the insects] don't seem to them to be as effective (Television interview with head of INIAP-Carchi).

Modernization policies promoting technological imports in the 1960s created strongly interconnected networks. These networks lacked diversity in terms of the different approaches to production. They largely excluded approaches such as agro-ecology, organic production and production for niche markets. The "modern" prevailed. "Traditional" sociotechnical paths were discontinued and are very difficult to re-establish. Their recovery would require strong efforts to build completely different sociotechnical networks with relevant expertise, technical devices and guidelines for ecological practices. When I asked farmers in a workshop why animal manure was no longer used, even in combination with chemical fertilizers, most remained silent. But one farmer spoke up:

> We can use manure, but no one here would dare to do that, at least not in daylight. People in the community would call him "backward," "stingy," or would just make comments about him in meetings and at parties (Notes from a farmers' workshop 20 November 2003).

These attitudes result in farming following an increasingly defined pathway. The dominant policies, markets, agricultural research institutions and educational systems in Carchi all promote a sociotechnical pathway. The interconnected networks that produce pre-defined pathways in agriculture (with little room for manoeuvrability) have been conceptualized as a sociotechnical regime (van der Ploeg 2003).

It is important to note that an apparently stable translation, in this case the formation of stable and interconnected pesticide networks, can also erode (Callon and Law 1997). An example of such erosion would be the recent increase in the variety of networks other than those promoted by modernization. The researchers from CIP, presented in this chapter, are part of networks that associate pesticides with negative effects on human health, rather than considering them as representative artefacts of 'progress'.

<u>Heterogeneity among farmers</u>

Although the sociotechnical regime in Carchi has been successful in advancing pesticide use, researchers from CIP found that farmers were not using agrochemicals in a standardized way (Crissman *et al.* 1998, Yanggen *et al.* 2003a). Figure 2.1 shows the application pattern of fungicides and Figure 2.2 presents the application pattern of carbofuran. These graphs show that the total number of applications varied from three to 11 for mancoceb and from one to 10 for carbofuran.

The findings suggest that the adverse effects of pesticides on human health are widespread. They affect both the applicators (farmers and their labourers) and their families, despite the fact that women and children are not usually involved in the application of pesticides in Carchi (Mera-Orcés 2000, Paredes 2001). Figure 2.3 presents the results of research done by Mera-Orcés (2000) on the number of patients suffering from conditions related to pesticide toxicity who visited a local hospital in Carchi. The results are differentiated by gender and age. They show that peasant farmers using pesticides suffer adverse health effects in heterogeneous ways despite sharing similar production conditions and despite the fact that technical recommendations regarding pesticide applications and safety measures tend to be homogeneous (see for instance Vademécum Agrícola Ecuador 2004).

Heterogeneity is a recognized feature of peasant farming. Many development workers who are influenced by notions of modernization consider it to be a feature that restricts development (van der Ploeg 1989, 2003). Research suggests that peasant farmers in Carchi are no exception when it comes to the diversity of application practice. In the rest of this thesis I will focus on the various dimensions of peasant differentiation in Carchi as a way to understand agricultural development patterns in the context of the modernization regime in Ecuador. In the process, I will take into account the evidence that peasant farmers have heterogeneous goals. These vary according to their material resources (land size and capital) and also in relation to their social needs and cultural values.

Figure 2.1. Seasonal fungicide applications in Carchi (n=320 fields)*

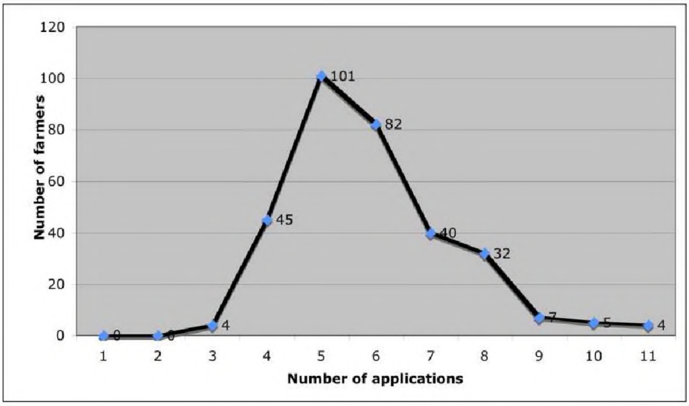
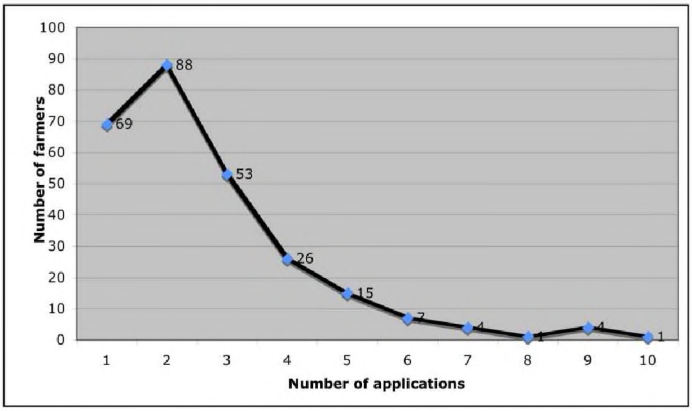
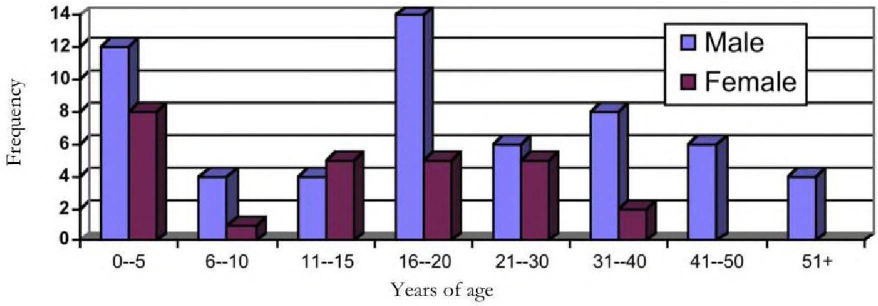


Figure 2.2. Carbofuran applications in Carchi (n=320 fields)*



*Source: adapted from Crissman *et al.* 1998: 115

Figure 2.3. Number of hospitalizations due to pesticide poisoning (by age and gender) between 1997 and 1999 in San Gabriel (active vigilance)



Source: Mera-Orcés 2000

Conclusions

In this chapter I used translation analysis to examine: 1) the positioning of agricultural modernization as a policy for social progress, and 2) the resulting controversy about the adverse effects of pesticides on human health in Carchi and the attempts of a group of researchers to lobby for a national policy that would result in the banning of highly toxic products.

The promoters of agricultural modernization in Ecuador presented the hacienda system as an obstacle to agricultural development. Agrarian reform was proposed as a way of achieving a better situation for the *precaristas*. The dominant discourse that emerged tended to represent the "powerful" haciendas and the "oppressed" *precaristas* as homogenous groups. A number of national actors in Ecuador took advantage of the increasing popularity of this view and succeeded in establishing modernization policies. These policies failed, however, to take into account the fact that national actors were diverse and that the relations between them were complex. Both commoditized and non-commoditized arrangements of production prevailed between the haciendas and some *precaristas*, for example. Ultimately some actors who had been marginalized from the policy-making process managed to change the central tenets of the agrarian reform law.

Similar to Peru (Long 2004, Mayer 2009), in Ecuador there was a fundamental difference between the stated intentions of the reform and what was ultimately achieved. In practice, the agrarian reform law in Ecuador led to the colonization of unoccupied land, while the modernization of agriculture primarily entailed the import of technology and skills and the establishment of institutions based on western notions of progress. It became apparent that "the State cannot prevent social actors transforming and translating land reform policies in ways different from how they were planned and designed by its institutions and experts" (Hebinck 2008: 34). This study, however, also presents evidence suggesting that access to land was a prerequisite for farmers to shift to new activities such as potato production for the markets, and that agrarian reform was an important way in which *precaristas* gained access to land.

The promotion of pesticides in agricultural production has increased over the last few decades as a result of the growing influence of interconnected networks. Research conducted by the International Potato Center reveals that almost all peasant farmers in Carchi use pesticides in potato production, but very few farmers apply them in standardized ways. The heterogeneous pattern of pesticide application implies that farmers are not passive recipients of the knowledge and technology prescribed to them by experts. This heterogeneity is of central interest to this thesis, and in the next chapter I develop a framework outlining the need to consider policy not just 'from above' (i.e. the stated intentions of policy) but also 'from below' (actions and practices initiated on the ground by peasant families) (Hebinck 2008: 41). The struggles of policy processes presented here form part of the historical context of this study that seeks to understand the capacity of farmers to develop unique social and material landscapes.

Regarding the methodology of this chapter, it should be noted that although the historical policy processes are analyzed in terms of the steps of extended translation, in practice such processes are complex and beyond the 'resolution' of translation analysis, which aims at a *general* explanation of collective phenomena and a comprehensive ordering of events. Contestations to modernization policies, for instance, have not occurred along a clear or specific timeline or as an orchestrated event but have involved a "cacophony" of demands from actors with competing and sometimes shifting interests. In the remainder of this thesis I will examine the grounded complexity of policy contestations in relation to the wealth of heterogeneity embedded in modern agricultural practice in Carchi.

Chapter 3

Styles of Farming: Conceptual Framework and Research Setting

Chapter Two concluded that peasant farmers had developed heterogeneous patterns of technology use despite the prescriptive force of modernization policies. In this chapter I present a conceptual framework for the closer analysis of these patterns from an actor-oriented perspective. The heterogeneity of farming practices is understood as a phenomenon intrinsic to peasant agriculture regardless of the milieu. Any analysis of farming styles must take into account the fact that local practices tend to co-exist with external interventions rather than being clearly determined by them. Heterogeneity results not only from farmers' reactions to constraints and forces, but also from their locally specific constructions, which are moulded by their experiences and cultural repertoires.

While translation analysis aims to reveal the unpredictable genesis and trajectory of modernization policies in the process of their implementation, an actor-oriented approach seeks to examine the nature of policy appropriations and transformations 'from below', focussing on the study of actors' everyday practices in their particular settings.

Rather than studying how agricultural development conforms to the modernization model, which is largely limited to technology and market considerations, my conceptual framework examines farmers' multiple translations of modernity, referred to here as farming styles. I will argue that farmers, by actively organizing farm labour and other resources, modify the process of production to suit their own constructed images of the "modern". This entails the development of specific relationships with people and objects across the spectrum of farming domains.[33]

[33]Domains evoke areas of social life organized by a cluster of values which have social and symbolic boundaries (Long 2001). Long maintains that the concept of domains is not rigid, but is produced within particular contexts. In the case of peasant farmers' agricultural practice, I studied the domains of production, reproduction, markets, technology, and economic and institutional relations.

Conceptual Framework

Modernization and modernity: The production of heterogeneity

Having presented the notion of modernization in Chapter Two, this section distinguishes between modernization and *modernity*. Both are important concepts that help to explain the evolution of agricultural heterogeneity and farmers' different positions with regard to modern technology.

The social sciences and contemporary anthropology in particular (see van der Ploeg 1989; Long *et al.* 1992, 1993; Long 1996, 1997, 2001; Bebbington 1990; Arce and Long 2000) have concluded that humans conceptualize and experience *modernity* in diverse ways, thereby generating different modes of knowledge production, some of which may be contradictory to western notions of *modernity* and science.

While the processes of *modernity*, such as the search for 'progress', 'improvement' or 'development', can be identified in different cultures, modernization as a policy process of planned intervention is historically situated in a specific period. Van der Ploeg (2003: 35) reveals in his analysis of agricultural practices in The Netherlands that agricultural practice had been modernizing for a considerable time even though modernization policies themselves date back only to the 1950's.

In order to theoretically position *modernity* and modernization, I begin by quoting Arce and Long's (2000) citation of Comaroff and Comaroff (1993):

> …we try wherever possible to differentiate clearly between 'modernity' as a metaphor for new and emerging 'here and now' materialities, meanings and cultural styles seen in relation to the notion of some past state of things (Comaroff and Comaroff 1993: xii), and 'modernization' as a comprehensive package of technical and institutional measures aimed at widespread societal transformation, and underpinned by neo-evolutionary theoretical narratives[34]. Whereas modernity entails self-organizing and transforming practices in different strata and sectors of society, modernization is normally a policy initiative undertaken and implemented by cosmopolitan administrative and technological elites (national or international) (Arce and Long 2000: 2).

[34]Neo-evolutionary theoretical narratives suggest that development is a linear process following more or less fixed steps according to the "evolution" or advancement of the individual, organization or country in question. When criticizing evolutionism, Giddens characterizes it as an ordered or linear view of history that "starts with isolated cultures of hunters and gatherers… and culminates with modern societies in the West" (Giddens 1990: 5).

With regard to the agrarian sector this implies that *modernity* is not planned, but 'emerges' from processes that involve "different sets of social forces originating from international, national, regional and local arenas… The interplay of these various forces generates specific forms, directions and rhythms of agricultural change" (Long and van der Ploeg 1988: 27).

The notion of modernization also suggests, however, that interventions can be planned in order to influence development. Modernization policy is then adopted and implemented by actors who belong to specific networks. These actors live in cosmopolitan cultures and belong to an elite. This enables them to act in the administrative and technological domain. They belong to 'expert systems' whose main feature is *disembedding*, "the 'lifting out' of social relations from local contexts of interaction, and their restructuring across indefinite spans of time and space" (Giddens 1990: 21).

Modernization, then, entails authoritative or expert conceptions of progress, based on 'neo-evolutionary' theoretical narratives that are modelled on the western conception of *modernity*. In policy documents in Ecuador, for example, the production and utilization of western technology (e.g., pesticides) is linked to the efficient achievement of economic, social (the entrepreneurial family) and organizational (market production) objectives that relate to competition in the global market. The view that technology is something that drives goal-directed development has been widely contested because the ways people understand and use technology are different from that prescribed by designers, developers and distributors of the technologies in question (Long 2001: 190). An illustration of this is provided by the various ways in which farmers plant potatoes in Ecuador, each using their own combination of so called "traditional" and "modern" technologies, (Paredes 2001 and earlier in this thesis).

Arce and Long (2000) argue that "a reworking of modernity values and practices takes place through the ways in which various social actors and groups process and act upon their experiences, thus re-constituting or transforming existing 'localized' situations, cultural boundaries and knowledge" (Arce and Long 2000: 6). It is also characteristic of agricultural development that "available resources (both material and social) are unfolded and developed in increasingly different ways" (van der Ploeg 2003: 7). While heterogeneity is inherent in agrarian development, it cannot be engineered and does not emerge casually. Each farming 'reality' is shaped by social and material forces, such as the availability of labour or weather conditions that create relations and order (Ibid).

Pesticides have been promoted with the goal of modernizing agriculture in Ecuador, but farmers in Carchi show *heterogeneous* patterns *vis à vis* the use of these pesticides and their associated adverse effects. I will now present a framework within which such heterogeneity can be assessed.

Farmers' positions within interfaces

Modernization policies have had an important influence on the development of *modernity* in Ecuador. The two processes interface directly in situations of development interventions. While modernization policy deploys notions of progress in the form of narratives, images, new technical devices and 'expertise', the actors towards whom the policies are directed can experience them either as resources and opportunities, or as limitations. Thus they construct their own images and experiences of what it is to be "modern" (see Long and Arce 2000 for a broad discussion).

The notion of interface is used here to explain the heterogeneity of farming from an actors' perspective. This contrasts with an approach that simply considers heterogeneity in terms of farmers' responses to imposed conditions of intervention. Long (2001) links concepts such as social fields[35], domains[36] and 'lifeworlds'[37] in order to explain social interfaces as follows: social interfaces are "critical points of intersection between different social fields, domains or lifeworlds, where social discontinuities based upon differences in values, social interests and power are found" (Long 2001: 177). He adds that these concepts are not rigid, but are produced within the context of multiple arenas[38]. In certain situations they may overlap with other arenas of intervention (Ibid: 59-60).

35 "A social field conjures up the picture of open spaces: an irregular landscape with ill-defined limits, composed of distributions of different elements…and where no single principle frames the whole scene…Whatever configuration of elements and relationships make up the fields, these are essentially the product of human and non-human interventions, both local and global, as well as the result of both cooperative and competitive processes" (Long 2001).

36 A domain identifies "areas of social life that are organized by reference to a central core or cluster of values which, even if they are not perceived in exactly the same way by all those involved, are nevertheless recognized as a locus of certain rules, norms and values implying a degree of social commitment" (Villarreal 1994: 58-65, cited in Long 2001).

37 "'*Lifeworld*' is the term used by Schultz (1962) to depict the 'lived-in' and 'taken-for-granted' world of the social actor. It entails practical action shaped by a background of intentionality and values and is therefore essentially actor-defined" (Long 2001: 54).

38 Arenas are "social locations or situations in which contests over issues, resources, values and representations take place" (Oliver de Sardan 1995: 178-9 cited in Long 2001: 59). Arenas involve face-to-face confrontations as well as those with distant actors, and their worlds (Long 2001: 59-60).

This thesis studies the styles of farming among peasant potato farmers. The principal domains within which different farming practices are studied are the family and the farm, particularly in relation to markets and technologies and the actors that promote the use of these technologies. One of the main arenas of this study is pesticide use in potato production.

The notion of interfaces makes it possible to study "whose interpretations or models (e.g., those of agricultural scientists, politicians, farmers or extensionists) prevail over those of others and in what circumstances" (Long 2001: 19). This entails an understanding of the struggles of power and knowledge involved.

Agency

A central notion of interface analysis is the conceptualization of human *agency* and its relation to power, knowledge and structures. Human agency is defined as "the knowledgeability, capability and social embeddedness associated with acts of doing (and reflecting) that impact upon or shape one's own and others' actions and interpretations" (Long 2001: 240-1). Agency can be viewed according to the fields, domains or arenas in which it is manifested.

In agricultural development, *agency* is expressed by the heterogeneity of styles of farming as realities that offer "certain development opportunities, while ruling out others at the same time" (van der Ploeg 2003: 13). Farmers aiming at low external input production, for example, can achieve this in various ways. Soil fertility can be improved through the use of cover crops, green manures and animal manure. Seeds can be exchanged or reproduced on-farm or by seed groups (*semilleristas*). Crop health can be improved through intercropping, planting associated crops, using homemade insect traps, etc. Labour can be exchanged with other farm families or sourced from within the family or through *mingas*[39]. This does not mean, however, that farmers randomly choose any of the above options. Instead they make use of their knowledge, embedded in practice, to manage "the labour process, within the context of the local eco-system, in order to improve the valorisation of elements provided by this local eco-system."[40] Farmers recognize available linkages, both existing and potential, in order to follow a specific path. Important criteria include social acceptance, the reproduction of the different production factors in time and space and their own satisfaction with the ongoing process of production.

[39] A community works in rotation on each farmer's field.
[40] Lacroix (1981: 95) quoted and translated in van der Ploeg (1989: 147).

Agency is exercised through interactions and interfaces with human (e.g., family, labourers and sellers) and non-human (weather, soils, seeds, machines) entities. Each farmer's projects (for example, farm enlargement or diversification) entail different linkages to those of other farmers in the same community. Knowledge and power are exercised in different ways.

> Hence, agency is also (and perhaps especially) the capability to interest and involve others in one's own project; the capability to encourage others to further unfold their projects in coordination with one's own. In other words, agency is the capability to create an actor-network. Only by doing so, is it possible to make the proverbial difference (van der Ploeg 2003: 18).

Power, knowledge and structure in relation to agency

Agency is closely related to three controversial concepts relevant to this thesis. I review these concepts below.

Power in this study is seen as an element of action:

> …power equates to the transformational capacity of human action: the capacity to intervene in a series of events in order to alter their direction. Consequently power appears closely linked to the notion of *praxis*, to the extent to which it relates to the conditions of social and material existence historically constituted and historically mutable (Giddens 1997: 230-1)[41].

The notion of power as the capacity to intervene entails the use of different kinds of resources in order to ensure desired outcomes. It also involves the enrolment or exclusion of others from an actor's project. This view is compatible with actor network theory, which regards power as "generated in a relational and distributed manner within networks" (Law 1992: 4, 2004; see also the concepts of *enrolment* and *interessment* in translation processes in Chapter Two).

Power commonly emerges from struggles that arise due to the disparate interests of actors (Giddens 1995: 231). The notion of interface suggests that, while social transformation can transcend the opposition of particular interests, divisions of interest among actors cannot be overcome completely. Agency emerges from processes of bridging, in which actors struggle against or accommodate each other's social and cognitive worlds. This can be seen in intervention settings where cultural differences between farmers and scientists make integration impossible and result in conflict. In van der Ploeg's (1989) study of peasant farmers in the Peruvian highlands, for example, the 'invisibilization' of farmers' knowledge through "the

[41] My translation from Spanish.

scientific design of a new superiority" (of 'improved' potato varieties) and the systematic marginalization of local knowledge systems became a strategic force in the process of legitimizing scientific knowledge (Ibid: 160-161). Yet, the provisional or fragmented character of power resources that are used to legitimize 'improved varieties' is illustrated by the fact that Peruvian farmers continue to this day to use about 200 native varieties[42].

Knowledge is realized in practice. In agriculture, particularly in 'craft-based' agriculture, knowledge forms a unity with the labour process and those involved in it. It is difficult to analyse knowledge in isolation from actors and the ways in which they apply their knowledge (van der Ploeg 1989: 146; 1993a). Van der Ploeg suggests, in relation to potato farmers in the Peruvian highlands, that farmers' knowledge should not be understood in terms of the sort of "nomological models" (models of direct relationship between cause and effect) that are used in applied science. Farmers manage to communicate effectively and to establish "fairly exactly the overall conditions of specific fields", despite their use of colloquial rather than "formal scientific language." Farmers' knowledge can be understood as a 'network of meaning'[43]. Furthermore, farmers include unexpected or unpredictable elements (e.g., weather, soils and pests) as part of their "global framework" of knowledge generation. Farmers employ the use of a "calendar," for instance, that spans considerable lengths of time in order to manage unexpected changes. The unpredictability of farming conditions is managed by flexibility with respect to variation in production factors and through the use of explanations of the natural world involving "traditional magic" (Ibid: 148-53). Farmers' knowledge is not nomological but is instead based on reciprocity between humans and the land. They do not believe that humans have unidirectional control over material resources. The ways in which farmers understand and enact empirical experience[44]) in Highland Peru are notably different from those of scientists. The value of farmers' knowledge is recognized once and again in the field, Zimmerer (1997) for instance, found that peasant farmers in Peru skilfully conserve the region's biodiversity despite tumultuous agrarian transitions.

---

[42] In Peru, in the Hancavelica Department alone, de Haan (2006) documented 195 native varieties of potato, which only represented a quarter of the total in that department (CIP and FEDECH 2006). Many authors mention that there are thousands of potato landraces in the Andes (Ochoa 1999, 2001; Pumisacho and Sherwood 2002).

[43] Hesse (1983: 27) cited by van der Ploeg (1989: 148).

[44] Knorr-Cetina (1999) is interested "not in the construction of knowledge but in the construction of machineries of knowledge construction". In this way Knorr-Cetina studies what she calls epistemics, "the strategies and practices assumed to promote the "truth-like" character of results" (p. 46).

Van der Ploeg (2003: 15) discusses the notion of *structure* and its relation to agency in some depth. He defines structure as the "process of ordering" impinged on by human agency, explaining that "…agency expresses itself nearly always as a manifestation of several actors… An individual only displays agency in interaction with other people or with other things."

In this view, phenomena that are traditionally regarded as structures, such as the 'market' or 'the family farm', do not possess a fixed morphology of norms and rules. Instead they are constantly defined afresh by the processes that accompany the formation of actor-networks and by different expressions of agency. The structural effects of such networks (irreversibility, lengthening and variety) (Callon 1995: 159, see Chapter Two) depend on more or less stable links between humans and non-humans and, therefore, on the kinds of translations made within networks. This notion opposes the structuralism that is implicit in the idea of modernization, which regards the effectiveness of an intervention in terms of the 'transfer' of knowledge and resources to the parts of a society that lack them. If power and knowledge configurations only become evident during the processes of interfacing and the making of networks, we need to ask how experts can define them in isolation from these processes. The outcomes of interface and translation can be better understood by studying the heterogeneous patterning and ordering on local farming practice.

Farming styles as the study of farmers' agency and heterogeneity

The exercise of farmers' agency can be recognized in the structuring of their different production strategies, strategies which result in the heterogeneity that characterizes the peasantry of Ecuador. This research studies farmers' different production strategies in Carchi through the methodology of farming styles.

The study of farming styles includes an analysis of the ways in which farmers structure the production process and the rationale that guides their approach to technology, markets and labour arrangements. It also takes into account the fact that a variety of actors in the different domains that influence farming practice possess agency. "Individual projects can only be realised if they are founded in the required degree of coordination, that is, if they become part of a larger system of interlocking projects" (van der Ploeg 2003: 7). Farming styles can be viewed as socio-technical networks:

> [A] socio-technical network [is] a particular constellation of various modes of ordering, interlocking in particular ways, and collectively defining the apparent courses of action and development opportunities…[they are] 'socio-technical'

> because the style is comprised of social elements, material elements (including aspects of the living world), and above all the interrelations between the two. (Ibid: 101).

Farming styles are actor-networks in the sense that each farmer does not make decisions as an isolated individual but in conjunction with a network of people and material elements that combine to make a given style of farming possible. A farming style involves stabilized relations or *translations* that are ordered in particular ways. In this context, technology is studied as a set of aligned heterogeneous elements, which together fulfil a specific function (Callon 1986, Latour 1987). Within the framework of faming styles, therefore, pesticides are not viewed merely as tangible chemical compounds, but are defined according to the relations established within the different networks in which they function as materials for pest control and as markers of modernity, wealth and social status.

The labour process as a space for ordering and patterning

Van der Ploeg (2003) describes the labour or production process in terms of the ordering of three elements: the objects of labour, the tools or instruments and the labour force (van der Ploeg 2003: 102). The objects of labour refer to those artefacts that are given additional value through the application of labour. Land, for instance, can be transformed into fertile soil for potato production and potato seed can be converted into potatoes packaged for the market. "It is characteristic of agriculture that labour objects are part and parcel of (are derived from) the living world" (Ibid). The tools or instruments refer to "those elements that are fabricated and used to lighten and improve the labour process" (Ibid). These include fertilizers, hoes, tractors and pesticides. Finally, the labour force refers to the labour mobilized for production. In peasant farming an important proportion of farm labour usually comes from the farming family itself.

Variations in the organization of these three elements can be seen on different farms, and, hence, different faming styles can be identified. The various styles of farming represent the different ways of ordering the human and material elements involved in the labour process. Van der Ploeg (2008), though, also highlights the importance of the labour process as a generator of progress (modernity). He asserts that:

> At whatever level of development, the possibility of designing, controlling, constructing and reconstructing the labour process (and the many resources, cycles, tasks and relations that it entails) is strategic (van der Ploeg 2008: 27).

Intensification versus extensification of production

We talk of intensive styles of farming when the organization and development of the farm are "centred largely on achieving increasingly productive results per labour object. Thus the quantity and quality of labour become of strategic importance" and "tools, instruments or techniques are skill oriented" (Ibid). Extensive styles of farming, on the other hand, refer to farms whose organization and development is centred on the tools themselves. This means that tools and their functions are developed to "enable the management of as many labour objects per labour unit as possible – that is the pursuit of as large a scale as possible. This usually leads to 'mechanical technology'" (Ibid).

Farm production and reproduction define the links with other farming domains

By studying the tasks that take place on the farm and the way in which they are performed, we can see how certain styles link different domains. In potato farming, for instance, soil tillage, planting, fertilizing, weeding, pesticide application, harvesting and potato selection are tasks that fall within the domain of production. Yet the manner in which these tasks are performed may or may not make them part of the domain of farm reproduction.

Farm reproduction does not only relate to the ways in which farming families provide for themselves and secure labour. It also relates to the reproduction of the means, relationships and conditions required for farming (van der Ploeg 1990: 24). This implies the translation of specific patterns of practices through different domains. The tasks that form part of the production domain, for example, may be interconnected, to a higher or lower degree, with the reproduction of soil fertility, seed quality and crop health. These tasks depend in turn on the reproduction of people's skills, which requires the securing of quality labour. To translate a specific farming project to other domains, therefore, farmers need to work within the domain of social relations, consisting of the kinship relations, gender relations and the *compadrazgos'* religious ties that structure families and communities.

The domain of farm work might also intersect with the domains of economic and institutional relations. Loan-financed production, for example, implies relations with banks and markets. Harvests need to be sold to pay off loans. Potato varieties must be marketable. In this way connections with input distributors and suppliers are developed.

Autonomous versus dependent farm reproduction

It is useful to contrast two extremes in the use of farm labour in order to understand different farming patterns. On one hand, farm production can be *autonomous*, utilizing family labour alone and dependent on relatively few purchased inputs for production. Production may be oriented toward the market, but may also be used for family consumption and for seeds for the next planting cycle. In this case, farming families rely on their own experience and on local knowledge, which is continually applied and enriched. At the same time, each task relating to the quality of the land and the selection of seeds ensures the physical reproduction of these resources for the next cycle. The family works to increase production through a pattern of optimizing production factors and inputs. To achieve this, it is necessary to enhance the technical efficiency[45] of the farm (van der Ploeg 1990: 13-16).

On the other hand, farm reproduction can also be *dependent* on the market. In such cases labour is usually hired and the majority of inputs are purchased. Production is market-oriented. New seed is often purchased for each fresh planting cycle. Under such conditions, farm production depends on present and future market prices rather than on the results of the previous growing cycle. In a situation like this, knowledge has to be constantly adapted in order to conform to the nature and quality of external inputs. Farmers have to accept the risks associated with the use of technologies about which they have, at best, incomplete information. The production process must be organized to comply with prevailing market relations in such a way that the difference between costs and benefits is optimal. In order to achieve goals under such conditions, it is necessary to raise the economic efficiency of the farm (Ibid: 17).

It is possible to observe variations and different combinations of these two patterns. Both models illustrate the fact that farm labour entails an interaction between the direct producer and the labour object. Re-adapting farm labour, therefore, requires continuous organization, observation, interpretation and evaluation (Ibid: 27). The labour process, moreover, involves a combination of mental activity and manual labour. It is considered to be the central process by which local knowledge or *Art de la localité* (the art of the locality) is reproduced through practice (van der Ploeg 1997: 209-210).

[45]"A firm is considered more technically efficient than another if, given the same quantities of measurable inputs, it consistently produces a larger output" (Yotopoulos 1974: 270 cited in van der Ploeg 1990: 33).

The structuring of farm labour varies between cultures and within localities. It continually adapts to farmers' different interests in an environment of complex interrelations and negotiations between the different domains of farming. An understanding of how the various labour processes interact with the different domains is therefore essential to understanding farming heterogeneity. It is also necessary if an accurate characterization of farming styles is to be achieved (van der Ploeg 1990 and 1995, Hebinck 1995, Den Ouden 1995)

Coordination and cohesion of domains

An important characteristic of farm labour is the co-ordination of different domains in which farmers negotiate decisions, so that farming is a long-lasting activity in terms of the farmers' goals and in terms of the farm's production. Thus a farming style is a patterned or 'regular' process of creating cohesion between domains through continuous translations. For instance, potatoes may be sold in the field, in a market place, or be transported to another city, but in all cases the manner in which potatoes are sold would depend on the arrangements made within and between the different domains. If labour is unavailable for harvest, potatoes are sold in the field; if capital is not available to pay for the costs of transporting the crop to the city, farmers can take a loan, or they can cooperate with a truck driver who might also be a sharecropper.

Farm externalization and commoditization processes

The process of *externalization* means "a gradual, or sometimes abrupt, shift of particular farm tasks to external institutions" (van der Ploeg 1990: 19-20). For instance, soil fertility, seeds and pest control can be obtained through the use of fertilizer, bought seeds and synthetic pesticides respectively. In these examples, the information about these inputs and directions for their use come from external institutions. Technical administrative relationships arise in this way, making farm production more market-dependent. In such cases, the technical efficiency of farm labour becomes less important than the farmers' entrepreneurial capacity to achieve the goal of economic efficiency (Ibid: 20-21).

Externalization levels are defined by the incorporation of production into market relations in order to supply inputs. A high level of incorporation into markets refers, therefore, to a high degree of market dependency on the supply of production inputs. Correspondingly, a low level of incorporation to markets implies a significant degree of independence of such markets. Farmers consciously decide whether or not to participate in a specific form of market incorporation, depending on the relationships they have within a specific sociotechnical network. This suggests that farmers do not operate independently in the market. Instead, they work with their allies in banks, industry, commerce and extension services (Ibid: 21-26).

Commoditization refers to "the processes by which the notion of 'exchange-value' – not necessarily at the expense of 'use value' – comes to assume an increasingly important evaluative and normative role in the discourse and economic life of a given social unit (e.g. household, village, region, or national economy)" (Long 2001: 21). While commoditization processes may be identified in any of the different phases of production, commercialization only refers to the point at which products acquire exchange-value through market relations (Idem: 21).

In more autonomous modalities of production, the production process creates commodities for the market but production itself takes place outside the market. It is not dependent on purchasing or financing the necessary labour, objects of labour or the means of production. These do not function as commodities but as 'use values', their value being to assure production (van der Ploeg 1990: 14). In market-dependent production, the necessary production factors and inputs are mobilized through relevant markets (capital, labour, food, cattle, etc.), so the production factors and inputs appear as commodities (Ibid: 17).

While *externalization* is defined by the degree of incorporation into the market (on the supply side), commoditization is more difficult to define. This is because the factors or inputs of production may acquire different values (from the exchange-value) in each phase of the production cycle, and even after commercialization (e.g. gifts). Nevertheless, the importance given to exchange-value in those styles of farming that show higher levels of *externalization* may contribute to higher levels of commoditization.

In practice, variations in the degree of *externalization* within a given farming population are likely to be reflected in differences in scales of production, levels of capitalization and styles of farm management (Long 2001: 2). Heterogeneity of styles of farming, however, does not only depend on the degree of incorporation and consequent commoditization. Markets only become a structuring principle when a high level of incorporation transforms the labour process itself on a cognitive level (van der Ploeg 1990: 263), which includes the ways in which notions of exchange-value signify in farmers' discourse.

This discussion of *externalisation* and commoditization is relevant to a discussion of the differentiation of farming styles, since different structural analyses have equated levels of commoditization with agricultural development, maintaining that low or partial commoditization levels characterize underdevelopment (for criticisms of these views, see van der Ploeg 1990 and Long 2001). For instance, chapter two shows that the modernization policies in Ecuador defined non-commercial relations within the hacienda system as "backward." These policies then pushed land reform and the integration of peasants into markets as a strategy to promote the development of agriculture.

In this study, I have adopted the view that commoditization does not necessarily drive local development, since market relations in different settings do not always represent opportunities, and can under certain circumstances actually create constraints on development (van der Ploeg 1990). Moreover, in specific Latin American contexts, commoditization has been shown to be less favourable, or even disruptive, of local patterns of development.

The constitution of farming styles

In terms of the concepts mentioned above, farming styles can be seen as expressions of four interactive processes. Firstly, farming styles emerge as different expressions of localized agrarian modernity defined through interfaces with modernization policies. Modernization policy has promoted extensive styles of production, dependent farm reproduction and externalization. One level on which farming styles can be defined is their proximity or distance from modernization as the result of the exercise of farmers' agency.

Secondly, agency creates differences that are not a characteristic of individuals, but that relate to the capability and knowledge constructed within networks. Thus actors' identification of convergences, and their interlocking with other's projects, becomes strategic in order to reproduce a specific farming style. A farming style is therefore an actor-network, a network of relations between heterogeneous elements, and at the same time "a relational effect that recursively generates and reproduces itself" (Callon 1995). Consequently, farming styles can be defined by the processes of structuring farming practice in time and space (van der Ploeg 2003: 19) and by the resulting morphologies and relations. The composition of, and above all the interrelations between, the social and material elements are of particular interest in the study of farming styles (Ibid).

This means that we should pay attention to the qualities of translation, as Law suggests, as well as the durability and mobility of a farming style and the systems of representation and calculability that relate to it (Law 1992: 5; see Chapter Two for a detailed explanation). In this way farming styles can be consolidated (become irreversible), enrol diverse and numerous entities (become large), and become differentiated from others (create variety) (Callon 1995: 59).

Thirdly, a farming style entails "a specific structuration of mental and manual labour" that results in a particular organization of production (van der Ploeg 1994: 18). The labour process is so central to the differentiation of farming styles that a style of farming can be viewed as "the material result of farm labour" (van der Ploeg 1990: 12). Farm labour, at the same time, entails specific relationships among producers, objects of labour and the means of production (Ibid p.11). The way in which these relationships are built depends in turn on a specific cultural repertoire and set of practices. Such cultural repertoires are not just responses to prevailing market relations, technology or policy, but are moulded by history, locality and culture (van der Ploeg 1993b: 36).

In the fourth case, styles of farming might be defined in terms of scale, level of intensity, the implied relations between capital and labour and the specificity of particular techno-productive aspects and relationships (Idem: 18). The definition of intensive and extensive styles of farming is dependent on their physical production levels. Thus an intensive style of farming relates to high production levels per object of labour, and an extensive style of farming relates to low production levels per object of labour (van der Ploeg 1990: 12).

The analysis of different styles of farming through the study of the labour process aims to find patterns of coherence among farmers' practices. Consequently, farmers who combine similar sets of practices are members of a constructed style of farming. This does not mean that farmers in a constructed group are homogenous, or that we can take the grouping as a blueprint for development. Rather, this analysis provides insight into local patterns of agrarian development (Hebinck and van der Ploeg 1997: 223).

An important feature of agricultural practice is the continuous change of scenarios due to the intensification of social relations extending beyond what has been seen as "localities" (Giddens 1990). Because the styles of farming are dynamic and overlap temporally (Remmers 1998: 133), they help to clarify the fact that changes in agricultural practice are neither homogeneous nor simple responses to the market or technology interventions. These different responses reflect not only what Richards (1995: 74) calls "coping strategies", but also a diversity of projects that interlock and arise as sociotechnical networks. In such styles it is possible to recognize how the "ugly sides of modern development" are generated and also how environmental resilience, or risk management, emerges from certain ways of interlinking the social and the technical (van der Ploeg 1994; Cristovao *et al.* 1994). Research setting

Carchi is the most fertile of Ecuador's Andean provinces. The soils are of volcanic origin, rich in organic matter, black and deep, with high levels of water retention (Barrera *et al.* 1998, 2000). The average temperature in the province is 12°C. Due to wind patterns and fluctuations in relative humidity, the probability of crop frosts is highest in the valleys during July, August and January, but frost can occur at any time of year. Potatoes can be grown throughout the year in most of the Carchi region due to evenly distributed sunlight and patterns of rainfall. Over the course of the last decade irrigation has become necessary in most communities due to variations in the length and intensity of the rainy and dry seasons.

Carchi has a good road infrastructure relative to other provinces in Ecuador, facilitating access to markets for the sale of crops and the purchase of inputs. Due to electrification programmes during the oil boom years of the 1970s and an ample water supply, the great majority of farmhouses (over 80 percent) have electricity and piped water (Crissman *et al.* 1998: 90). Haciendas predominate in the valleys, and peasant farmers utilize the sides of the valleys (Ibid). In this study I visited peasant farmers living in communities that acquired land as cooperatives during the period of agrarian reform, as well as farmers who purchased land prior to the agrarian reforms.

<u>Population and description of "peasant farmers"</u>

The subjects of this study are generally referred to as "peasant farmers", to distinguish them from other farmers. Peasant farmers are characterized mainly by a degree of "internalization of production" and "autonomy." These farmers actively build non-commoditized relations of production, the central feature of which is the use of family labour. This allows them to sell a proportion of their crop on the markets even though parts of the elements and factors of production (labour, labour inputs and the means of production) are independent of market forces.

Other terms have been used to characterize the forms of production in Carchi, but I consider them inaccurate or inappropriate in the context of this study. The term "subsistence farmer", for example, usually refers to farmers who produce only for family consumption. This is not the case with the farmers in my study. Although there are a few farmers who produce solely for consumption, most of them sell at least a portion of their produce, and some sell everything they produce. The term "small farmer" usually refers to small-scale landholders. This is also inappropriate for my study because the subjects include both small-scale and big-scale landholders. I use the term "peasant farmers," therefore, because it includes most of the farming styles I studied in Carchi. The term is the equivalent of the Spanish "*campesino*," which distinguishes the type of farmer in my study from those who practice industrial styles of production. My thesis aims to explain differences in production among peasant farmers.

The term "peasant farmers" is also relevant to the study of the different material and social conditions of pesticide use. Most of the farmers in this study are *mestizo*, a genetic mix of the original native population and the descendants of the Spanish invaders. Their average level of education is six years of schooling.

The population of peasant farmers in Carchi has grown to its current level since the Agrarian Reform Act of 1964 (Barsky 1984). The peasant farmers in the communities that I studied live in houses relatively close to their cultivated fields (within one hour's walk). A typical farm is composed of a number of fields of various sizes. These fields are situated in a variety of ecosystems. Potatoes are economically the most important crop, but a dwindling number of farmers still divide each field and rotate potatoes with barley, wheat or fava bean (*Vicia fava*). The fields are left fallow, as grazing for cattle, after two or more years of cultivation. Mixed-breed cows are kept, mainly for milk. Some of the milk is sold and some consumed by the farmer's family. The number and quality of animals varies widely from one farm to another, as does the level of milk production per animal.

Producing potatoes and pasture for dairy comprise the agricultural basis of all four communities. Women tend to manage milk production and/or small animal species such as pigs, chickens and guinea pigs, while men generally manage potato production. Women who own and cultivate a potato field are usually single or widowed.

Communities included in data collection

The communities studied here are made up of households that formed associations through a process of land acquisition. They either bought land from hacienda owners prior to agrarian reform in the early 1990s, or acquired it during the period of agrarian reform of 1964 or the late 1970s. Organized groups of farm workers were assigned a central area for housing and individual fields for cultivation. The community in this study is similar to one in Peru, described by Mayer (2002: 36) as follows:

> Following the colonial pattern, each new community today is born through an act of *fundación* or creation. This provides a charter of legitimacy, an identity for the group, and a place on the map. The *fundación* implies a process of recognition by officialdom, a name and a dedication to a saint and sacred places that give it identity… [The authorities] decide on the limits and limitations of how much power and pressure can be brought to bear on individual households concerning matters of social, political, religious and cultural life.

Communities in Carchi are politically and legally organized by the Ecuadorian state as "Parishes". The name is derived from the period when the state and the Catholic Church were unified, and implies that there is a church in the community. Nowadays, however, parishes are public territorial divisions in which the authorities are elected every four years.

I previously conducted a study of three communities in which the "Ecosalud" project took place. This was a research and intervention project. I decided to conduct research in the same communities in this study in order to gain a better understanding of the community dynamics over time. I expanded the study to analyse a broader population group than in the earlier research.

Data was collected from a fourth community, Mariscal, in 2003. All the farmers in this community cultivated potatoes under the "*wachu rozado*" system. My research showed that this system of cultivation had the potential of reducing pesticide use. The study focused on the reasons for farmers maintaining their traditional systems despite the growing influence of "modern" agriculture in other communities. A forest intervention programme had been implemented in Mariscal, which was not the case in the other three communities.

Carchi province is composed of five municipalities (political and administrative divisions also called *cantones*). This study included one community from each of the four potato-producing municipalities: San Francisco in the municipality of Espejo, Cuba in the municipality of Tulcán, San Pedro in the municipality of Montúfar, and Mariscal in the municipality of Huaca.

Physical characteristics relevant to the research

Soils

Pumisacho and Sherwood (2002:55) describe ideal soil for potato production as black with a high capacity to fixate phosphorus and high organic matter content (8 to 16 percent). Such soils usually have good drainage and high porosity, permeability and water retention capacities. They also often have low microbiological activity because they are generally located in cold areas. Low temperatures tend to slow down the decomposition of organic matter, leading to its accumulation over time. The chemical characteristics of these soils are defined as follows:

> …approximately 50 percent of the soils have low nitrogen content despite their high organic matter content. Eighty percent have low phosphorus content and 70 percent have high levels of potassium, calcium and magnesium. Sulphur is generally considered a limiting factor in potato production, due to its loss caused by lixiviation and crop extraction. There exist common deficiencies of micronutrients such as zinc, manganese and boron… Most soils in the potato producing areas have pH values between acidic and slightly acidic (>6.4). When planted in acidic soils, potatoes have difficulties meeting the crop's high nutrient demands, especially for phosphorus (Pumisacho and Sherwood 2002: 55).

Crissman *et al.* (1998: 182-38) classify soils in Carchi as Andepts, or soils of volcanic origin. They found that Carchi's soils are more variable than volcanic soils in the USA. There is considerable variation from one watershed to the next. The variability of soil quality in Carchi is a result of inconsistent patterns of land use from colonial times to the present day.

Veen (1999: 55) looked at the dynamics between land use, management, topography and mechanical erosion and compaction. The history of land use and management for each area was related to the level of mechanical erosion and compaction of soil. Veen concluded that "in general, with lower altitude, longer amount [sic] of tractor applications in a field, mechanical erosion and compaction increased, together with their effects upon production" (Ibid: 60). The soils in Santa Martha have been eroded and compacted in this way.

Harden (1991) used precipitation simulation techniques to study soil erosion in two Ecuadorian watersheds. He demonstrated that the level of soil erosion was more closely related to land use practices than to soil type.

Altitude, temperature and precipitation

The Carchi study sites are located between 2,500 and 4,000 meters above sea level in the humid, high altitude ecosystem of the Andes (Sherwood 2009: 22-3). As altitude increases in this area, rainfall tends to increase and temperatures decrease. The average temperature ranges between 11.5 °C and 12.1 °C (Knapp 1991). Communities situated close to the East Andean ridge tend to receive more rainfall than those on the West Andean ridge or those in the valley. Rainfall and temperature are also influenced by proximity to forest or *páramo* environments. A brief description of weather conditions in each community area follows:

- San Francisco is situated close to the *páramo* on the western flank and higher than the other communities (between 2.900-3.600 masl). It has the highest rainfall of the study areas with 1.200 mm/year, although the rainfall is not always well distributed. The average temperature is 10 °C.
- Mariscal is situated next to a protected forest on the Eastern flank at between 2.800 and 3.400 masl. It has the 2nd highest precipitation level with 1.050 mm/year. It enjoys better rainfall distribution than San Francisco. The average temperature is 11.5 °C.
- San Pedro is situated on the Eastern flank at between 2.900 and 3.400 masl. It has an average rainfall of 950 mm/year and an average temperature of 11.5 °C. It has been deforested and experiences longer dry seasons than either San Francisco or Mariscal.
- Santa Martha lies mostly in the valley at between 2,800 and 3,200 masl and has the lowest precipitation at 800 mm/year. It has an average temperature of 12.5 °C and experiences prolonged dry seasons and occasionally severe droughts (Sherwood 2009)[46]

The region is one of the most agriculturally productive in the Ecuadorean Andes, and the land can be cultivated continuously through the year.

Pests, diseases, pesticides and human health

The geographical and environmental context of the communities included in this research are important for beginning to understand the relative

[46] Barrera *et al.* presented different measurements of rainfall in 1998 for the three communities they studied: San Pedro: 1045 mm/year, Santa Martha: 950 mm/year and San Francisco: 920 mm. The variation within a six-year period shows that San Pedro and Santa Martha are getting progressively drier, while San Francisco is experiencing an increase in precipitation.

development of potato pests and diseases as well as the corresponding patterns of pesticide use (mainly fungicides and insecticides). While humid conditions are conducive to late blight attacks (*Phytophthora infestans)*, dry conditions tend to be conducive for the proliferation of the Andean weevil (*Premnotrypes vorax*) and Guatemalan tuber moth (*Tescia sp.*) (Pumisacho and Sherwood, 2002).

Under cool, humid conditions, late blight spreads quickly, and control demands frequent use of fungicides. During heavy rainfall periods, farmers in Carchi commonly apply fungicides multiple times per week and sometimes daily, as precipitation can wash off products before they act on the pathogen. Thus, weather monitoring is central to management. The most common fungicides used are based on mixtures of mancozeb and cymoxanil. While these active ingredients have low toxicity (WHO toxicologic category III or slightly hazardous), mancozeb belongs to the dithiocarbamates group of pesticides, which produces skin problems and is a suspected carcinogen.

To control the Andean weevil, farmers mainly use the liquid soil insecticide-carbofuran, which companies recommend applying a maximum of three times during the potato cropping season. Nevertheless, we observed that some farmers apply carbofuran as much as 10 times. Carbofuran belongs to the carbamate group of pesticides and is a highly toxic product (WHO Category Ib) that affects the nervous system in mammals. Foliar pests are usually controlled with metamidophos, also a WHO Ib, highly toxic pesticide. Metamidophos belongs to the organophosfate family of products. Taken together, the quantity of applied mancozeb, carbofuran and metamidophos represents about 80% of total insecticides applied in Carchi, which explains why this province has a high rate of pesticide intoxications. This also explains why, when discussing taxation policies, the elimination of highly toxics is a central concern.

Labour and production arrangements for potato production

Non-wage labour and gender issues

"Non-wage labour" usually refers to *"family labour"* in this study. All the members of the family who are older than twelve usually work full time except for those who attend school. The use of family labour allows families to purchase inputs with the money that would otherwise have been spent on labour. Most farmers in Carchi do not expect women or children younger than twelve to work full time in the potato fields. Most of the

women participate in the daily activities that shape labour relations, however. As Mera-Orcés observes (2000: 15), women prepare food for their families and fieldworkers during the production cycle. They also participate to a degree in planting, harvesting and sorting potatoes, as well as in seed selection, storage and disinfection.

Payment in kind

Some farmers allow their labourers to take home small quantities of potatoes (*raciones*) during harvesting. The labourers' wives or children collect the potatoes that are left in the fields after harvest (*recaves*). These payments in kind compensate for lower-than-standard wages and are an important resource for those households that are entirely dependent on their labour as a source of income. Nearly all the labourers whom I interviewed would choose a lower wage, which was supplemented by *recaves* and *raciones* above a higher wage without the ration of potatoes. However, many farmers are too proud to allow their wives to collect *recaves*. They do not like their families to be considered poor and believe that "only the poorest [*pobrecitos*] go for *recaves*." Some farmers prefer to pay higher wages rather than offer *recaves* because they believe that some labourers take too many potatoes.

Paid labour

Wage labourers are usually drawn from within the community, although contracted groups (*cuadrillas*) led by a foreman are becoming increasingly common. Some farmers prefer to hire relatives or family friends (*compadres*). They maintain that good relations with labourers are important "to take care of the crop" and to "prevent misuse of the products [inputs] and tools." Some also maintain that "with relatives or friends, it is easier to reach an agreement on payment conditions."

Men usually earn higher wages than women. The women's salaries depend on the kind of work available and what a particular *patron* (employer) is willing to pay. During the harvest, both men and women earn a set amount of money for each *quintal* sack[47] they harvest, but women receive lower wages for weeding and hilling-up at other times.

The high cost of living and the gradual elimination of payment in-kind have resulted in pressure from labourers to increase wages. Employment opportunities are scarce and food is expensive in relation to salary levels. Many labourers prefer applying pesticides to doing other manual work. The

[47] 1 quintal = 100 pounds or 45,36 kilograms.

wages for pesticide spraying are relatively high because farmers consider this job to be more physically demanding than most other work.

Sharecropping relations

When farmers in Carchi lack a factor of production (e.g., land, capital or labour), they commonly access it by means of sharecropping commonly between a landholder and financer. As social research in Carchi and elsewhere in Ecuador (Lehman 1986, Barsky 1984, Bebbington 1990) have shown, terms of sharecropping are highly variable and can change according to input prices, especially of synthetic fertilizer which are tied to international oil market. Typically, the landholder takes responsibility for hiring and supervising labourers and for preparing the soil for planting. Meanwhile, the other partner (or partners) provides seed, fertilizers and pesticides. The monetary value of family labour is also taken into consideration. The harvest is shared proportionally, as negotiated according to each party's contribution.

The number of farmers participating in sharecropping varies from one community to another. Those involved in these arrangements need to agree on wages and also on who will be employed as labourers, before planting. The person who contributes the capital usually has the most to say in these decisions, but the balance of power may change considerably, according to specific contexts and different visions on farming practice.

In hacienda times, sharecropping was practised between the *hacendado* (hacienda owner) and the workers, often with the landowner exploiting the *partidario* (landless sharecropper) (Bebbington 1990: 229). Following Agrarian Reform, sharecropping became a common arrangement among neighbours and within families, while sharecropping with remaining hacendados is only common for peasant farmers capable of contributing high amounts of capital alongside the hacienda owner. In three of the households I visit in this study, crops were produced in a sharecropping arrangement between a father and one or more of his sons. Although the harvest is divided as normally, the land is not given a rental value and labour contributions are not clearly defined. This is because the entire family contributes labour to other aspects of the farm, such as rearing cattle. This sort of arrangement helps to ensure that there is a long-term pool of labour in the family. In many cases, this system enables sons to begin to accumulate capital while learning production skills, before seeking land.

Financing

Most farmers do not take bank loans due to high interest rates (usually above 20 percent). To finance potato production, small farmers use their own resources or arrange informal loans from other community members. Middlemen often give payments in advance for crops, and commercial shops sometimes provide agrochemicals on credit. These arrangements are dependent on each farmer's social relations.

Data sources

Dynamic survey of potato production: working with a team of farmers

The Ecosalud survey was conducted in 2000 by a group of three extension workers with technical backgrounds in agriculture and health. Data collection was central to the project and the staff spent much of their working time conducting four-hour surveys with farmers. This approach had several limitations. Firstly, the presence of extension workers created an expectation that future projects would be funded. Secondly, the extension workers were paid according to the number of surveys they completed, and thus had an interest in doing as many surveys as possible in the least amount of time. Thirdly, the fact that they tried to arrange for farmers to be interviewed at home in the daytime meant that the interviews were often rushed or had to be postponed because farmers were often busy in the fields during the day. Lastly, this method of data collection required farmers to recall the details of a full potato production cycle a year after the harvest. Farmers were often unable to remember a lot of relevant information.

Quantitative techniques of standardization were applied to compensate for inadequate data. This approach tended to change the way that reality was represented, however, by "normalizing" unusual variations in the data. If pesticide prices, for example, are standardized, specific variations in price, relating to factors, such as the "non-legal" pesticide trade on the Colombian border, might be missed. An analysis of the data would then exclude a consideration of the networks that farmers develop outside the country. A particular pesticide might be available on the border for a fraction of the price that would have to be paid in Ecuador. My goal was to expose the variations in the data rather than standardizing them.

I collected data on each potato field by visiting farmers every two weeks during the potato production cycle. This is known as dynamic data collection because it accompanies the different stages of the cultivation of the crop. Most of the visits were to the fields themselves rather than to the farmers' houses. The visits were arranged so as to not interrupt the farmers' work. Some were made in the evening when the farmers returned home and some in the early morning before they left for the fields. I employed a farmer in each community to help me with data collection. These assistants helped me to collect information from a total of 94 fields every two weeks.

None of the farmers were initially willing to work with me. They considered surveys to be "useless" and something that "only extension workers do." They did not want to be perceived as extension workers. Three male farmers and a woman eventually agreed to be part of my research team. They were all from different communities.

Some farmers began to ask the farmers from my team for technical advice in the course of the research. My assistants gained confidence after one or two visits to the study fields. Three of them had participated in Farmer Field Schools and were reasonably familiar with the process of filling in forms. Initially, my assistants believed that the data from different potato fields and from different farmers would be very similar because "all farmers do the same thing." After the second survey, however, they began to realize that "every farmer did something different." The team became increasingly motivated as their interest in the project increased. One assistant told me: "This is like getting into my friend's head." Three members of my team included their own fields in the study, and two of them also included the field belonging to their associated farmers' group.[48] Most farmers were willing to give information about their activities, but many of them did not want feedback regarding their finances, a matter considered to be a source of misfortune (*mal agüero*). The community whose members were most hesitant to give information was one in which many farmers had been losing money. Nineteen farmers in this community eventually agreed to cooperate on condition that information regarding their financial status was not giving back to them. Farmers avoided talking about financial losses in order to maintain confidence in their future endeavours. They believed strongly in the concept of *fortuna*, or good fortune. I will return to this phenomenon in Chapter Seven.

Working with a team of farmers was the most efficient method of data collection that I observed in Carchi. This was because all the farmers participated for the duration of the potato production cycle. The subjects of

[48] Some farmers decided to conduct their own research in groups after participating in Farmer Field Schools, and some have tried to create formal farmers' associations.

the study were more confident talking about their activities to fellow farmers than to extension workers. Only one of the 95 fields that were initially included was omitted from the final study. One farmer was excluded from the study after the third visit because, according to my team, his information was not reliable. As one member of my team said:

> Javier told me that he sold his potatoes for 12 dollars a quintal the same day that I sold mine for four! So I asked him, did you sell your potatoes to the *gringos*[49] or what? And then he explained that potatoes were actually sold in two lots: the first lot in Quito three weeks ago, when the prices were actually higher and another part in El Angel at four dollars a quintal.

In such cases, the team relied on their own experience to correct the data.

Sample selection "well mixed"

There were two main selection criteria for the study. Firstly, the farmer had to be willing to cooperate for the duration of the potato production cycle. Secondly, the fields needed to be "*bien mezcladito*" (well mixed), or as diverse as possible in terms of the farming styles practised. Although a wide variety of farming styles was evident in all the communities, a particular style predominated in each individual community.

We selected potato fields that were still at the soil preparation stage, so that we could study the entire production cycle. We included potato fields under full tillage in Mariscal because most farmers in this community produced in the *wachu rozado* style (a traditional minimum tillage potato planting system[50]). *Wachu rozado* facilitates effective soil drainage and is thus suitable for Mariscal with its heavy rainfall. In addition, most of the fields in Mariscal were on steep hillsides inaccessible to tractors. *Wachu rozado* fields were uncommon in the other three communities where the rainfall was lower. The farmers regarded *wachu rozado* as unsuitable for dry soils. They believed the low rainfall in these areas was due to deforestation and the burning of *páramos* (high wetlands). Full tillage was common and tractors were used where possible.

We only found one field that was farmed by a woman, although I had found four during my previous research in Carchi (Paredes 2001). We

---

[49] Gringo is a nickname usually given to US citizens but in Ecuador it is also used for all tall, white foreigners. Since the local population regard foreigners as rich people they tend to charge them more for commodities in the open market where prices are not fixed.

[50] *Wachu* in Kichwa means furrow and *rozado* in Spanish means cut. This describes the system of forming furrows by cutting sod mats and bending them towards the centre of furrow where the potato seed is planted.

studied different sized fields to see if there were a correlation between styles of production and field size. Farmers from San Francisco tended to work smaller fields than farmers in Santa Martha, but both communities had fields of different sizes.

We included farmers who had participated in Farmer Field Schools as well as farmers who had not undergone any training. The FFS-trained group consisted of several farmers who had attended up to three rounds of training (each one lasting for 6 months) and two farmers who were FFS facilitators.

It was very difficult to find farmers who had not participated in some form of training by pesticide companies. One farmer explained:

> …because most of us have received visits from the *técnicos* [technicians], others [other farmers] have been to courses, [and] even the small kids have gone to parties or sports days organized by pesticide companies… See, I am wearing this pesticide t-shirt and hat.[51]

Each assistant was able to visit one or two fields every day and coordinate these visits to suit the owners' work schedules. Each assistant visited 20 to 30 fields twice a month, while I visited all the fields at least twice during the course of the potato production cycle. We used a notebook to record qualitative data during field visits and designed forms for the recording of quantitative data. Each visit to a farmers' field involved observations and a review of the farmer's activities during the period since our last visit (usually a week).[52] All the quantitative and qualitative data relating to each task was documented in a way that enabled me to analyse the network of relations involved. During a typical visit we might, for example, record the date of the second fertilization and the quantity and types of fertilizer applied. The cost of the fertilizer and how it had been acquired would also be noted. Other information recorded would include the kind and cost of labour utilized for the task and descriptions of specific arrangements concerning the production process, such as those related to food requirements for labourers and the agreements within the family for food preparation.

---

[51] The hat and t-shirt advertised a brand of pesticide. The hat was given to all farmers who could answer pesticide-related questions in a meeting and the t-shirt came as part of a pesticide promotion package.

[52] The next appointment was confirmed with the farmer during the course of a visit. It was not always possible to predict all the activities that would take place in the period between visits. (e.g., pest controls measures could fluctuate). Sometimes the planned tasks had not been finished by the time of the visit.

The final presentation of quantitative data resembled data that might have been collected only at the end of a production cycle. However, the dynamic methodology of this study (following the network of relations through continuous visits during the production cycle) enabled me to understand the results of the analysis more deeply.

Living with the "families"

I stayed with different families (20 in total) in each of the four communities while the quantitative data was being collected. Different families were chosen according to their farming practices. I lived with five families for ten days (2 days with each family) in each of the four communities. In other words, I worked with 20 families over a 40-day period. For the second part of my research, I lived for a period of two weeks with each of eight families (2 from each community for a total of 4 months). I was already acquainted with most of the farmers from my previous research and so it was not awkward for me to live in their homes and work with them in their fields.

I participated in the daily farming activities during my stay with each of the 20 families. I would discuss various relevant issues with the farmers and their families at night. I participated in a wider range of activities with the eight families with whom I stayed longer, both on and off the farms. These included selling potatoes, buying pesticides and taking part in family or community meetings.

I explained to each family that I wanted to learn about the different ways they produced potatoes in order to write a thesis. I asked to be employed without payment as an unskilled labourer for two to four days. Families generally accepted this proposal eagerly, but when people did not respond to my request I did not ask again.

I lived with each family for a period of two to four days, depending on their activities and the weather conditions. In Carchi it rains frequently throughout the year, and it is not always possible to work in the potato fields. I usually worked with family members on potato production activities for two or three days and on cattle and home-based activities for one day.

I gathered information about matters I wished to explore during daily talks with family members. Farmers were willing to explain their different practices to me in detail. Children were especially helpful because they were willing to talk about sensitive subjects such as pesticide poisoning in a more open way than adults were. I took notes during coffee breaks and after meals and recorded my own observations during the course of the day.

I made comparisons between the ways various tasks were performed by different families. These included how they managed costs and made decisions. I prepared a list of questions before I returned to a particular farm, in order to help me with this process. Some activities were performed in ways common to a group of families, but some families had unique ways of performing certain tasks. I will examine differences in Chapter Four.

The units of analysis

I interacted with all the people in a household, not just the owner of the potato field, whom I refer to as the "the farmer" in this study. In some case these "farmers" were younger sons who still lived in their parents' homes. Each of these farmers had a different arrangement with the rest of the people living in a particular house. Sometimes more than one family lived in the same house and the families sharecropped the potato field. Some of these working relationships could not strictly be considered as sharecropping because the agreements regarding inputs and harvest were not clearly established. Although families did not always contribute equally to the production process, the benefits were often distributed according to need rather than input. In addition, there were a variety of different working arrangements involving land tenure, the supply of potato seed and other elements of potato production.

I treated the family or families living in a particular house as a "unit" because it was not possible to distinguish methodologically between families living in the same house. I also did not take the boundaries between households into account in cases in which families lived in different houses but shared production resources. My analysis drew on empirical evidence and focused mainly on the relationships within and between the families that were involved in the process of potato production. I have used the term "family" in this study to refer to persons living in the same house, and the term "farmer" for the person or persons (men, women and sometimes teenagers) who participated in agricultural production.

In order to differentiate farming styles, I have identified families living together in a house as the "unit" of negotiation that structures a farming style. To avoid the sort of ecological fallacy[53] that Bernard warns against, I have designated the "farmers" within a family rather than the family itself as the lowest unit level of analysis. The term, "informants", often refers to

[53] "Drawing conclusions from the wrong units of analysis - usually making generalizations about individual people from data about groups - is known as ecological fallacy" (Bernard, 1988: 47).

children. I also refer to potato fields as material units in relation to which farmers, their families and labourers make decisions regarding the potato production process.

Different units of analysis are more evident than others in each of the chapters in this thesis. In Chapter Four, for example, the "family," the "farmer" and their relations to potato production are emphasized. In Chapter Five, the potato fields are viewed as visible units where farmers and their families materialize their styles. In Chapter Six, the relationships between farmers, their families, labourers and pesticides are foregrounded.

Narratives and description of situations

A narrative is a form of storytelling that presents events in a linear fashion and imposes a preferred version of events (Howard-Malverde 1997: 13). In Chapter Four, however, the actors' narratives that I present offer contrasting views. These views underpin various observations I make and also help to explain the different family histories that are involved in the process of agricultural production.

In Chapter Six, I draw on farmers' narratives about pesticide use and toxicity as an analytical device to understand the ways in which interviewees relate their experiences (Green and Thorogood 2009: 213). I contrast these narratives with my own participant observation of specific pesticide application. I sometimes refer to sensory descriptions of pesticide use (e.g., the "smell" of pesticides or the fatigue and hunger felt during pesticide applications) in order to describe these situations in a more comprehensive way (Pink 2009).

Chapter 4

Potato Farming Styles in Carchi

This chapter illustrates how potato production is embedded in the social environment of different families. The following case studies describe how a community's history of family, culture, labour relations and land acquisition determines the extent to which farmers choose to be involved with modern markets and technology. The studies also shed light on how farmers compose and interrelate the social and material elements of a particular farming style.

The case studies use qualitative material collected by the researcher while living with families in Carchi. Local narratives are combined with the researcher's observations. The analysis explores diversity in farm management and establishes a foundation for the quantitative research that is pursued in Chapters Five and Six.

Overview of farming styles

Context

I characterized three farming styles in Carchi in the year 2000. This was done by the analysis of qualitative material collected from the study of nine families living in Carchi and my observation[54] of farmers' training meetings. This research formed the basis of my MSc thesis. It was done in collaboration with the International Potato Centre (CIP), which had implemented a research and intervention project (Ecosalud[55]) in three different communities in Carchi. The intervention applied Farmer Field Schools[56] (FFS) methodology to train farmers how to reduce their use of

[54] Refer to Appendix 4.1 for the methodology, timing and sample selection of this research.

[55] The project intervention aimed to reduce pesticide poisoning in three communities in Carchi: San Francisco, Santa Martha and San Pedro. It involved basic research on productivity and the consequences of pesticide use on health, as well as intervention activities to promote safer use of pesticide and more integrated crop management (ICM). The three-year project started in 1998 and was implemented by the International Potato Center (CIP) and the National Agricultural Research Institute (INIAP) (Paredes 2001).

[56] The Farmer Field School methodology is defined as "a field-based learning experience that lasts for a full cropping season" (Gallagher 1999, LEISA 2003a and b, van der Fliert 2006)

pesticide in potato production. Ecosalud was starting a second cycle[57] of FFS, and the researchers and trainers were interested in understanding why farmers were interested (or not) in training. I chose a sample of families from participating communities. My objective was to describe local farming styles and to analyze not only the level of interest in FFS but the reasons for this interest. Three groups of farmers were initially identified: *Arriesgados*, *Intermedios* and *Seguros*. My MSc research concluded that the level of participation in training activities was related to each farmer's unique aspirations and expectations. FFS focused on the utilization of local human and natural resources for pest management. Most of the farmers who participated in the training sessions were *Seguros* who were interested in learning how to reduce their monetary costs. A very small proportion of participants were *Arriesgados*. *Arriesgados* generally tended to rely on modern technology and viewed the FFS activities as a way of gaining access to new potato varieties. Most *Intermedios* did not sustain interest in FFS. These farmers were chiefly interested in access to credit facilities. They regularly missed meetings and very few completed the six-month training course.

Two families that planted potato in *wachu rozado* were included in my sample. W*achu rozado* is an uncommon, pre-Colombian, reduced tillage system. It provided interesting opportunities for the potential reduction of soil erosion and the suppression of soil pests. These families maintained that this system of cultivation produced good quality potatoes. CIP had carried out an analysis of existing data from the study communities in 1998, and had concluded that *wachu rozado* appeared to reduce pest attacks and hence the need for pesticide application (Sherwood 1998). Despite these findings, CIP and the National Agricultural Research Institute (INIAP) had largely overlooked this promising system in their research in Carchi. CIP and INIAP conducted a pilot study of *wachu rozado* in four communities in 2000 (INIAP-CIP 2004), based on surveys and controlled experiments. The results corroborated the earlier observations, but the research did not include data from actual farms (Appendix 4.2 provides a summary description of *wachu rozado* and the findings of the initial studies).

I looked at a broader population of farmers, beyond the CIP intervention area[58], during my second research project in 2003 and 2004. The sample

---

[57] Each Farmer Field School training cycle ran for six months.

[58] Chapter 3 explains the selection of the 'sample' for this research. In all, I worked closely with 20 families, participating in and observing their daily activities, both on and off the farm. I included the fields of these 20 families in my periodic visits to 94 potato fields belonging to various families. The purpose of these visits was to document in detail all the

group for this study included a community that lay outside the Ecosalud research area. Mariscal Sucre was locally renowned for the practice of *wachu rozado*. The study of this community lead to the identification of two additional farming styles that were clearly differentiated from those found in 2000: the *Experimentadores* and the *Tradicionales*.

None of the farmers who participated in the CIP training sessions were *Experimentadores*. The *Tradicionales* were mainly farmers practicing *wachu rozado*. The *Intermedios*, identified in the first study in 2000, were designated as a sub-group of *Arriesgados*. The *Arriesgados* were known locally for having lost their capital after *dollarization*. In order to maintain production without modifying their style too much, these farmers resorted to sharecropping with "rich"[59] farmers. For this reason this style is not presented here as a distinct group.

Appendix 4.3 details the sample selection for this chapter and Chapter Five. Qualitative data was collected by means of extensive participant observation and interviews during a five-year period (2000-2004). The quantitative analysis, presented in Chapter Five, represents only one potato crop production cycle, but involves a larger population of 94 farmers. In the following section, I summarise each of the four styles studied in this thesis, as per the participants' own characterisations and terminology. In addition, farmers practicing a competing style provide a brief description of the others. These critical opinions will be emphasized in order to shed light on how different practices are inserted into the broader community.

Description of farming styles

Tradicionales

The style of farming of the *Tradicionales* involved high levels of labour use and the specialization of the labour force in order to cope with the demands of *wachu rozado*. This system of cultivation maintained good soil quality and produced high yields and benefits.

Tradicionales (traditional farmers) prioritized the management of the application of pesticide and fertilizer based on daily observation and

---

practices performed in the potato fields for one production cycle. Most of my time was spent with the 20 families collecting data for this chapter. I had the support of a team of farmers who visited the 94 potato plots every two weeks. They collected most of the quantitative data shown in chapter 5.

[59] "Rich" was defined by this group as farmers who had access to capital (either their own or by means of loans) to invest during the potato cycle.

monitoring of crops. They worked very closely with their labourers to ensure efficient and technically correct application of agrochemicals. The quantity of pesticide and fertilizer was of less significance to them than the timing of application. Farmers themselves coined the name *Tradicionales*. It suggests a strong sense of pride in maintaining their "old" ways of producing potatoes. An *Arriesgado* described the *Tradicionales style* as follows:

> Those who produce in *wachu rozado* make things too difficult; they usually plant more than 100 quintals [of potato seed] at once. If you see, they are living close to the Colombian border, because they are Colombian descendants and produce in the old fashion, thus they have to spend lots more on labourers than on other things. That is why they have to work beside their labourers; otherwise they could not afford to pay the fortune they would have to pay. Even their families sometimes work in their fields because they want to decide how much fertilizer they should apply in each plant. That is why these people who are still traditional can only produce in sharecropping in order to make ends meet [for potato production]. They are so extreme that they want to check their crop everyday.

Education, particularly of women, was a priority for *Tradicionales,* and many families aspired for their children to become professionals. They felt that agriculture in general, and potato production in particular, was becoming ever more difficult and financially risky. They valued farming as a worthy occupation, however, and were not opposed to one of their children taking over the management of their farm.

Seguros

The *Seguros* style compensated for poor soil quality by prioritizing the use of large quantities of seed. Their pattern of practice, based on continuous potato cultivation under full tillage, gave low production per hectare. The poor yield was exacerbated in many cases by the steep slopes upon which they farmed. They used tractors to till fields that were not too steep.

The *Seguros* invested little in external inputs when compared to other styles in Carchi. The name (secure ones) refers to their aversion to monetary risk. They did not take bank loans and limited investment in potato production according to their available resources. *Seguros* were locally considered *"poor"* for this reason. A *Tradicional* described the *Seguros* style as follows:

> These farmers are too *Seguros*, they plant between one and 50 quintals and also produce in sharecropping but only with their family. They do not take loans and mostly work exchanging labour (*mano vuelta*).

Seguros, however, characterized themselves as "independents", because they were not indebted to the banks and did not work as labourers. They produced mostly by sharecropping with family, friends and *compadres*. According to *Seguros*, "being a labourer was like being a slave," and sharecropping with a "rich farmer" disempowered the less wealthy partners with regard to making decisions about their own fields. The *Seguros* regarded their pattern of production as stemming from the breakdown of the hacienda system.

The production rates of *Seguros* had been decreasing and some of these farmers were consequently reducing the area of land dedicated to potato production in order to increase their investment in cattle and milk production.

Seguros and their families prepared their children to eventually take over the farm by teaching them to cooperate and to produce with minimal monetary investment. Gender relations within these families were strongly linked to decision making. There were constant negotiations between men and women. The women managed dairy production and capital flowed freely between the systems of dairy and potato production.

Arriesgados

The *Arriesgados* style relied on high levels of mechanization and high use of fertilizer. Despite these measures, the low soil quality meant that production per hectare was still low. Only a few *Arriesgados* recovered their input costs in 2004, and even fewer managed to make any profit[60].

Arriesgados (risk takers) were often wealthy farmers who had accumulated their own capital in occupations other than farming (e.g. as traders). The term *Arriesgados* referred to farmers who financed large investments in potato production by means of bank loans, and who modelled their production systems on the "modern" hacienda system. Most of the inputs for their production were market-acquired. Large investments were related to farmers' values of wealth and social identity as "pure potato producers" (*paperos puros*) or as "complete" farmers (*completos*), because they invested everything they could in a crop that was considered a "lottery game." The motivation to continue this form of production came from the many examples of *Arriesgados* who had "good luck" in earning high revenues that completely changed their economic status, allowing them to purchase

[60] I use the word "profits" for monetary return after the deduction of production costs. "Benefits" refers more generally to monetary and non-monetary returns.

vehicles, build relatively expensive houses, send their children to study in the capital etc. These "lucky" farmers were one reason why people referred to *Arriesgados* as "rich farmers."

Potato yields and benefits had been decreasing in the decades prior to this study. Cattle production was thus becoming an important element of the farming strategy. Investing their profits from potato production in cattle helped them to withstand the instability of market prices or crop failures. A *Seguro* farmer described the *Arriesgados* as follows:

> Farmers who took all the risks 20 years ago were able to build a good house and buy a nice car, but if you visit them now, their house is not well painted anymore and many of them had to sell their cars after *dollarization*. But yes, they continue to plant between 50 and 100 quintals [of potato seed], because they are not afraid to take loans as they plant in sharecropping with rich farmers. These farmers almost never exchange labour because they don't like that people bother them asking for their labour in return.

Arriesgados preferred to use paid labour because they did not like to feel indebted to those who worked for them. Paying wages was less complicated than exchanging labour, working with family or paying in kind. *Arriesgados* mostly hired individuals but were also known to use teams of workers (*cuadrillas*) and to mechanize production in order to reduce labour costs.

Gender roles within *Arriesgados*' families were clearly defined. Women rarely participated in field activities but were in charge of pigs, chickens, guinea pigs and other home-based activities. Men and women jointly made most decisions regarding overall investments, but men usually made decisions specifically regarding potato and cattle. Risk was a central element of the *Arriesgados* farming strategy. They believed that perseverance would provide the resources necessary for educating their children and "preventing them from becoming peasant farmers." Children were encouraged to become "professionals" rather than to take over the farm.

Experimentadores

Experimentadores farmed intensively but sustainably on small fields using family labour. Because *Experimentadores* did not have cattle that went into the fields in fallow, they reincorporated weeds and leftover crops into the soil after each production cycle in order to boost their yields by maintaining soil quality and minimizing erosion. Although they did need to use foliar fertilizers to a degree, their overall fertilizer input was considerably less than in other styles.

Experimentadores lacked capital and considered family labour as "the capital of the poor." They believed that family put more "care" into tasks such as soil preparation, seed selection, planting and hilling-up. Such care and attention was possible because their fields were very small. An *Arriesgado* described the *Experimentadores* as follows:

> The poorest farmers do not even have enough land and only plant in sharecropping, like my brothers in law. They go on making miracles in order to make something out of their land but they don't have money for most crop [chemical] treatments or fertilizer so they apply the cheapest [chemical] products that they can find in the shops.

Unfortunately, *Experimentadores'* high use of carbofuran (a cheap but highly toxic pesticide) put them and their families at risk of pesticide poisoning.

By sharecropping with family members, *Experimentadores* gained access to seed, labour, oxen and even agrochemicals. Often the cost of these resources was paid back after harvest. Due to their limited resources they had to "experiment" with new methods and "find their own way" in order to make a living from agriculture. They experimented in order to keep producing for the market while investing as little money as possible. For this reason, farmers from other styles considered *Experimentadores* as "playing with the land" and "not true farmers."

Experimentadores encouraged women and children to acquire formal education, as they considered handing over the farm almost impossible due to the limited availability of land. Women usually studied or participated in community activities and men shared the responsibilities at home. The women in two of the families had established a family fund dedicated to finance the rearing of small animals such as pigs or guinea pigs.

<u>Communities and the predominant farming style</u>

A specific farming style was predominant in each of the four communities studied in 2003 and 2004. *Tradicionales* were predominant in Mariscal, *Seguros* in San Pedro, *Arriesgados* in Santa Martha, and *Experimentadores* in San Francisco. The specificity of farming styles in each community was influenced by their history of land acquisition. Their experience of land redistribution shaped their attitudes towards traditional practices and the use of natural resources.

Land acquisition and origin of the communities

Table 4.1 summarizes the history and characteristics of each community in 2004. The communities of Mariscal and San Pedro originated from haciendas described by some politicians and historians as "modern" and "progressive."[61] The owners of these haciendas were considered "modern" because of their early adoption of technologies and production systems that considerably reduced labour demands. The term "progressive" was applied to hacienda owners who identified the problem of *precaristas*[62] early on and developed strategies to solve the problem. These hacienda owners usually maintained good relations with their servants and many of them willingly sold portions of hacienda land many decades before land reform. Much of this land was hilly but still forested. This had important repercussions because the forests provided peasants with a means of income by selling forest products such as wood and charcoal. This source of revenue enabled the inhabitants of areas such as Mariscal and San Pedro to pay off fields of land and to subsequently develop their potato farming styles over some decades. A farmer from Mariscal explained:

> People from Mariscal used to live off charcoal selling and other products from the forest. They needed money to pay for the land and for their living expenses. My father says that the only possible job in the 1940s was the exploitation of the forest because the rains were strong and did not stop through the year. Little by little farmers cleared the forest and started planting *melloco, oca, mashua* and potato [Andean tubers]. The potatoes that we planted most were *chauchas* [native varieties] and we only planted in *wachu rozado* because there was too much water on the soil. We cultivated where the forest had just been cut, thus the potatoes did not need pesticides or fertilizers because those lands were virgin [rich in nutrients and low pest populations]. We always planted in *wachu rozado* and only fertilized with animal manure from cattle and sheep.

Santa Martha and San Francisco, on the other hand, originated from "traditional" haciendas, where the hacendados were not willing to adopt "modern" technologies. Despite growing pressure from precaristas, these haciendas remained dependant on manual labour for their production. The relationships between workers in need of land and hacienda owners in need of labour were increasingly characterized by the bad treatment of workers.

---

[61] Chapter two explains in more detail the names given to different hacienda owners in relation to their positions and actions with respect to land reform.

[62] *Precaristas* was the name for the growing population of hacienda workers who increasingly applied pressure on hacienda owners for land. See chapter two for a more detailed explanation.

Table 4.1. Community characteristics

	Mariscal	San Pedro	Santa Martha	San Francisco
Predominant farming style	*Tradicionales*	*Seguros*	*Arriesgados*	*Arriesgados* and *Experimentadores*
Hacienda origin and relationships	El Vínculo and then el Salado; "modern" and "progressive" haciendas. Workers had good relations with hacienda owners.	El Vínculo and then el Salado and Indujel. "Modern" and "progressive" haciendas. Workers suffered harsh treatment.	El Quatis; "traditional" hacienda poorly managed by absentee owner. Workers suffered harsh treatment.	La Rinconada and Rinconadita; "traditional" haciendas. Workers suffered harsh treatment.
Land acquisition	1932, 11 families, organized by local leader, peacefully purchased 800 ha. by assuming hacienda debt.	1942, 45 outsiders peacefully purchased land from el Salado. In 1960, 250 additional workers purchased land from Indujel.	Agrarian reform in 1971. 103 workers and others, organized by outsiders, seized land; eventually purchased through negotiated settlement.	Agrarian reform in 1972. 180 workers and others, organized by outsiders, seized land; eventually purchased through negotiated settlement.
Geographical aspects and characteristics at time of acquisition	Eastern flank, 2,800-3,400 m. sloped to steep terrain; heavily forested.	Eastern flank, 2,900-3,400 m sloped to steep terrain, heavily forested.	Western flank, 2,800-3,200 m. flat to sloping terrain; deforested.	Western flank, 2,900-3,600 m. sloped to steep terrain; mountain environs.
Economic development	Charcoal exploitation (1930s-1960s). Subsistence agriculture and high diversification (1940-1964). Slow conversion to potato and pasture (1960-today).	Charcoal exploitation (1945-1980). Subsistence agriculture and high diversification (1950-1964). Slow conversion to potato (1980-today).	Immediate conversion to potato production and rapid technification (1975). Slow conversion to pasture (1980-today).	Subsistence production (1975). Slow conversion to potato and pasture (1980-today).

Table 4.1. Community characteristics (*continued*)

	Mariscal	San Pedro	Santa Martha	San Francisco
Natural resources available for agriculture in 2004	Guanderas reserve, a privately managed Inter Andean forest. Productive soils with slow erosion. Good water sources.	No forest. Medium to low quality soils due to mechanical erosion. Water sources only in lower lands close to river.	No forest. Low quality soils due to mechanical erosion. There are no water sources.	El Angel reserve, a *páramo* environment managed by the state and an NGO. Acidic soils with high organic matter content. Good water sources.
Climate: rainfall and average temperature (2004)	1,050 mm/year and 11.5 °C. Good rain distribution.	950 mm/year and 11.5 °C. Longer drier seasons.	800 mm/year and 12.5 °C. Longer drier seasons.	1,200 mm/year and 10 °C. Longer drier seasons.
Potato pests and diseases (2004)	Late blight and foliar insects.	Late blight, Andean weevil and *polilla.*	Late blight, Andean weevil and *polilla.*	Late blight and Andean weevil.
Principal markets	San Gabriel, Tulcán and Quito.	San Gabriel and Ibarra.	San Gabriel, Tulcán and Quito.	El Angel, Ibarra, San Gabriel and Quito.
Population (2003)	200 households.	120 households.	250 households.	180 households.

Source: Adapted from Sherwood 2009.

Land reform forced "traditional" haciendas to distribute land. This process involved much resistance and conflict. The Ecuadorian state bought the land from hacienda owners and sold it to hacienda workers who had to make an initial deposit followed by monthly payments. Peasants in these two communities thus became indebted to the state in the process of land acquisition.

In Santa Martha, the land sold to the workers was part of the former hacienda itself, while in San Francisco the land acquired was mostly in the *páramos* (fragile wetland environments). Farmers from these two communities had to sell their livestock in order to make the initial payment for the land. This was unfortunate at a time when they were beginning to produce for the market. They lost their valuable supply of animal manure (an important natural fertilizer) and were forced to buy chemical fertilizers to increase the commercial production of potato. A farmer from San Francisco explained:

> In our life we had never heard of the quantities of money that we had to pay for the land. In the hacienda I first earned two reales per week and the last I earned was five sucres[63] [per week]. Suddenly we had to pay 800 sucres per hectare of land! Thus we sold all the cattle and sheep we had but we still could not pay the debt. With that worry, we slowly started selling potatoes in El Angel but we had to take loans in order to buy the agrochemicals, otherwise we could not produce enough. Moreover, we did not have the manure from our animals so we had to buy chemical fertilizer. With the money from loans we felt rich, we never counted that much money before. We did not realize that we had to pay back with interest, so we had to produce in order to sell again and again, and we got indebted.

Natural resource management and the development of farming styles

Tradicionales and *Seguros*

The economic development of Mariscal and San Pedro were similar in that the first inhabitants cleared the forests to prepare the land for agriculture. In the years prior to land reform (Mariscal in the 1940's and San Pedro in the 1960's), peasants in both communities produced a wide variety of crops mainly for home consumption. After land reform, however, potatoes became the principal cash crop thanks to the growing market for potatoes. This shift in production was further encouraged in both communities by the availability of credit for the purchase of agrochemicals. Although Mariscal and San Pedro originally shared similar climates and hilly soils –ideal for potato production in *wachu rozado*– only Mariscal retained its system of reduced tillage, green manure and intensive labour. The practice of *wachu rozado* was closely linked to high soil humidity and high rainfall[64]. Such conditions were in turn affected by the proximity of forest. In 1994, there was an extensive remnant of the Inter Andean forest in the upper hills of Mariscal. This forest became the Guanderas reserve, managed privately by an NGO with the participation of local leaders and foreign volunteers. Peasant farmers in San Pedro had, in contrast, divided up and cleared the forest by the early 2000s.

Wachu rozado was practiced far more in Mariscal (mainly *Tradicionales*) than in San Pedro (mainly *Seguros*) in 2004. The Guanderas reserve forests created humid conditions and well-distributed rainfall throughout the year in

[63] In the 1970s 1 sucre was comprised of 100 reales, and the exchange rate was about 25 sucres to 1 US dollar, according to the Ecuadorian Central Bank data.
[64] *Wachu rozado* facilitated the drainage of excess water. Farmers cut and bent grassland sod mats towards the centre of a furrow where the potatoes were planted (see appendix 4.2).

Mariscal. The practice of *wachu rozado* allowed farmers in this area to maintain good soil quality and created unfavourable conditions for the Andean weevil to lay its eggs (see Appendix 4.2). The humid conditions, however, were conducive to continuous late blight attacks. In contrast, San Pedro was drier than Mariscal due to the absence of forest. Farmers here could only produce potatoes if they used spray irrigation. The practice of farming under full tillage in hilly soils degraded the soil. The incidence of late blight (*Phytophtora infestans,* locally called *lancha*) was slightly less than in Mariscal, but the dry soil and weather were more favourable for infestations of Andean weevil (*Premnotrypes vorax*, locally called *gusano blanco*) and potato tuber moth (*Tecia sp.*, locally called *polilla*).

Arriesgados and *Experimentadores*

Santa Martha and San Francisco both acquired land long after land reform. Farmers from Santa Martha had access to relatively flat areas of medium quality land which had previously been managed by the hacienda as grasslands. Their land was close to the Pan American highway, giving them easy access to Colombian and Ecuadorian markets. They rapidly developed a farming style (mostly *Arriesgados*) based on the use of available "modern" technologies. Mechanized full tillage was practiced far more than in the other three communities. The result was that in 2004 Santa Martha had low quality soils due to erosion. The soils were acidic from the intensive use of chemical fertilizers. In addition, the warm, dry weather in this area was highly favourable for the reproduction of the potato tuber moth and the Andean weevil. Farmers in San Francisco, on the other hand, obtained mostly *páramo* land without easy road access. They took longer to clear their land of *páramo* vegetation and initially produced a wide variety of crops for their own consumption. The *Arriesgados* style thus developed more slowly in this community. The soils in San Francisco were of better quality than in Santa Martha in 2004. *Experimentadores* in San Francisco had access only to small fields of land because the land had been repeatedly divided to enable inheritance within large families.

Families representing each farming style

In this section I describe four families who represented each farming style[65]. The Cruz family in the community of Mariscal represented the *Tradicionales.* They produced potatoes by sharecropping. In San Francisco, the Fuentes

[65] The surnames of families and the names of individuals have been modified for anonymity.

family represented the *Seguros*. They also produced potatoes by sharecropping, but only within their family. The Olivo family from Santa Martha produced independently (without sharecropping) and represented the *Arriesgados*. Finally, the Taimal family from San Francisco represented the *Experimentadores*. I had worked with both the Fuentes family and the Olivo family since 2000 and it was therefore possible to compare the production figures for the same field between 2000 and 2004.

Cruz family: *Tradicionales*

"We are not just old fashioned [chapados a la antigüa], we know that in this land the pesticides and fertilizer produce more and best in *wachu rozado*."

Family history and agriculture

Norman Cruz (40) and his wife Glenda (38) had been married for 12 years. They had two children, 10 and 12 years old. The family owned a food outlet and lived in a double-storey house. They were one of the most prosperous farming families in Mariscal.

Norman's father was one of the first farmers to buy land from the hacienda in 1933. He made a living selling charcoal that he produced from forest trees. Norman was one of seven sons who worked with their father. He studied engineering at university for a period but identified himself primarily as a farmer:

> I was born and reared here and I think I will die here. I have been a farmer since I was 12 [years old]. My father sent me to study high school in Huaca, but every afternoon I came to work in the farm and when I graduated I went to study textile engineering in Ibarra. One day I came back for holidays and I met my wife. We decided to marry right away because we were old and I did not return to study in Ibarra anymore.
>
> Agriculture was inherited from my father and I continue to live from that. I am proud to say that I know how to produce potatoes in *wachu rozado* because, even if I had the money to spend in agrochemicals, without *wachu rozado* we could not have the good soil that produces the quality of potatoes we have here. Then we could not live from agriculture, we wouldn't be farmers.

Potato production practices (technology)

a. Multiple applications of chemical fertilizer

Norman applied quantities of fertilizer similar to farmers practicing other styles in 2004, but he made applications more frequently and at different stages of crop development. He also varied the dosages depending on the crop's requirements. Norman took soil samples that he sent to Quito for analyses. This was very rare in Carchi but more or less common in Mariscal. Norman explained some of his practices:

> People say that the money of the people can be seen in the sacks of fertilizer applied for each sack of potato seed but I think the most important is the number of fertilizations, because the greater number of fertilizations is the best for plant growth and tuber formation. I apply at planting, then 30 days after planting when the potato shows its first leaves; we call that "*tape*." The third fertilization happens around two months after planting, and we call it weeding or "*retape*." It means that we will go weeding, applying fertilizer and hilling-up. For the third fertilization I use fertilizers with NPK, which I complement with a fertilizer that has sulphur and minor elements. Currently, I conduct a soil analysis in order to know what our soil needs, and we apply only those elements. But only a few farmers do this. Those who don't conduct a soil analysis apply fertilizers capriciously, without knowing the content of the fertilizer or what their soil needs. I also apply foliar fertilizers. Those we apply for the development (*desarrollo*), for the filling out of the tubers (*engrose*) and even for the flowering (*floración*). But if a farmer doesn't know what he is applying, he is just throwing his money away.
>
> In this field, we [he and his sharecropper] analyzed the soil only in the parts that looked poorer. We identify poorer spots where we see that this plant grows [pointing to a weed]. This is called *ollco,* and even cows don't like to eat that. We also know that where there are plants like *pacta, barrabás* and *lengua de vaca* the soil is rich in iodine or it is too acidic, thus it could prevent the plants from taking nutrients from the soil. In those parts we found out that the soil was poor in phosphorus and too acidic, so we applied 10 [quintal] sacks of lime (*cal dolomítica*) because it improves the pH of the soil and it seems to control even the *lanosa* [fungal disease]. In this field I practice *wachu rozado* twice, but the third time I turn the soil because the sun helps to kill the fungus.

b. Multiple careful applications

Norman was one of the farmers in Mariscal in 2004 working with an NGO that established experimental potato fields to investigate ways of reducing pesticide use. Nonetheless, he made numerous pesticide applications to control late blight during the study period of 2003 and 2004. He maintained that this was necessary given the weather conditions of Mariscal. He also applied pesticides with different active ingredients in order to prevent pest resistance.

> At present, for the control of late blight, I use Manzate and Kursate [fungicides]. It is important to rotate products so that the *lancha* [late blight] does not get resistant.

Norman did not use Carbofuran, the cheapest, most toxic, pesticide then available for the control of the Andean weevil. Norman was one of the few farmers who used cardboard beetle traps. He said it was worth doing so because he was afraid of the adverse effects of pesticide on his health.

Norman regularly used water pH regulators in the pesticide mixture to ensure that the pesticide was effective. As he explained, not all the farmers used pH regulators or knew how to use them properly:

> Some pesticides don't work when the water is too acidic like here in Mariscal. I use Ludicate that regulates the water pH. It comes in a drop container that we add to the water only until it gets pink. Most people don't know how to use it [Ludicate] and put the whole container in, thinking more is better.

c. Daily crop observations and "fine-tuning"

Norman and other *Tradicionales* made careful, ongoing observations of the crop and applied fertilizer whenever it was deemed necessary. Norman went to each potato field every day, even if for a few minutes, to observe the development of the crop and to identify late blight infections before they became too established. Even when there was no work to be done on a particular field he would check on it once or twice a day. I asked why he went to the fields so often and he replied: "*porque el ojo del amo engorda al caballo*" (because the eye of the master is what fattens the horse). This saying expressed the importance of observation for *Tradicionales*. Norman explained that daily observation and family labour were the only ways to cope with pest and disease attacks in a climate such as Mariscal's.

> If I don't go to the potato field it is like abandoning my child. It is even worse because potatoes don't cry, they only get lost (*lanchadas*) and then it is too late to give attention to the crop. With our weather it is not possible to wait until the next day. Sometimes we have to take decisions overnight because *lancha* (late blight) does not wait; it gets [attacks] the crop in few hours. If we apply in the morning because the potatoes are infected and it rains after application then we have to apply again. That is why we prefer to apply ourselves and ask our family to help. We cannot wait for labourers to come the next day.

d. Using their own seed

Tradicionales like Norman and his sharecropper generally had high production rates per hectare and had enough potatoes at the end of each production cycle to select and store their own seed potatoes. Norman said that the choice of varieties they planted depended on their market price, the "faith" of the farmer (on the performance of the varieties) and their suitability for *wachu rozado*.

> We select our own seed from each harvest because we want to know the quality of potatoes we are planting. But our seed also gets so weak every four or five years we buy new seed from our relatives in Huaca. We mainly produce the *super chola* (a potato variety of high production but susceptible to late blight) because of its price. Although there are a few varieties we have faith in, only one do we have faith as in a saint. Each farmer has a variety that is his favourite. Moreover, from the varieties that we have now, *super chola* is the one that produces best in *wachu rozado*.

e. Tradicionales' view of mechanization

Mechanization was becoming more common in Mariscal in 2004, and there were already a few tractors in the community. Norman called it an "invasion," but most farmers in Mariscal still preferred to plant in *wachu rozado*. Many years of planting in this style had shown farmers the benefits of the practice in relation to their specific farming conditions:

> The tractors invaded us in the 1970s. It was like an illusion. The first tractor was a Caterpillar; the owner of a mill brought that and tried it in the flatlands. We heard about that and we all went to see it with curiosity. The machine went faster pulling the disc plough[66] or tiller and threw the land up, more than people or oxen [could do]. That time we were all sad because we did not live closer to that machine but fortunately in our lands it was impossible to have one of those because there were not roads. The first harvest after preparing the land with tractor was always higher but later it decreased. That is why in Mariscal even people that have the money to rent a tractor still practice *wachu doblado* [*wachu rozado*] because it does not remove that much soil. Where farmers use the tractor we see soils that look like skulls and farmers continue to send the tractor as a vice or as a caprice. Is the same with the people who had the vice to cut the trees and suddenly had a sawing machine in their hands; they will cut everything even if they are suffering from dry seasons.

f. The soil: Planting in *wachu rozado*, *wachu doblado* and *wachu cruzado*

Wachu rozado was one of the most important practices that differentiated *Tradicionales* from other styles of farming. *Wachu rozado* is a reduced tillage, pre-Colombian system of cultivation used to plant potato in grasslands (natural or planted). *Wachu* means furrow in Kichwa, and *rozado* means cut in Spanish. Furrows were formed by cutting and lifting sod mats (see more details of this planting system in Appendix 4.2). It was generally possible to cultivate in *wachu rozado* twice consecutively on the same field. There were numerous ways to prepare the soil in *wachu rozado*, and farmers had different

[66] Farmers in Carchi use a sled of disk ploughs to prepare soil; these act as a break that slows the tractor down but they displace soil to the order of 80 to 150 tons per hectare (Veen 1999; Valverde *et al.* 2001).

names for variations of the system. The first time it was done on virgin grassland farmers called it *wachu doblado* (bended furrow) and the second time *wachu cruzado* (crossed furrow). Norman prepared each furrow by cutting two edges of the grass sod mats and bending them towards the centre of the furrow, where potatoes were then planted. Decomposition of grass within the furrow elevated the temperature and maintained a relatively dry environment for the plant. When the grass mixture included a legume (e.g. *vicia* or clover), nitrogen was contributed to the soil via this "green manure." Farmers used *wachu rozado* in highly humid places, such as Mariscal, and in steep areas inaccessible to tractors. Norman's field, however, was beside the road and was not very steep. Norman explained:

> I only plant manually because I want to take care of the land that I inherited for my children. I don't use tractor or oxen but only contracted *cuadrillas* [work teams] and hoe because I work in *wachu rozado*. *Wachu rozado* is the best. When the weather is too humid and the soil watery, we prepare the furrows in the direction of the slope and the water drains out fast and the potato plants stay dry. When the weather is humid but the soil tends to dry up fast, we prepare the furrows against the slope. The water does not drain fast and the furrows are humid enough for the potato plant. *Wachu rozado* is a cropping system on high ground, works well on humid and wet soils and also when it rains a lot, so that the plants have more strength and don't get rotten. It has two types of planting, one is a *piquete* and another is a *golpe*[67]. I plant a *piquete* but it requires more labour. The potato produced in *wachu rozado* is nicer and cleaner, because the tubers are not in contact with the soil and have a nice red colour that the buyers like a lot. Potatoes produced in *melga* [full tillage] are very dirty with mud [when harvesting].
>
> We can plant in *wachu rozado* twice in the same grass; the second time we turn the grass sod mats in the opposite direction. The third time we need to remove all the ground by hand, oxen or tractor if the tractor can enter the field. The third potato round [in the same field] I plant in *melga* [full tillage] but I do that by hand in order to remove the soil and plant grass for cattle.

Glenda also explained that rotating potato and grassland was more profitable because other crops were either less resistant to pests and diseases or sold cheaper in the market place.

> We plant potatoes three times then grass such as ryegrass, oats, clover and *vicia*. The grass produces two or three cuts (1 year). Some years ago we used to plant potatoes three times, then we planted *habas* [fava beans] and then grass.

[67] Planting "*a piquete*" involved removing the soil from the sod mats where the potatoes were planted. "*A golpe*" meant that potatoes were planted directly in the middle of the sod mats.

> Now *habas* do not grow because they get *roya* [a disease] and they only cost two dollars the *talega* [1 quintal weight with the vines]. We couldn't live on that.

g. The forest as a central resource for the Tradicionales

Norman was aware that the area's humidity was at least partly due to the presence of the *Interandean* forest reserve close to Mariscal. He said that the forest was highly appreciated by farmers, but admitted that this had not always been the case, and that the community had come to see the value of the forest more and more over the years.

> In 1994 the Jatun Sacha Foundation came to Mariscal and bought the remaining forest to start the Guanderas research station. At first there was a lot of resistance because people thought that there were gold mines in that forest and did not like foreigners there. Even now there are people that do not like the reserve because they cannot touch that part [for agriculture]. Before [the Jatun Sacha foundation came] there was nobody telling us about the further consequences of cutting all the forest and each person did what they thought was best. Then we started to see that the rain decreased far more than we wanted, and we felt that the forest had a function. Before we did not need many pesticides; now we have *gusano blanco* (the Andean weevil) and other pests because the land is drying up and warming up (*seca and calurosa*) while the forest is the one that "calls" the humidity. Thank God we have gas now so that we don't need firewood anymore. We have economic needs and we would like to expand agricultural production but we cannot do that if we don't have the rain that comes because of the forest.

h. Combining "traditional" and "modern" methods

Farmers in Mariscal, unlike those in the other three communities, were proud to produce in *wachu rozado*. They did, however, consider themselves "modern." They were proud of the fact that their production per quintal of seed (and per unit area) was higher than that of farmers practicing full tillage. For *Tradicionales,* the idea of "modernity" involved the ability to use the "modern" technologies, such as pesticides and fertilizers, efficiently to produce high yields while conserving resources. Norman talks about the marriage of *wachu rozado* and modern resources:

> I do not mean that *wachu rozado* is perfect. It removes the soil but it doesn't remove the same way as with tractor or oxen. We know this because even when we use the same amount of fertilizer as farmers that use tractors and work in full tillage [*melga*], we still get more production than those people. Also, in their fields you can see white [eroded] spots of land but not here. The main problem is that potato production is a vice (*estamos enviciados*): we plant only potato and too many times in the same land. Then we get pests and diseases like in other places, or even worse if we talk of late blight due to the

> humidity. Yet, without the rain we could not plant potato, without *wachu rozado* we could not produce in wet months with high yields. That is why during the year our third potato crop (in full tillage) usually coincides with the drier months. *Wachu rozado* is not cheaper either, but we know it produces more per quintal [of seed] and the tubers are of best quality and it is likely that they will be sold first. We are not just old fashioned [*chapados a la antigüa*] but we know that in this land the pesticides and fertilizer produce [*rinden*] more and best in *wachu rozado*. People believe that planting in *wachu rozado* is easy, but not everybody knows how to do it right. That is the reason why we are proud. It is like an inheritance from our ancestors because it keeps the soil fertile.

i. The labour process: Specialized labour and Colombian migration

Norman recognized that *wachu rozado* required more labour than full tillage, and he hired labourers so that a number of tasks could be tackled at the same time. He also contracted organized teams of labourers called *cuadrillas*. These teams were employed on a contract basis to complete a particular amount of work for an established fee, rather than being paid a daily rate. *Cuadrillas* did not expect food as part of their working arrangement, and they usually worked faster than individual workers. This made them cheaper than other forms of labour, but Norman had to make sure that the quality of work was acceptable. This involved the building and maintenance of long-term relationships with *cuadrilla* foremen. Norman also had to supervise the team to make sure that the members knew how to prepare the soil properly for *wachu rozado*.

> Labour here is not a problem. On Mondays there come four to five trucks with labourers from other parishes and from Colombia. I contract *cuadrillas* from Julio Andrade or from Colombia because our own people [from Mariscal] have bad habits and come to work at eight or nine in the morning and leave before five. Others have problems with alcohol. *Cuadrillas* instead leave only when they have finished the task and they do any kind of work you ask them to do. That is why here we harvest everything at once instead of in pieces as in other communities. Labourers from Mariscal are not obedient (*son resabiados*). If you ask them to bring a [potato] quintal they would say "what is going on? I don't do that job (*yo no soy carguero*)." Here the [local] labourer only works for 4.5 or five dollars. If you can't pay that they say, "but you are only a person like me" and they don't want to work for less than that.

I told Norman that I had not met many labourers in Mariscal and asked who the local labourers were:

> All of us who are here are labourers and we only work for five dollars a day! (laughter). Look, Mariscal is not a very poor town because everybody has some land and even then we are not ashamed to work as a labourer once in a while,

> mainly when we do that for our own family. But most people here don't like to work making the furrows for *wachu rozado* [*wachar*] because it is heavy and specialized work, while most *cuadrillas* are not afraid of the hard work. They even bring their own food and cook! Labourers from outside charge less and the owner only has to agree with the leader of the *cuadrilla*. Some of them are even my *compadres* whom I visit when I go to Colombia, or they bring me cheaper agrochemicals once in a while. During the harvest the *cuadrillas* do everything; they even bring their own materials such as sacks and rope. The owner is only in charge of taking the quintals by mule, horse or car if the potato field is far away.

Many *cuadrilla* members came from Colombia to work illegally. The exchange rate from US dollars to Colombian pesos was favourable for them, even when they were paid a fraction of what Ecuadorian labourers earned. There were problems with reliability, however, because immigration control at the Ecuadorian frontier sometimes delayed or refused entry to these workers. Norman explained:

> While Ecuadorian labourers earn five or six dollars per day, the Colombians come to earn three dollars because back home they exchange that for 8,000 pesos, while in Colombia they earn 5,000 pesos per day. Yet, once in a while Colombians cannot come because the controls are getting tighter at the frontier, so people from Mariscal are organizing as *cuadrillas* as well.

Inputs and potato markets

a. Buying inputs from local shops

Norman, like most *Tradicionales,* worked fields of one hectare or more. He bought agrochemicals in small quantities from local shops where he could often get credit. He would pay off the credit when he sold the harvest:

> Applying against late blight at the right time is very important, when people do not have money for the pesticides they buy here from known vendors that sell to them on credit until the harvest is sold. In order to buy in San Gabriel or Julio Andrade people have to buy in cash.

b. Selling potatoes locally: creating "good luck"

Norman belonged to a marketing cooperative called COPAPAC. This cooperative was organized by the Pastoral Social, the branch of the Catholic Church responsible for social work. COPAPAC provided credit to farmers and marketed potatoes in supermarkets and large shops (*comisariatos*). The cooperative paid an average of $10 per quintal in 2004. The price varied according to the size of the tubers. Farmers often committed their entire harvest to the cooperative. COPAPAC encouraged them to plant any of three commercial varieties: *super chola*, *fripapa* or *capiro*. According to Norman, COPAPAC also required participating farmers to submit soil samples for analysis at a laboratory in Quito, and recommended that farmers use non-toxic green label pesticides. Norman explained the advantages he saw in working with this cooperative:

> In the past, we used to agree on a price. Now it is not serious anymore and the price depends on the day we get to the market. Potato prices are different in different cities; there has always been a market in Carchi but once I wanted to go to Quito just to see how it was. I don't like to go there anymore because going to Quito means to travel overnight, and once we get there we have to wait for the trader woman (*intermediaria*) to sell everything. Once there, farmers buy alcohol (*puntas*) and start spending the money before they sell their product. Sometimes I was unlucky, not because of the potato production but because of the bad prices. The minimum price for us to benefit when going to Quito should be 15 dollars per quintal. You see, the transport to the truck is 40 cents per quintal, then the sacs cost 18 cents each and the truck to Quito charges 60 or 70 cents per quintal. We have to give bread and refreshments to the labourers and they will charge us 1 dollar per harvested quintal. Just for harvesting and transport we spend three dollars per quintal and then we have to pay to the trader 50 cents commission per quintal sold. I haven't talked yet of the costs of production. Maybe COPAPAC doesn't give us the best price, but it is certain.

Norman accepted the idea of "good luck" but felt that farmers could influence their own fortune:

> The good luck depends on the good prices, although we heard that bad prices occur because people here do not get organized and we all plant any time of the year; then some lose and some win. If we could get organized we could produce only in certain times when the prices are fine. As it is now, prices get so low that sometimes we don't even harvest and leave the potatoes in the field. Also we should not plant only potatoes because here everything can be produced, but we produce potatoes because it has better prices than other products.
>
> Good luck also depends on *dollarization*. Potatoes were more profitable [*rendían mas*] before *dollarization*. Also we cannot plant during full moon because the potatoes get worms (*se agusanan*). The potato seed needs to be adapted as well. For instance, we can bring potato seed from Huaca (lower land) and it works well, but we cannot plant potatoes from Mariscal in Huaca.

c. Capital acquisition: Sharecropping between equals

Sharecropping was a common arrangement for potato production in Mariscal, and farmers involved generally viewed themselves as equals. Norman usually planted in sharecropping, with his partner contributing half of the input costs. The partner who contributed the land generally had more decision making authority. Norman usually had more land available than his partner and thus managed the land and bought the pesticide, while his partner paid the *cuadrillas* and bought the fertilizer. The cost of the agrochemicals needed was shared in this way. The number of days that each of them worked in the field was taken into account when the produce was divided after the harvest. Norman believed that sharecropping was the only way to cultivate large areas of potato, especially when the price of agrochemicals had risen sharply after dollarization.

> In sharecropping, everybody prefers to contribute with the land and the remedies [pesticides] than with the land and the fertilizer. Yet, who has the land usually decides on this. The fertilizer is one of the most expensive costs, thus we have to plant in sharecropping and contribute the labour because nobody alone has all the money to buy the fertilizer and pay the labour. The cost of seed is usually shared.

d. Family relations and the future of farming

Norman worked mainly on the farm growing potatoes and breeding cattle. Glenda managed a small shop and reared pigs. The level of communication between the couple appeared to be good, and Glenda considered herself to be a lucky woman despite the fact that they adhered to certain traditions which she felt restricted her liberty somewhat. Glenda explained:

> I prefer to rear pigs more than cattle because the price is a lot better than cows. I have my own business with animals and with the shop, but I have been really lucky because my husband knows how to cook well and he can help himself or give food to the children if I am not at home. He even washed diapers when our children were babies and I was sick! I am surprised that some women who visit us from the city are more than 30 years old and they are still not married, and even they said they do not know how to cook. Here in Carchi it would be impossible because men don't let women be free. Women from the city seem more liberated.

Norman and Glenda hoped their children would become professionals of some kind, but they were comfortable with the idea of one of them taking over the farm. Their children did not work on the farm regularly, but they often helped with seed selection and minor chores around the house. It seemed that the future of the farm was dependent on the career choices their children made, but Norman and Glenda planned to work the farm until they became old. Norman in particular felt that being a farmer was a good career option, regardless of market insecurity and other problems. He enjoyed the sense of autonomy, which he did not think one could find in the city:

> When I went to study in Ibarra, at first I enjoyed being in the same classroom with rich people –at least richer than me– but still I continued to be a peasant (*campesino*) because I did not like the bad manners of the people in the city. The neighbours don't know each other, nobody helps each other, and I saw my future as an employee of somebody else. I did not want to be that kind of professional. Here we are our own bosses. The work is hard in all forms you can imagine, but in order to succeed (*salir adelante*) we need curiosity and interest in learning from our parents, from *técnicos* [technicians] and from our own practice. Here we are at a university (laughs). As somebody said in a workshop, we need to be more proud because we produce food for the people in the cities so we are professionals that serve others. You see the carpenters or the builders are called masters, why don't people call farmers[68] "masters"? We peasants survive not only by producing food for everybody, but we produce work for our family and neighbours and future opportunities for our children so that they can stand on their own feet. Our pride is not the money in our pocket but the food on our table. We want to keep doing what we know how to do. We don't want the government's charity or people from the city feeling pity for us. We don't want to be like those sick cows that produce pity instead of milk[69]; we want to do our job. I understand if my children don't want to be farmers, but as for me, I will die here.

e. Potato production costs and benefits of the Cruz family

Norman and his sharecropper planted a field of 2.5 hectares in October 2003. The figures in table 4.2 show their costs and benefits calculated per hectare. They planted 1,633 kilograms (36 quintals) of *super chola* per hectare in *wachu rozado*. They used the seed that Norman's partner had stored for planting. They made 12 pesticide applications, three fertilizer applications and six applications of foliar fertilizer. These inputs accounted for 33 percent of the total cost, while labour represented 31 percent. They managed to utilize non-commoditized resources and services for 14 percent of the total cost. The largest non-commoditized input was labour. Their

---

[68] In Ecuador a worker without formal education but with specific technical skills, such as a carpenter or builder, is referred to as a "master" in Spanish (e.g. *maestro carpintero* or *maestro albañil*) in recognition of their skill. The term farmer (*agricultor*) is not afforded the same level of respect and a farmer would never be called a master (*maestro agricultor*).

[69] The farmer used the Spanish saying "vacas que producen lástima en lugar de producir leche".

return on the production represented 57 percent of the total cost, but this calculation excluded the six percent that accounted for the labour of the cook. Most farmers did not usually include cooking as a production cost. If the Cruz family had included this, the return would have been around 50 percent of the total cost.

Norman calculated his return by subtracting the monetary input cost from the value of the total harvest. Calculated this way, Norman's benefit was 82% of the total cost, instead of 50%. This benefit was low, but acceptable because with this return he could afford to plant another potato crop.

When calculating the cost-benefit ratio with different minimum and maximum prices for *super chola*[70] potato, the Cruz family had a positive value for 2004[71]. They only had a negative cost-benefit ratio when the price was at the minimum for the period 1990-2004.

Norman and his sharecropper harvested 15.059 kg of potatoes per hectare (332 quintals), of which 77 percent was sold to COPAPAC. The market price of *super chola* went up to $15 per quintal, and Norman sold their produce for an average of $12.50. He maintained that using the cooperative saved him $0.50 per quintal for transport to Quito and $0.50 per quintal commission for a trader. The remainder of the harvest was stored for seed (17%) and for family consumption (6%).

The ratio of "good production" was based on the amount of seed planted relative to the amount of potatoes harvested. This ratio was 1:9 (9 quintals of potatoes harvested from each quintal of seed planted) for Norman and his sharecropper. A ratio of 1:20 was the benchmark for most farmers in Carchi. Farmers who had sufficient capital to buy fertilizer[72] used the ratio 2:1 as "good practice." It means two quintals of fertilizer applied per one quintal of seed planted. The ratio for Norman and his sharecropper was 1:1.

---

[70] These prices were taken from the data of the Ministry of Agriculture of Ecuador.

[71] The data of the Ministry of Agriculture only show a variation of 49% in the price of *Super chola* in 2004.

[72] Farmers of all styles referred to the ratio of "good production", whereas mainly farmers with capital used the ratio of "good practice". Although all farmers tended to compare their own fertilizer/seed ratio with the benchmark of 2:1 (2 quintals of fertilizer per 1 quintal of planted seed), they did not necessarily consider it a good ratio for their own production.

Table 4.2. Costs and benefits of the Cruz family per hectare for one potato field

Paid costs	Quantity	Cost USD	Percentage
Seed	1633 kg	252.0	14
Transport to market	2 truck trips	142.4	8
Labour days	111 days	556.2	31
Pesticides	12 applications	155.6	9
Soil fertilizer	3 applications	403.6	23
Foliar fertilizer	6 applications	24.4	1
Other costs		2.4	0.1
Total paid costs		*1536.7*	*86*
Non paid costs			
Transport to road	2 horses	14.2	1
Labour days	28 days	140.8	8
Lunch for labourers	89.6 lunches	89.6	5
Total non-paid costs		*244.6*	*14*
Total cost		1781.3	100
Cook labour days (not included in the analysis)	20.0	100.0	6
Yield in kg/ha	15059.2		

Benefits calculated with different potato prices in the market

	Actual price	Max 2004	Max 90-04	Min 2004	Min 90-04
Price in $/kg of the variety *Super Chola**	0.28	0.24	0.54	0.16	0.07
Yield $/ha	2796	3614.2	8119.2	2402.0	1161.4
Benefit (total cost – yield in $/ha)	1014.7	635.5	1832.9	6337.9	620.7
Net benefit in percentages	57	103	356	35	-35

*Data from the Ministry of Agriculture of Ecuador

Farmer's calculated benefit with different potato prices

	Actual price	Max 2004	Max 90-04	Min 2004	Min 90-04
Benefit' (Production-Total paid costs in $/ha)	1259.4	2077.6	6582.6	865.3	-375.3
Benefit'/Total paid costs (%)	82%	135%	428%	56%	-24%

Farmer's analysis of production performance

	Obtained	Standard
Harvested potatoes/used seed (quintals)	9	20
Applied fertilizer/seed (quintals)	1	2

Use of the harvest

Use	Percentage
Sold	77
Seed	17
Self-consumption	6

Fuentes Family - *Seguros*

"We do not dress well but every day we work and eat well. We do not need to sell our work force for the benefit of the others. We may be poor but we are free; we do not have a patron telling us what to do."

Family history and agriculture: being a labourer is like being a slave

Hugo (59) and Fidelia (48) Fuentes had two sons, Esteban (26) and Lirio (15), and two daughters, Carol (18) and Lupe (13), in 2000. Esteban, who got married two years prior to my first visit, was living with his wife Ester and their three children in an extension of the family house. The two nuclear families shared the land for agriculture and cattle production. It was difficult to establish a clear division of "households." Much was shared, but the two families were independent in many ways.

Hugo was one of ten children from a poor family. He had been working since his father passed away when he was nine years old. He worked at the big haciendas in different towns, mostly as a servant or labourer[73]. He said: "Being in many places, one picks up ideas for one's life. Then one wants to live differently. I lived as a servant with various rich people and learned that I wanted to live in a better situation than the one I had."

Hugo met Fidelia in San Francisco. She came from a family of eight children; her parents used to work for hacienda "La Rinconadita," one of two in San Francisco. Hugo and Fidelia travelled together working as labourers.

[73] Servants worked full-time and lived in a hacienda's "house". Labourers, on the other hand, were hired only for temporary tasks and lived outside the hacienda.

They went to Ecuador's capital city, Quito, when Esteban was born. Hugo had various jobs (*oficios*) but did not earn enough to support the family, so they decided to return to San Francisco. Both parents worked as servants in hacienda "La Rinconadita" for a short time. When land reform law was first applied to the big haciendas in Carchi, the Fuentes left their job and joined the July 23rd cooperative, which was claiming land. The family did not have a place to live so they built a mud house in the *páramo* (high wetlands). Hugo said: "When we heard about the cooperatives, we went to fight for the land, and because of that we had to escape from the police, so we went to the *páramo* where nobody else lived."

They worked as labourers to make a living until land became available. On weekends, they collected firewood and Fidelia made bread. They sold both in town. Later, when they received a field of distributed land, they began breeding animals. Over the years they slowly shifted to cultivation.

> In that time [before working as a farmer] I only cared about money. I did not want to have animals and I did not like them. I was a labourer. Later we needed somewhere [an investment] to put our money, so we had sheep. While we went to work, harvesting potatoes until late at night, Esteban –who was three [years old] – stayed at home grazing the sheep.
>
> I did not quit being a labourer all at once. First I kept Sundays free to work my land and the other days I went to work as a labourer. Later I kept the whole weekend free, and each time I took one day more for my own land. When we had potatoes to eat instead of money (from the labour), I started to skip one week (working as a labourer) and sometimes more. After some years we learned that we could do fine by ourselves, we were not going to die without working for others, and we stopped being labourers. It was the main objective because the bosses (*patrones*) are never happy with the work [labourers do] and they treat people badly.
>
> It is really difficult [to change from labourer to farmer]. It seems that one is going to die of starvation without the daily salary. That is why many people could not stop being labourers even when the land came from heaven [was free]. They did not want to work cutting the "*monte*"[74] to produce potatoes, because they did not have money to eat, so they sold the land. They wanted the money. Then these people went back to being labourers because to be a labourer is like being a slave for money.

After 25 years of land distribution, the Fuentes had accumulated more land than most other members of the cooperative. By 2004 they had about 30

[74] Monte is the name for secondary Andean forest, but farmers also use it to denote vegetation that grows in fallow fields.

hectares altogether between *monte*, pastures, and agricultural land. Hugo explained:

> When the land was distributed, people sold their part immediately to other members. Mainly they thought that the *páramos* were not productive at all. Today most of the land is in the hands of 25 persons; the rest of the members have very few hectares. The same thing happened with the other cooperatives. The difference is that in our cooperative we do not have individual property titles to the land. Only ten of us want the titles and the rest expect that we [the ten] will pay for everything.

Most of the land the Fuentes bought was close to the *páramo* and was still covered with natural vegetation. Each year, the Fuentes cleared a new part of the Andean forest to include in their rotation scheme. In 2004, the Fuentes no longer had any uncleared land. Like most of the farmers in San Francisco, they combined potato and cattle production.

Potato production practices: (Technology)

a. Fertilizer: "the biggest investment"

As the Fuentes ran out of virgin land to clear for new fields, they were forced to reduce the frequency of fallow periods. This lead to a decrease in soil quality and they began to use progressively more fertilizer on each production cycle. They never relied on loans for this kind of input, but fertilizer was nonetheless their biggest cash investment. Esteban explained:

> Fertilizers are getting too expensive and it is crazy (*una locura*) that we mainly sell potatoes to obtain the fertilizer for the next cycle! Maybe we should start buying potatoes instead of fertilizer. We try not to use much fertilizer because it makes our soil more acidic, but each year we use a little more because we can't let land stand fallow as much as we used to. Also the *veranos* [droughts] are more common now and urea helps potatoes to endure the bad weather.

b. Pesticide application and management

The Fuentes monitored the weather and applied pesticide accordingly. They tried to apply as infrequently as possible. Fidelia explained:

> During winter (rainy season), because it rains a lot, we may apply every 15 days, making 10 times within a cycle. During summer (dry season) we apply once a month, so we reach harvest with four to five applications. Before we even had to apply less pesticide than today, but the soil is now more infested and the weather has changed.

The Fuentes kept their equipment, fertilizer, and pesticide in a locked room in the back of their house. Fidelia also reared guinea pigs in the same room for family consumption. She explained:

> We have to lock the room because my grandchildren are very curious. When they [the men] go out to spray, they change their clothes there. When they come home, they immediately take a shower, even if they did not spray.

c. High quantities of seed ensure production in difficult conditions

The Fuentes saved money by using seed (potatoes) put aside after previous harvests. They bought new seed every five years from producers in the valleys. Like most farmers in Carchi, the Fuentes planted "*super chola*" because it fetched good prices. Occasionally they bought seed for varieties that were not as valuable but that were more resistant to pests and diseases.

The Fuentes used large quantities of seed per hectare relative to most other farmers. The potatoes used for seed were stored in a diffused light storage platform (*silo verdeador*) like those Esteban had learned to build during FFS training. The Fuentes used larger seed potatoes (about the size of a fist) than most farmers, and they planted only when the tubers had begun to germinate. Esteban explained:

> Planting in the *páramos* and the slopes means using better seed but also more seed. We look for more or less good weather conditions to start planting. Thus using germinated seed helps potato to take advantage of the conditions immediately. Bigger seed is the same as fatter cows. If you compare small size with big size seed during summer [drought] or in worked [eroded] soil, the bigger seed supports them best.

d. The soil: Full tillage in páramos had reduced land and harvest quality

Hugo's second son, Lirio, had observed that although the tuber size and the yield per hectare fluctuated with changing weather conditions in the *páramo*, the overall production was slowly decreasing over the years:

> While in the *páramo* we get 50 quintals of first class potatoes and 50 quintals of second and third class, in the lowlands farmers can get 80 quintals of first class and 20 of the other classes. It would be excellent if we could get 18 or 20 [quintals of production] per one [quintal of seed] but production instead is decreasing, because dry years are dryer and humid years are increasingly humid.

In 2000 Hugo believed that rotation was the best way to maintain fertility and protect against diseases or pests such as the Andean weevil. The Fuentes looked at the quality of the soil after two consecutive cycles of potato and then either sowed grass or let the land lie fallow for up to seven years. They had less land to clear as the years went on, however, and thus less land to leave fallow. Freshly cleared *páramo* was relatively fertile, but full tillage degraded the fragile soils over time. As a consequence, new pests and diseases became increasingly common at high altitudes. Hugo explained:

> After two years of cropping in *tierra desmontada* [land that was in fallow], it is necessary to apply more fertilizer and more pesticide because the land gets tired and starts to fill with *gusano blanco* [Andean weevil]. Before we used to let the land rest for about seven years or more so that the *gusano blanco* disappeared. Now we can't do that and even when we put out traps (for the Andean weevil) we still get damage.

e. Low investments and the shift to cattle production

The Fuentes' aim was to produce potatoes with as low investment in inputs and labour as possible. As the fallow periods were made less frequent it became increasingly difficult to achieve decent yields without increasing the inputs. The Fuentes were making less money from potato production in 2004 than in 2000, but they continued to grow potatoes because there were other benefits apart from profit. They consumed their own potatoes, for example, and were able to keep a portion of the harvest for seed. Hugo believed that producing a crop for money alone was too risky and referred to potato farming as a lottery in which they could lose everything. The Fuentes cultivated pastures for cattle in order to give their operation more stability in the face of fluctuating potato prices. Potato was a suitable crop to rotate with pasture because it involved preparing the soil thoroughly, which help pastures to develop well. In addition, if the potato crop was lost to pests or disease, the fertilizer that remained in the soil was still available for the pasture grasses.

> If you only produce for selling and forget that your family has to eat and has other needs then you become too ambitious. Potatoes have given us some money but they could also take everything from us, thus we only cultivate the quantity of *super chola* that is within our possibilities and don't rely on that for our living. We also plant potatoes to rotate it with pastures so that the land does not get tired of potatoes and in the worse case [when potatoes get lost or don't have a good price] the pasture takes advantage of the fertilizer left in the soil. The true poverty and the true wealth exist in our community because people trust that the price of potato will rise

> one day so that they get indebted in order to buy all kinds of chemicals. We don't do that.

The Fuentes cultivated between four and five hectares of potato in 2000, but in 2004 they only cultivated one hectare. According to Esteban, *dollarization* of the economy in 2000 caused a progressive increase in the cost of external inputs and labour. As a result, potatoes from Colombia and Peru could be sold for less in Ecuador than those produced locally. This was one of the reasons why the Fuentes reduced their scale of potato cultivation. Esteban explained the consequences of *dollarization* for his family:

> *Dollarization* affected us with high prices of fertilizers and the lowest prices of potatoes. Then we lost a lot of money and we were so poor that I went with my wife to look for a job taking care of a hacienda. There I learned about cattle production and now we only produce one hectare of potato every year and dedicate more to cattle.

f. The labour process: "Helping each other make capital"

The Fuentes prepared potato fields by hand (*a fuerza de brazo*) for cultivation under full tillage. Hugo and Fidelia were reluctant to contract labourers after their experience as hacienda servants. Hugo re-emphasized that "being a labourer is like being a slave." Nonetheless, it was sometimes necessary for them to contract people to help with land preparation and harvest. For Hugo, it was important to give the labourers decent food as a sign of respect for them:

> The food for the labourers varies according to the owners of the crop. It seems that the poor give better attention to the labourers. Because we have been labourers ourselves we usually serve rice with green peas and, as second dish, rice with milk, morocho or cauca [local hot drinks made with corn]. During harvest when there are too many people we serve cooked potatoes and pasta (*fideo*) soup with juice.

Hugo did not rear oxen because he maintained that keeping them was only profitable when they were rented out to others. Although there were few oxen available for rent in San Francisco, he did not want to work oxen for other people. The Fuentes' land was hilly and they could use machinery only to prepare it when the weather was dry. Family labour was crucial to produce because it allowed them to accumulate capital. Hugo explained:

> Even though my first son is already married, I continue to work together with him and my youngest son. I helped Esteban build his capital for marriage, and as of last year we started to help Lirio. Everything we get from potato production we divide in three equal parts. We do not usually

> contract labourers other than for the potato harvest. Instead, we help each other make capital. Here (in San Francisco) you can see brothers, one rich and the other poor, but they do not help each other.

Sharecropping was very common in San Francisco, but the Fuentes cultivated only as a family. Their operation did have certain similarities to sharecropping, but Hugo, as the landowner, allowed his sons to contribute less capital than they would have in regular sharecropping arrangements. He wanted his sons to remain as part of the family production unit, and thus allowed them more advantages than he would have a non-family partner. His sons, in turn, remained a part of the family operation because they appreciated these advantages and understood that over time they would be allowed more responsibility for the farm. Lirio said:

> Here there are few families working as we do. Nowadays most of the young kids go to work in other cities, but we prefer to stay with my father because we feel that he is growing old and needs us to control more things in the farm.

The Fuentes occasionally planted potatoes in *wachu rozado* in 2000, but *wachu rozado* fields were rare in 2004. They believed that this style of practice produced a smaller harvest[75] and was more labour intensive than full tillage. They did concede that when the season was unusually wet *wachu rozado* was the only possible way to cultivate potatoes in the *páramo*.

Inputs and potato markets

a. Buying with credit from friends

The Fuentes relied on a large social network to mobilize resources for potato production. This included lorry drivers, traders, agents, shopkeepers and friends with capital. These relationships were reciprocal, as Hugo explained:

> To borrow money from poor people is not good business because they always ask for interest. I prefer to take credit from people who have money. I have one special friend who lends me money when I need. If I want to pay him interest he says: "What are friends for?" I have friends who give me fertilizer, pesticide, clothes, food, and many other things on credit. They do not have complaints and never charge me interest. But just as friends give us things we have to respond to them and trust them. For instance when I harvest potatoes

[75] When *páramo* land is cultivated only occasionally in *wachu rozado,* farmers do not get a chance to see the benefits of the system in terms of soil quality and pest and disease control.

> I have a friend who buys the whole production. Sometimes he does not have the money to pay me, so I wait until he sells, and then he comes to pay. It is the same with a cattle trader who waits until we have the money to pay him.

b. Finding a niche market: why farmers synchronize their losses

The Fuentes were reluctant to sell their produce in the markets because they felt that the process was risky and unfair. They sold their production for the year 2000 to friends who acted as middlemen. These friends occasionally offered the Fuentes credit. I discovered, in 2004, that the Fuentes were unable to sustain their production after having sold potatoes for low prices in the markets for many years. Even Esteban gave up cultivating his own land in 2003.

When Esteban later returned to work the family land, he made contact with a consumer-group in Quito. The "*canastas*" were interested in buying carbofuran-free potatoes in bulk. Esteban had learned to grow potatoes this way in the FFS and had done so for many years. This was an important opportunity for the Fuentes because it would allow them to cultivate a smaller area of potatoes while being guaranteed a more stable price. The new scheme needed planning and organization. Esteban explained:

> Before, if we had 200 or 300 quintals to sell we left at midnight and arrived in the market in Quito at three in the morning, there I looked for friends [traders] who helped selling the potatoes and charged 50 cents per quintal they sold. It didn't matter if potatoes were cheap or not. Can you imagine? From three to five in the morning they already made 100 or 150 usd just by selling our production and we were happy that they did that! That is why each post [to sell] in that market is very expensive, being a trader (*intermediaria*)[76] is a very profitable job. Once a woman told me that she was selling her place for 50.000 usd. I don't want to think how much they earn per day out of our work [the work of farmers]. However if you don't make friends with her, the trader woman puts the price on your potatoes and earns 1.00-1.50 usd per quintal.
>
> Now we only sell our production to the group of the *canastas* [groups of organized consumers] in Quito. I don't plant much but I recover the costs and I get some benefit. This is a great opportunity for us and I am glad that we can meet the consumers personally. I haven't been able to sell potatoes to them every 15 days as they require because it needs good planning and convincing other farmers to do the same while eliminating Furadan and other red label products. That is not an easy task but I believe it is possible to achieve.

[76] Potato traders in Ecuador are mainly women and are called *intermediaries,* or *revendonas.*

Esteban did not believe strongly in the notion of "good luck" that many farmers referred to. He was of the opinion that one's fortune had more to do with access to capital than anything else:

> You can call it good luck but for that the most important is having the money to produce again right after you lose. I will explain: If you lose this week because of the bad price, there would be many farmers that will lose at the same time as you. I mean all the farmers that harvested in the same week. If you have money you will start the next planting cycle immediately the next week, while the rest of the farmers have to wait for a while until they get the money needed for the next cycle. Most farmers will take a month or three weeks to get money again because some will have to go to work as labourers and others will need to sell a cow or take a loan. For seed, farmers will have to wait until their own potatoes get ready to plant. Then most of the farmers who don't have money will synchronize for the next potato cycle and will have the same price when they harvest their potatoes again. The farmers who don't have money cannot separate from each other at the time of planting. It is very difficult because they go together in cycles of capital and seed availability. The farmer who had money will finally get a better price because it will be less likely that everybody would be selling the same week as him. Most farmers even like to plant at the same time because they like to compete and see whose potatoes are better. When farmers lose some of them feel bad, but they compare with one another and they get relieved if they are not in the worst situation. People who are addicted to planting potatoes take potato planting as gambling (*apuesta*) and they will try again and again and sometimes they will invest double.
>
> There is a family here that only plants potatoes in summer and harvests when all of us are planting; thus they usually receive a good price for their crop. I planted twice at the same time as them and both times I got a good price. People here think that this family has good luck.

c. Capital acquisition: Sharecropping within the family to avoid debts

The Fuentes did not take loans because they were still paying off their land to the National Development Bank (Banco de Fomento) and did not want to increase their debt. They did not sharecrop with wealthy people either, because they felt disempowered in a relationship in which those who contributed the capital had the most say. The Fuentes preferred to rely on their own family to mobilize resources such as labour. This enabled them to operate without large inputs of capital. On occasions when extra capital was needed they knew they could usually obtain credit from friends. Hugo explained:

> We do not farm by sharecropping [*al partir*] because we went broke cropping that way with Don Lucas Espin. He is rich and, in addition to land, he has a

lot of money. We put in our labour and he paid for the fertilizer and pesticides, so he was the one who decided how much to apply. When planting in sharecropping it is sure that the quantity of pesticides to apply will increase, it will never decrease. Then we could not say anything, and since he spends money as a rich man, the production did not cover our expenses because labour is always cheap. Working with our own family doesn't have a price[77] and is the best way to go forward (*salir adelante*) when you don't have money in your pocket.

d. Cattle production

The Fuentes were shifting progressively towards cattle production, but potato was still important because the profit from a successful crop could be used to boost the cattle herd. Cattle production was seen as an investment that "kept money safe." The cattle could be sold at any time and the money diverted into potato production. Occasionally they bought a bull for breeding and later re-sold it when they needed finance for the potatoes.

For the women, cattle were important not only for the sake of agricultural production, but for the "everyday life" of the family. Fidelia and Ester managed the revenue from the milk and were responsible for buying food and for managing daily activities on the homestead. Fidelia said:

> With the money from the milk we (Fidelia and Ester) buy food, clothes, and other small expenses for the family. When men need money to start a new potato field, they sell a cow, and if they are lucky and have good production and good prices, they replace the cow with another one or maybe with two. If the men are unlucky, we lose the potatoes and the cow. That is why I do not like the idea of selling all the cows; they give us the money to live every day. A family who does not have cows has to sell labour.

The Fuentes had 10 dairy cows in 2004. The practice of vaccination was uncommon in San Francisco, but the Fuentes vaccinated their cows against foot and mouth disease (*fiebre aftosa*). They also gave them vitamin injections to help maintain their condition in summer when the grazing was poor. Young Lirio also started to breed cattle. The animals belonging to the two nuclear families shared the same grassland field, but each woman milked her own family's cows. Fidelia milked those belonging to Lirio.

The Fuentes did not have much capital to allocate to cattle production, so they compromised productivity in order to put less money and labour into the operation. The women used to get approximately 18 litres per cow per

[77] Hugo meant that family labour could not be valued in a purely monetary sense because there were other advantages associated with it.

day when they were milking each animal twice a day. The cows, however, needed vitamin and food supplements to maintain this level of production. The Fuentes decided to save money by terminating the supplements after *dollarization* pushed input prices up in 2000. They were then able to milk only once a day, but now had more time for other income-generating activities, such as weaving.

e. Off-farm activities

Fidelia, her daughter, Carola, and her daughter-in–law, Ester, wove garments for a small entrepreneur who supplied them with wool. There were very few women in the community who did not weave. A skilled weaver could complete two sweaters a week, earning $1.60 U.S. apiece. The women had complete control over this supplementary income. Fidelia used it to pay Lupe's school fees, while Carola used it to cover her basic household expenses. Ester had a baby and could only weave two sweaters a month, but she also received a monthly state subsidy of $6.50. Many women used the revenue from weaving to pay for peasant health insurance (1 dollar annually).

f. Family relations and the future of farming

The Fuentes managed to keep their farm operating by working together. Despite the high level of cooperation there were disagreements and different members of the family had different aspirations and dreams for the future.

Hugo's main aim was for his children to stay on the farm to ensure the future of the family operation. He believed that managing a farm required dedicated people willing to make sacrifices. His dream was to increase the scale of production, but he knew that they were barely surviving market fluctuations. It was family labour and access to a niche market that allowed them to continue farming. What Hugo had to say on the subject defined his thinking about family and farming:

> Everything that happens to kids, and especially to sons, depends on their father. If you are a labourer and want to become a farmer it is possible in only one way: as a father you can retain your son's salary, and after some time you put all the money together to buy land. But you need to prepare (*cultivar*) your children for that from when they are small. You have to teach the children not to be too ambitious, getting enough from the land but not taking everything, because land is like cows: they give you a portion of milk everyday, but the quantity depends on how you treat them.

Esteban had his own ideas about the future of the farm:

> I think that potatoes are more risky nowadays and they require a lot of capital to grow. What I want to do is use potatoes to increase the number of cows I have, but I want to improve the quality of the pastures and raise [genetically] better cows. In the future I mainly want to work in cattle production, but with better technology. I want to make sure I have the capital to educate my children until they are professionals.

g. Potato production costs and benefits of the Fuentes family

Hugo and his son Esteban planted one hectare of "Gabriela" potatoes under full tillage. They used 1,724 kilos (38 quintals) of seed. Table 4.3 documents the costs and benefits of the Fuentes' potato field.

65% of the Fuentes' total costs for this field were monetary. Fertilizer was usually the main expense, but the *Gabriela* variety did not require as much fertilizer as *Super chola,* and they were thus able to reduce this input to 19 percent of the total production cost. Pesticide represented a further 19 percent and labour 21 percent. The latter was the highest monetary input because labourers had been hired both for land preparation and for harvest. 2004 was very humid in the *páramo.* The Fuentes had to apply pesticide 12 times over the course of the growing cycle; four of these applications were made directly to the soil to control Andean weevil infestations, and eight were made to control foliar pests and diseases.

The Fuentes' non-monetary costs made up 35 percent of the total. This included 20 percent for their own seed, nine percent for family labour, six percent for the labourers' food and 0.3 percent for the use of their own horses to transport potato sacks to the road. The Fuentes harvested 15.422 kg (340 quintals) of potatoes, of which 82 percent were sold and 18 percent retained for seed. Most of the sales were made from the farm. Hugo said they had favourite varieties for self-consumption, but "*Gabriela*" was mainly for the market. The Fuentes' return was 35 percent of the total cost. Fidelia and Ester were the cooks and their labour amounted to four percent of the total. The returns would have been 31 percent with this included in the accounting.

The Fuentes cost-benefit ratio, calculated with the exclusion of non-monetary costs, was 254 percent in 2000, compared to 108 percent in 2004. They used family labour because capital was their limiting factor. When their labour demands were high, and mechanization was not suitable for the task, the paid labour input increased. Saving their own seed was their main way to cut costs. The Fuentes had a positive cost-benefit ratio with different minimum and maximum prices for potatoes of the *Gabriela*[78] variety for 2004. They would only have had a negative cost-benefit ratio if the price was the minimum for the period 1990-2004.

The degree of monetary investment had changed considerably since the year I first documented potato production on this field. This may be due partly to the fact that the variety cultivated then (*Super chola)* usually requires more fertilizer than *Gabriela*. For the same field in 2000, fertilizer applications represented the highest investment (43%). Pesticide applications were the second-highest investment at 26 percent. The Fuentes renewed their seed stock that year. The cost of the new seed represented 16 percent of total capital investment. Wage labour made up 14 percent of costs. The field in question was on a hillside, but because it was a dry year the Fuentes contracted a tractor to prepare the land. This represented two percent of the total investment. 2004 was a wetter year and it was only possible to prepare the soil manually. This meant an increased input of labour.

Pest and disease infestations had become more prevalent on land that had been continually tilled. These problems were intensified by the weather changes that resulted from deforestation of the *páramos*. The use of pesticide in these areas increased accordingly, as did the demand for waged labour.

The Fuentes' ratio of "good production" was 1:9. Their ratio of "good practice" was 0.6:1. Although this was better than the standard 1:2, they wanted to lower their fertilizer input even more because of rising costs.

Table 4.3. Costs and benefits per hectare of the Fuentes family for one potato field

Paid costs	Quantity	Cost USD	Percentage
Transport of inputs from the market	Truck trips	32.0	2
Labour days	62 days	319.0	21
Pesticide	12 applications	288.9	19
Soil fertilizer	2 applications	282.4	19
Other costs		58.0	4
Total paid costs		*980.3*	*65*
Non paid costs			
Seed	1723.7 kg	304.0	20
Transport to road	Horses	4.4	0.3

[78] These prices were taken from the data of the Ministry of Agriculture of Ecuador.

Table 4.3. Costs and benefits per hectare of the Fuentes family for one potato field (*continued*)

Paid costs	Quantity	Cost USD	Percentage
Labour days	26 days	132.8	9
Lunch for labourers	Lunches	87.5	6
Total non-paid costs		*528.7*	*35*
Total cost		1509.0	100
Cook labour days (not included in the analysis)	15 days	77.8	4
Yield (kg/ha)	15422.1		

Benefits calculated with different potato prices

	Actual price	Max 2004	Max 90-04	Min 2004	Min 90-04
Price in $/kg of the variety *Gabriela**	0.13	0.20	0.48	0.13	0.06
Yield $/ha	2040.0	3084.4	7402.6	2004.9	925.3
Benefit (USD/ha)	531.0	1575.4	5893.6	495.9	-583.7
Net benefit in percentage	35	104	391	33	-39

*Data from the Ministry of Agriculture of Ecuador

Farmer's calculated benefit with different potato prices

	Actual price	Max 2004	Max 90-04	Min 2004	Min 90-04
Benefit(Production-Total paid costs)	1059.7	2104.1	6422.3	1024.6	-55.0
Benefit/Total paid costs (%)	108%	215%	655%	105%	-6%

Farmer's analysis of production performance

	Obtained	Standard
Harvested potatoes/used seed (quintals)	9	20
Applied fertilizer/seed (quintals)	0.6	2

Use of the harvest

Use	Percentage
Sold	82
Seed	18

Olivo family - *Arriesgados*

"We are the ones who people call 'the crazy who have money to lose.'"

Family history and agriculture: The "modern" hacienda style

I visited the Olivo family for the first time in 2000. Andrés (50) was married to Rosa (42) and they had two daughters, Arlin (16) and Tina (12), and a son, Raúl (4). Their house was large and relatively luxurious, with 15 rooms. It had a well-tended garden at the back. It was one of the few double-storey houses in Santa Martha. By 2004, Arlin was studying medicine at the university in Quito, and Tina was joining the professional police institute[79]. This was one of the wealthiest families I visited during my research.

Andrés was 13 years old when he went to work on the coast and in Quito. He later joined the army, where he saved money before returning home:

> During the Paquisha war[80] I was in charge of guarding the border, and we were not allowed to let Peruvians cross the border, but I let them pass if they gave me money. When the war ended, I came back to my parents' place. I was very fat and I brought 10,000 *sucres* (about 250 US dollars). I bought 20 quintals of potato seed and I gave the money to my father to start again, but we lost one time after another. Then I went to Quito and to the coast, where I earned a lot of money building houses. Before I spent all the money drinking, I returned home to grow potatoes, and I was lucky. I earned 100,000 *sucres* (about $2,500). With that profit I got married and bought this land.

By this time the process of land reform had started, and Andrés became a member of the cooperative Santa Martha de Cuba[81], which claimed land from the haciendas. The Olivo family had about ten hectares for intensive cattle and potato production in 2004.

Andrés considered himself a "pure potato producer" because potato production was his main business. Nonetheless, he considered it to be a risky "game" in which he had at times lost a lot of money. This may be part of the reason why he reinvested the profits from potatoes in cattle production in 2004.

> My father used to say: "whoever is made to be a *papero* is a good *papero*, and whoever is made to be a drunk is a good drunk." I think, I only know how to grow potatoes, and I will keep on doing it until the end of my days. Of course, I also have to think strategically ("*cranear*") how to do this work: where to plant what, and on whom in the family I can count for help, if needed. It is like a card game, and the outcome is never certain. You never know what comes next; you just have to think very well beforehand.

[79] The qualification for both medical and police schools was expensive in Ecuador.
[80] Ecuador and Peru had a war over of a disputed border in 1982, in a region where Paquisha is the biggest town.
[81] The name "Santa Martha de Cuba" honours the Cuban revolution and Che Guevara.

Potato production practices (technology): "The production of decay"

a. Real farmers use high levels of soil fertilizer

In 2000 Andrés believed that applying high quantities of fertilizer at fixed times was good practice. He explained:

> The 18-46-0 started to be sold in the 80s. Later on we knew the triple 15, the 24-34-4 and Potassium, and just some years ago in 2000 we got the German fertilizer [microelements]. The quantity of fertilizer applied depends upon the pocket [the capital available] of each farmer but if you want to harvest, you should at least apply 0.5 quintal of fertilizer per one of potato seed. Using fertilizer always pays and farmers that have money buy many different ones and mix them all for the application. There is a man that planted 100 quintals of seed and only applied eight quintals of fertilizer. This means that he plants just because he wants to plant. He likes to plant but he doesn't like to spend money. Can you imagine that he only applied a hand full of fertilizer in each potato plant, or may be applied in one plant and nothing in the next? He probably said, "*If I produce it will be good otherwise I will be fine anyhow*." He cannot be called a farmer.

The price of fertilizer rose in 2004, and Andrés recognized that his method of using fertilizer was difficult to sustain. In addition he found that it promoted pest and disease infestations of the soil.

> Now farming is really difficult compared to two years ago. The 18-46-0 is really expensive and in the pesticide shops they said that it is because there are not the raw materials to make the fertilizer because it comes from Europe. We know that the Euro is more expensive than the dollar thus the prices are in the sky. While the cost of fertilizer goes up 30% more the price of potatoes have gone 100% down.
>
> …There has always been Andean weevil here in Carchi but it only became a pest in the early 70s when we started to sell [potatoes] in the market. It is because we applied chemical fertilizer and the potato crops were almost immediately infested with Andean weevil.

Andrés was also of the opinion that those farmers who used foliar fertilizer instead of soil fertilizer did not know much about potato production:

> Regarding foliar fertilizers, there is some incomprehension (*desconocimiento*). The engineers said that the fertilizer should go to the soil but some people only apply foliar fertilizer. That way of producing could work in a new field [in fallow or that has not been planted before]. It can be a coincidence (*relancina*) that because they only plant in small areas the field is well cared for and rested, thus it gives a good production anyway. The normal result is that you apply a lot of foliar fertilizer and the production is low. I will call those farmers the

> ones who do not know *(desconocedores)* of potato production. They would say "*my potato plot looks really nice*" but it does not have potatoes. Instead a real farmer would apply everything that is needed even in a small field. But these differences are normal; each one does what he can (*cada cual hace lo que puede*).

b. Pesticides applied according to the calendar

Andrés applied pesticide every 10 days during the rainy season and once a month during the dry season in 2000. He explained:

> In summer [dry season] when it is cold the *lancha* (late blight) increases. Before we used Patafol and Curzate, then we used Fitoraz with Mancozeb and now we use Curzate with Sandofan together (*congeniados*). During the rainy season it is necessary to apply every 10 days and in five months [the potato production cycle] it takes more or less ten applications. In the dry season the applications can go down to 9 [for the whole cycle].

His pesticide application patterns changed in 2000. It was a dry year, conducive to the rapid reproduction of the potato tuber moth. He applied pesticide every week, despite the technical recommendations that the potato tuber moth could not be controlled with pesticide. He said it was unusual for him to disregard the recommendations of technicians from the pesticide outlets:

> I try to do what the engineers recommend. They come to visit to the farmers that buy their products; most of them come from Bayer and Farmagro [commercial houses]. Although I mostly buy in one shop I try to buy a little bit of everybody and in that way they all come to visit us.

c. Potato varieties and the market: The seed as the source of pest infestations

Andrés planted about 100 quintals of *Gabriela* each cycle. He preferred this variety because of its high price in the market. He used to buy new seed almost every year but noticed that many seeds came infested with the potato tuber moth. He then began to use his own seed or to buy at INIAP:

> We usually need to bring the seed from another place otherwise it degenerates, but, in the last years the seed came infested with the potato tuber moth. Then I leave part of the production for seed or when we decide to buy we go to San Gabriel and buy from INIAP. I prefer to use my own seed and sometimes when I have to buy, I buy from a known farmer in San Gabriel.

d. The soil: Fast jobs and the use of tractors as the main cause of soil erosion

Like most farmers in Santa Martha, Andrés used a tractor to prepare the soil and for various other tasks. He did recognize that this practice of mechanized tilling was the main cause of soil erosion, but explained why he and other farmers like himself continued to use tractors:

> Initially the tractor was not expensive because in one day of using a tractor we saved one week of oxen. The cost was the same as a labour day! In the present it is more expensive but we use the tractor because it makes the work faster, especially when we plant large extensions of land and have the money together to pay for it (*reunido*). The tractor takes the soil down hill thus uphill the land is not good anymore for agriculture. The owners of the tractor only care about finishing the job soon they don't care about soil erosion. The thing is that we value fast jobs and our work is more productive (*rinde*) since the tractors came here. Everything goes faster, even the soil (laughter).
>
> Some years ago people from INIAP came to teach us about the erosion caused by the tractor, but farmers did not care because they did not think that the soils here could ever end. Now you can see white patches even on my fields that are more or less flat. One of the reasons we stopped using oxen is that we need grassland to feed them, and because we all use chemical fertilizer we don't value animal manure anymore. Thus oxen don't show advantages in the short term.

e. The vice of planting potatoes: the lottery game

Andrés summarized his views on "modern" technology and the reasons why *Arriesgados* continued to produce the way they did:

> Now the land does not produce like before. The proof is that 40 years ago, when I was at school, farmers who cultivated closer to the forest harvested 60 or 70 [quintals of potato] per one [quintal of seed]. When I started farming I got 50 per one and now the maximum we get is 15 per one and some people only harvest 10 or seven per one. In the past the land was good; it had enough nitrogen and phosphorus and all the elements needed. In the present it seems to us that every crop needs [synthetic] fertilizer and pesticides, even the carrots. The luxury here is to harvest big potatoes. If you plant potatoes without agrochemicals you can always harvest, but if you use agrochemicals you have faith that the potatoes will be big and we like that.
>
> I plant potatoes because it is my vice and because I haven't lost the hope that one day the prices will get high and the [wet] weather will help to kill the *polilla* [potato tuber moth]. One day I will win. It is all or nothing. We are accustomed to plant potatoes, even when we lose we want to continue. One of

> my neighbours has bad luck; he loses and loses again. He lost his house and his car but he continues planting in big areas. The thing is that there are no other jobs and potato is what gives the most [money] here.

When asked what he would do if he lost everything (*¿pero qué hace si usted se queda en la calle?*), Andrés said that his strategy to continue planting potatoes would include sharecropping, taking out loans and selling cattle.

> I will look for another chicken that wants to help [laughs], I mean a sharecropper. People lose everything and even then it is still possible to take a loan. But it is not possible to lose everything because there are potatoes and cattle. If we don't have money then we sell cattle. Some people are lucky (*les da la suerte*); it all depends on that. But we are made in the campo so this is the way that we live here (*toca pues toca*).

Andrés almost never talked about production failure, but Rosa told me about the problems that began sometime in the 90s and got progressively worse after *dollarization* in 2000:

> The best moment for potatoes was during the 90s because the costs were cheaper and the potato prices went up. We used to sell at 200 or 400 *sucres* a quintal and it suddenly went up to 7.000 *sucres*. With those prices we did a lot of things. Most farmers improved their houses and some others, like us, bought cars. We were very lucky and earned 500 million *sucres* and we built our house in Ibarra. Then there came the low prices and the drought so the production went down. Because we were indebted with the bank our house was mortgaged. I told him [Andrés] that I preferred to lose the cows than the house.

> Potatoes are not as profitable as before. If you earn some money in one production and invest it in the next one you can always lose the investment and even get indebted. Even the pests are more resistant. We were going well with potatoes but now we are producing less quantity because it is too risky. Before we did not lose that much money when producing potatoes, but after *dollarization* the price of inputs went up and potatoes produced in Ecuador became more expensive to produce. We were invaded with cheaper potatoes from Colombia and Peru, so the prices went down. The price per quintal of potato was 3 dollars for a long time and it did not pay the cost of harvesting and transport to the market. Most farmers decided not to harvest their potatoes and left them in the field. Even now there are people that cannot pay the debts from that time and most farmers decreased the area planted with potatoes. The price of potato only started to go up slowly two or three years later. However, the price of the agrochemicals goes up from Monday to Monday. We don't have any hopes for the government in Ecuador; it always listens to farmers on the coast because they export and the government gains money from them, but not from us [potato farmers].

f. The "modern" hacienda: large investments are for "good luck"

When asked about the "vice" and "good luck" of *Arriesgados,* Andrés mentioned the hacienda production as a model:

> I first learned to produce potatoes with my father. We used to pay attention to the hacienda owners because we didn't want to produce like poor peasants. Don Gilberto [a hacienda owner] always had good production and he was a wealthy man, so we watched everything that he did. Sometimes we even went to the places he used to throw the pesticide bags and then went to buy those pesticides in the shop. Later we became big farmers [produced a lot] and my father used to pay engineers to come see the crop and tell us what to apply. The same was for the use of tractors. The hacienda owners took the tractors anyplace they wanted because they paid the tractor to make the roads. We only started using the tractor when it came with wheels and could reach our fields by the roads that the Provincial council widened up.
>
> To produce well you need money for all these inputs, but there are people who don't like to invest, even when they have money. I always say, if I am going to plant I will truly plant otherwise the work does not make any sense. In farming, whether you spend little or big money, you always take risks. The farmer that spends more is a true farmer; he spends because he likes farming.

Andrés was aware that the success of potato production was dependent on factors such as markets, soil quality and weather conditions, but he was convinced that for good luck a *papero* should accept the risk and invest without fear:

> To be a good *papero* we need the luck to get a good price and good production at the same time, but we also need to have capital to invest, because that way you can use enough fertilizer and pesticides. When you have money to put two to one [two quintals of potato seed for each quintal of fertilizer], you get good production, especially when it is a good potato like Gabriela. Then you also need a good price, which depends on the markets. If potato is going to other countries, then there is a good price, but when it is coming from Colombia and Peru, the price is nothing. When I lost 100 million *sucres* [about 10,000 U.S. dollars] in 1997, the prices were really low and the fertilizer shop cheated us by selling us sand instead of fertilizer, so the crop did not produce. But even then I continued to produce. There are only a few [people] who continue after a big loss. We are the ones who people call "the crazy who have money to lose."

g. The labour process: paid labour as the main workforce

Although Rosa had brothers who worked as labourers, Andrés preferred to hire other people because he did not want to complicate his relationship with his relatives. Rosa ran a clothing shop, so Andrés hired a woman to cook for his labourers. The cook's family also worked for him doing various jobs, and he developed a good relationship with this family over a decade or so. The cook mentioned that the amount of work available had decreased over the last years:

> In the past, Don Andrés used to plant more potatoes, so we had work everyday, including weekends, because production demanded it. Now we only work some weeks and even partial weeks. He [Andrés] said that he lost a lot of money and that he cannot buy the necessary products because they are very expensive. This situation is difficult for my family; I have three children and we all live in the same house with my two brothers and my father, but at least we can get potatoes in the *recaves*[82]. Santa Martha is a poor town because people here mostly work as labourers. Only the *hacendados* do not work as labourers.

Andrés trusted the cook's brother to oversee contracted labourers for him, and when sharecropping in other towns he trusted his sharecropping partner with the hiring of labourers. He explained:

> I am planting in share with a farmer from La Esperanza and he knows the people there, so he is in charge of contracting the labourers.

Andrés started contracting *cuadrillas* because he felt that they were easier to organize and manage than individual labourers:

> I started working with *cuadrillas* because recently the labourers are organizing in that way and each time it is more difficult to contract individual labourers. It is easier to deal with the leader of the *cuadrilla* because we ask him for the number of labourers we need, we pay him and he makes the arrangements with the group. He will tell everybody were to go the next day. The problem is that the *cuadrillas* [have the power to] set the price on the day of work.

h. Arriesgados' view on wachu rozado and manual labour

When asked why farmers in Santa Martha did not plant in *wachu rozado* in the *páramo* lands, Andrés said that this system was a part of the Colombian culture of production and was only suitable for good soils. He also thought that this system was "old fashion" and that it was too labour intensive:

> You have to consider that the people that produce in *wachu rozado* are Colombian descendants, and in Colombia people only plant in *wachu rozado.* They never let the tractor enter in their land and their soils (*tierras*) are better than the ones here. I would call them the guerrilla men [laughs]. Here, if you

[82] *Recaves* refers to the practice of collecting potatoes left over after harvest on the employer's land (also see Chapter 3).

> plant in *wachu rozado*, people will say that you are planting in the old fashion ways (*a la Antigua*) and maybe it goes well in hillsides. It is not a good thing to plant in that system here for different reasons. Firstly, the tractors are abundant because the labour is very expensive. Secondly, today we have learned that the *cuadrilleros* do not want to work if you don't pay them seven dollars per day. Thus we try to avoid manual labour as much as we can. If somebody does not have money to pay a tractor then they will hire oxen in order to reduce labour. I contract oxen even for hilling-up, and it goes better than with manual labour because the labourers only do it half way.
>
> We calculate that in one hectare you need 30 labourers for hilling-up at seven dollars per day, which makes 210 dollars. With oxen you can spend two or even three days exaggerating a bit, and it costs 20 dollars per day. So it only makes 60 dollars. I only work with two labourers who have oxen and that I know well. I have definitely reduced labour in this way.

Inputs and potato markets

a. Buying inputs through credit

Andrés could get credit in the agrochemical store, despite the fact that he was still paying off a loan from a bank. He did not think that there were many advantages to taking credit though:

> The pesticide shops do not give you credit if they do not know that you will produce enough to pay them back in thousands. When I receive credit in pesticide shops, they charge me interest beginning at 15 days. That is how the owners of the shops get rich very fast, while each time their products are of lesser quality.

b. Selling potatoes in the big markets

Andrés paid a truck driver to transport his potatoes to the market in Quito. He avoided selling locally because the prices were lower:

> In Quito we go to Alicia or to Angel's market place [traders' place]. They are the ones that help us to sell at a better price. They only lend us the place and sell our potato to their contacts and clients in the market. For this job they charge us 50 cents per quintal. They sell to the middlemen. For that we travel to Quito with the potato truck at midnight. We get there at one or three in the morning and we have to wait for our potatoes to be sold by the traders, until about seven in the morning. We have also sold to a Sir in San Gabriel or to an indigenous man who comes from Latacunga [the south], but they come here to harvest and pay us for the potato field and usually pay too cheap.

c. Capital acquisition: taking loans and avoiding sharecropping

Andrés sharecropped with the big *hacendados* in 2000 and never planted less than 500 quintals at a time. At first he was "lucky" enough to enjoy a combination of good production and high market prices. After *dollarization,* however, potato prices fell while input costs increased. The Olivo family lost all their money and got deeply into debt to the bank. From then onwards, Andrés tried to plant independently. Only when he was struggling for money did he consider sharecropping with other farmers, and he no longer planted with the *hacendados* at all. He explained that the main reason for trying to be as independent as possible was his lack of capital:

> If you want to plant with a rich *hacendado,* it does not matter how trustful you are, you still need to have money. Once you get into business, the rich will not take risks if you are poorer than they are. The rich only go for safe businesses like cattle, and they will only invest enough when their sharecropper is rich enough, so they can produce a lot safely. Once I planted half-and-half with a *hacendado* on his grassland. I prepared the land, but I did not have enough money for further expenses. The *hacendado* did not want to invest his money when the potatoes got *lancha* (late blight), and we lost the field. When he invited me to eat guinea pig (*cuy*), he told me "*at least I got my pasture turned over*."

When Andrés needed money to plant potatoes, he either sold cows or took loans from the banks. He was reluctant to borrow money from his family:

> Getting money from your family is a delicate matter because it creates big conflicts and provokes fights. It is really rare that I borrow money from my family; we do it only when we really need to rescue one another from an emergency. Only when we were really broke I went to my family; it is easier to go and ask for 100 dollars as a favour for some days. I usually take loans in Banco de Pichincha at 40% annual interest rate and in Banco de Fomento at 18 percent, although the president [of Ecuador] said that it will go down to 5%. I have gone to the *chulco* [illegal lender] as well.

Andrés had once had as much capital as many of the *hacendados*, but he did not belong to their social group[83]. Although he had lost a lot of money, he was still one of very few rich farmers in the community. He thus found himself in a somewhat isolated socio-economic position, somewhere between the *hacendados* and the rest of the farming community. His social

[83] *Hacendados* no longer have as much land as they did before land reform, but are still wealthy because they were allowed to keep the best agricultural land and because they were well educated and well connected. *Hacendados* often live in big cities and hire people to run their farms; they do not usually mix with people in the communities other than to organize labour. They enter into sharecropping arrangements with only the richer farmers in the communities.

ties were stronger with those below him on the economic ladder, and he often provided capital stability to poorer sharecroppers. He complained that although not many people in his community had the resources to sharecrop with him, he had no ties to those who were wealthier than he was. The scale of his production had eliminated many of his non-commoditized relationships, and he believed that the only way to achieve anything was by means of capital and market relations. Even his wife's relatives or his old friends expected him to pay them for anything they did for him.

d. Cattle production

Cattle were an important investment strategy for the Olivo family. They had six dairy cows on their farm, but it was difficult to determine exactly how many cattle they owned altogether. Andrés told me that they had an additional ten cows in co-ownership, but Rosa maintained that they actually had 45 cows:

> My parents gave a heifer to Arlin (first daughter), and my husband's parents gave another one to Tina (second daughter), so we kept them until they were full-grown cows and they have been increasing in number each year. Now Raul (their third son) has a cow that has just given birth. Our idea is that with these cows they will have money for their studies. That is why we do not sell their animals to buy clothes or other things. If we sell something, we put that money in their bank account. From these my husband has about 45 cows in co-ownership [*al partir*]. They represent the good luck of my girls[84].

Andrés and Rosa milked about 30 litres a day from their cows, but it was difficult to know how much was in "coownership". Andrés claimed that with ten cows it was possible to earn about $6,800 a year from milk production and the sale of calves.

Even though Rosa was involved in milk production, she did not depend on this to cover her daily expenses. She had the clothing shop and reared pigs, chickens, and guinea pigs. Decisions regarding cattle were largely up to Andrés, while Rosa had independent control over the small-animal production:

> We talk together if we want to sell a cow, but he [Andrés] does the negotiations. Also, he sells the potatoes. I do not like to interfere in that,

[84] A farmer in one of the communities said, "Each cow is reared in the name of a different member of the family, because each person has different 'luck'. If the person has 'good luck', the cows reproduce quickly and without many expenses." Fortune was related to almost every activity in the production of cattle, potato, guinea pigs, etc.

> otherwise people will say that I do not let him do his business. I only sell my things –guinea pigs, chickens, or pigs– and he does not say anything about that.

e. Off-farm activities

Apart from farming potatoes and cattle, Andrés worked as a building contractor in the community. He earned five to six times the salary of agricultural labourers doing this. He said that he only worked for his relatives, and only when the job was big enough to employ him for at least a few weeks at a time. He said that he used the money from building to cover daily expenses. Rosa, however, did not approve of this sort of work, because to her "it is only a way to meet friends to drink." She said: "When Andrés is working building houses, he usually comes back late at night. He also drinks and spends most of his money with his friends."

f. Family relations and the future of farming

Andrés and Rosa wanted their children to be educated at university. Andrés felt that being a *papero* was hard and tedious and he did not want his children to work as farmers. Rosa did not particularly enjoy working as a farmer either. She just wanted to manage her clothing outlet, and she wished that her husband would only farm cattle because it was less risky than potatoes. Andrés was not surprised by her attitude towards potato production:

> Women take fewer risks than men do, so we have to discuss differences. It is impossible to live together if problems grow worse, so we need to reach agreements. But those are only momentary illusions, because even wishes for the future are different between men and women. We cannot talk about support with constant agreement. Each one ends up behaving individually. Love is only for a moment, and then we return to our everyday responsibilities, which in the long run maintain the cohesion of couples. Even our children are not really ours. They are nice until seven [years old] because they are innocent and they depend on their parents, but later they make their own decisions; they do not belong to us anymore. We can only support them with education, so they do not have to end up being *campesinos* [peasants] like we are.

g. Potato production costs and benefits of the Olivo family

Andrés planted one hectare of Gabriela potatoes under full tillage. He did not sharecrop. He used 1,361 kilograms (30 quintals) of seed that he had paid people to select from his previous harvest.

Table 4.4 documents the costs and benefits of the Olivo family's potato field. The monetary costs represented 81 percent of the total. Labour costs accounted for 22 percent, soil fertilizer a further 22 percent and pesticides 19 percent Relative to farmers who practiced other styles, Andrés spent a high percentage of money on using a tractor (14%). He applied a high quantity of fertilizer in only two applications, whereas *Tradicionales* like Norman applied similar quantities over three or four applications. Andrés also made five applications of foliar fertilizer; he said that this complemented the soil fertilizer.

2004 was very dry in Santa Martha (as opposed to the very humid weather in the *páramos*) so the potato tuber moth was particularly problematic. Andrés made nine applications of pesticide to the plants and two additional applications to the soil. The pesticide was designed to control a range of pests but Andrés applied it predominantly to target tuber moth[85].

The non-monetary costs for the Olivo family represented 19 percent of the total and included eight percent for their own seed, seven percent for Andrés' labour days and four percent for the cost of the labourers' meals. In contrast to most other farmers, Andrés employed a cook for the labourers. The cook's wages were included in the overall labour costs.

Andrés harvested 10,070 kg (222 quintals). He sold 75 percent of this produce and retained 20 percent for seed and five percent for consumption. Previously he had sold almost the entire production and bought seed each time he planted.

The Olivo family's return was negative (-42%) due to their low production per hectare and high production costs, combined with low prices. They had low production in 2000 as well, but were lucky enough to have very high market prices at the time. Their cost-benefit ratio, calculated without including non-paid costs, was 182 percent in 2000, compared to -29 percent in 2004. These figures were for the same variety of potato grown in the same field for both years. This explains why *Arriesgados,* like the Olivo family, thought of potato production as a "lottery game" that changed their "luck" from year to year.

Even using the farmer's method of calculating the cost-benefit ratio with minimum and maximum prices for *Gabriela* potato, the Olivo family only achieved a positive ratio with the maximum price of 2004 or the maximum for the period 1990-2004.

---

[85] The technical recommendations of INIAP state that this pest cannot be controlled with pesticides.

Table 4.4. Costs and benefits per hectare of the Olivo family for one potato field

Paid costs	Quantity	Cost USD	Percentage
Mechanization		252.5	14
Labour days	104 days	427.4	22
Pesticides	11 applications	352.0	19
Soil fertilizer	2 applications	405.8	22
Foliar fertilizer	5 applications	36.1	2
Other costs		41.3	2
Total paid costs		*1515.1*	*81*
Non paid costs			
Seed	1361 kg	150.00	8
Labour days	23 days	135.00	7
Lunch for labourers	lunches	74.00	4
Total non-paid costs		*359.00*	*19*
Total cost		1874.01	100.00
Cook labour days	Already paid	0.00	0.00
Yield in kg/ha	10070		

Benefits calculated with different potato prices

	Actual price	Max 2004	Max 90-04	Min 2004	Min 90-04
Price in $/kg of the variety *Gabriela**	0.11	0.20	0.48	0.13	0.06
Yield $/ha	1072.5	2013.9	4833.5	1309.1	604.2
Benefit (USD/ha)	-801.5	139.9	2959.5	-564.9	-1269.8
Net benefit	-42%	7%	158%	-30%	-68%

*Data from the Ministry of Agriculture of Ecuador

Farmer's calculated benefit with different potato prices

	Actual price	Max 2004	Max 90-04	Min 2004	Min 90-04
Benefit' (production-total paid costs)	-442.5	498.9	3318.5	-205.9	-910.8
Benefit'/Total paid costs (%)	-29%	33%	219%	-14%	-60%

Farmer's analysis of production performance

	Obtained	Standard
Harvested potatoes/used seed (quintals)	7	20
Applied fertilizer/seed (quintals)	1	2

Use of the harvest

Use	Percentage
Sold	75
Seed	20
Self-consumption	5

The period of 2004 was a "bad year" for potato farmers in Santa Martha. Most farmers, including Andrés, did not like doing their accounting and asked me not to show them my calculations regarding their production. They said it was unlucky to know such information in a poor year. Nonetheless, when I asked Andrés about his production for that year, he was not unaware that he had a negative return ("*perdimos*").

When comparing the Olivo family's production for the year 2000 with that of 2004, the monetary costs of wage labour, pesticide and mechanization were very similar (23%, 19% and 12% respectively). Wage labour was the highest monetary investment for both years. This was despite the fact that Andrés had reduced labour inputs, from 180 days per hectare in 2000 to 104 days in 2004. *Dollarization* had increased labour costs and thus the percentage of the total cost remained largely unchanged. Fertilizer applications, on the other hand, had increased significantly from 2000 to 2004. Andrés increased the application of fertilizer because the soil quality had declined since 2000, and because he believed the crop needed extra nutrients to survive the dry weather. In 2000, he bought seed (13% of total cost) but used his own seed in 2004. Andrés had shifted his focus towards cattle production, and thus spent less of his own time on potato production in 2004 (23 days) than in 2000 (29 days). Andrés' ratio of "good production" was 1:7. His ratio of "good practice" was 1:1.

Taimal family - *Experimentadores*

"The quantity of foliar fertilizer not only depends upon the quality of soil, but upon the kind of farmer because not everybody knows how to use it."

Family history and agriculture: scarce land and capital

Gilberto (30) and Elena (26) had two daughters, four and seven years of age. They lived in San Francisco in a small house that they built in 2001. Gilberto worked mostly producing potato and occasionally as a labourer. Elena took care of the house and reared guinea pigs. The land Gilberto farmed belonged to his parents, but he did not know much of the history of production on the land prior to land reform. Gilberto's approach to farming potato was quite different from his father's. Elena explained how Gilberto learned about agriculture:

> My husband used to work with a cousin buying potatoes here and selling them in Quito. They used to leave at 10 at night and get to Quito at two a.m.; there they had to wait until the traders helped them to sell everything until seven in the morning. My husband got tired of the travelling and selling overnight. Then another cousin called him as a labourer and taught him to produce potatoes and later my husband started producing by himself in small fields of land from his parents.

Gilberto's parents, Secundino and Umbelina, had 12 children, eight of whom were still living. They bought seven hectares of land in the 1970s from the owners of hacienda La Rinconadita. They had worked there as hacienda servants for most of their lives[86]. The Taimal family later lost most of their land because they did not have the means to continue farming and needed money to live. Secundino explained:

> When the land reform started, the hacienda owners sold some land voluntarily to the servants. It was different for the labourers who had to fight for the land. I was a servant and *wasipunguero,* so I bought more or less three hectares and my wife got more or less four and a half hectares. The price of the land was 8.000 *sucres* per hectare. To complete the initial payment for the land, I gave the patron two cows and one bull. Later we continued paying with our animals. When the labourers organized in a cooperative they took some land from us, but I also joined the cooperative that was fighting for land. We invaded 250 hectares, and finally the patron gave us the *páramo* on his own will for grazing cattle. Even then we sold most of our land because we did not have animals to produce manure (*majada*) or the money to buy fertilizer.

The following narratives illustrate some of the differences between potato production before land reform (as experienced by Gilberto's parents) and Gilberto's way of farming potatoes in 2004. As Secundino said:

> Before, we only planted potato in *wachu rozado*. In the *páramos* even the *patrones* [hacienda owners] planted in this way. We prepared the land and at first we planted without any fertilizer. From 8 quintals we harvested 80 quintals more or less. I don't know exactly because we did not measure by quintals before. We just piled the potatoes in different places of the field and later we took them to the hacienda or to our house if it was in our *wasipungo*. There were no

[86] Hacienda servants were permanent workers doing specific tasks for the hacienda owners. As part of their payment they were assigned (but not given) a field of land on which to produce their own food and build their house. Such a plot was called a *wasipungo,* and the people who benefited from this arrangement were called the *wasipungueros.*

> tractors or cars. Later people started using oxen and then the *wachu rozado* was replaced with full tillage (*melga*) because it was possible to make the furrows and do the hilling-up with the oxen and leave it there until harvest.
>
> The owner of the hacienda where I worked bought a tractor. At first he prepared the land and planted the potatoes of the variety *Curipamba* without fertilizer, and he had a very good harvest. I used to take care of his harvest because he had thousands of quintals. We were amazed at the tractor because it reduced the work in the hacienda, but later he had to apply fertilizer.
>
> For planting potatoes we had our own seed. In that time we had potatoes of many kinds, such as *Pintada*, *Paspuela*, *Tableada*, *Blanca*, *Colorada*, *Rosada*, *Piña*, *Mirango* and many others. From each plant we harvested one arroba [25 pounds or 12 kilos]. Sometimes the patron used to bring seed of a different kind from Ibarra. That seed was for him and for all the servants, and he discounted us from our work. Most of us kept the seed and produced our own seed later.
>
> The *abonos* [chemical fertilizers] came after the tractor. Now the production is different because everybody applies fertilizer (*abono*). We apply for planting, weeding and hilling-up.
>
> In the hacienda the food was not cured [with pesticides]; we just cut the bushes, burned, made the furrows and planted. We did not need any application. I remember that the first pesticides we bought were past the expiration date, but we applied them because we saw that the other people did, but the crops were damaged anyway. Now the pesticides work and sometimes we can get back (*recuperar*) a crop that has been attacked by late blight. We bought the first pesticides in El Angel, but if we did not find it there we went to San Gabriel or even to Colombia because people there knew more.
>
> In order to learn about pesticides we used to ask in the pesticide shop, and the engineers would tell us what to apply. At first the pesticide shops only gave us the pesticides if we paid them cash. Now we have to take credit and if the potato has a good price, Gilberto makes up to six applications for selling in the market. For our own consumption we apply two or three times only. We started planting in sharecropping after the hacienda time because the *patrones* always planted alone with their own servants and oxen. We first started sharecropping within our family because it was safer. For the fertilizer we took loans from the bank.

Umbelina also gave her opinions regarding the changes that agriculture had undergone:

> Before it was better because there was another knowledge (*otro saber*) and the food was healthier; we did not have to spray pesticides. The potatoes, fava beans and oats did not have any diseases or pests. We only planted with animal manure since everybody complained that they did not have money for

> chemical fertilizer. People started applying pesticides because a worm appeared, and from one field it went to the fields of the neighbours, and also people got accustomed to planting only with chemical fertilizer (*abono*). The past times were better. Now we have to suffer looking for daily jobs so that we can have money to buy fertilizer and pesticides for our potatoes. Now even the cows need to be injected, and we get intoxicated because we eat food with poison.

Potato production practices (technology)

a. High levels of foliar fertilizer

Experimentadores like Gilberto characteristically applied foliar fertilizer as often as they could afford it. Much of their scarce capital was spent on this input. Gilberto explained that he was continuously experimenting with different kinds of foliar fertilizer at different stages of the cycle and with different potato varieties. Most farmers in Carchi used foliar fertilizer to complement soil fertilizer and because they made the crop look greener and healthier. Gilberto believed, however, that they could be used to great effect when one knew how and when to apply specific products correctly and according to the needs of the crop. He admitted that his strategy worked better in the valleys than in the *páramo,* and even then only when the soil was in good condition.

> Engineers always say that we should only apply fertilizer according to the soil needs. Now the fertilizer for the soil is really expensive and continues to go up. That is why we mainly apply foliar fertilizer and it works according to our experiments. We apply foliar fertilizer in good soil in the lowlands, while in the *páramo* people always have to spend more money [on soil fertilizer]. In the highlands the soil is acidic and the foliar fertilizer would not work there because potato plants will get very elegant, but with thin stalks and low production. In the *páramo,* or in bad quality land, even the Progib [giberelic acid] does not work well.
>
> The clue for applying foliar fertilizer is to have land in the lower parts and the land should be rested or be rich enough. I like to use Fetrilon, which is a really good mixture of microelements. The quantity of foliar fertilizer not only depends upon the quality of soil but upon the kind of farmer, because not everybody knows how to use it. I used to apply a lot of fertilizer to the soil but now it is too expensive; it would be cheaper to buy potatoes!

b. Low number of applications. High dosages due to miscalculation

Gilberto was continually experimenting with ways of controlling different pests without using pesticide. Low frequency of pesticide application was central to his farming strategy, which involved crop rotation on small fields. He observed the crops carefully throughout the cycle. He also varied the strain of potato and multi-cropped. Elena spoke of the relationship between pest attacks and the application of chemical fertilizers to the soil:

> To control foliar pests we use the yellow traps. Those traps can last for three or four planting seasons and some times more if you retire them when the [potato] plants are flowering. The problem is that when you use more fertilizer the crop gets better but it also needs more pesticide applications because everything likes to eat that crop, including the pests. This is not good because we spray the pesticides ourselves and we don't want to get intoxicated.

Gilberto:

> *Tecia solanîbora* is the *polilla guatemalteca* and it is the one that causes damage to the potato [tuber]. *Tecia torimea* is another *polilla* that causes damage to the potato leaves. Farmers say that when it is dry there is more *polilla* and the pesticides cannot kill them in the rainy season. It is true that it [potato tuber moth infestations] depends on the weather, but pesticides have nothing to do with that. I went with an engineer to look for *polilla* in a potato field and we set three sprayers in the field until it was muddy, and there the *polilla* was dead. Since then we don't have many problems with *polilla*. We know now that there are not poisons that kill *polilla*, only water. Sometimes farmers believe that pesticides have killed *polilla* but it is actually that *polillas* died because the water in the pesticide mixture hit them.

Another characteristic of the *Experimentadores* was that they applied the cheapest pesticides available, despite the new products promoted by the pesticide outlets. Gilberto said that in a sharecropping arrangement he could "experiment" more freely because his partner paid for the pesticide:

> These days some engineers are promoting a new product for controlling the Andean weevil. It is called Engeo and they said it is very effective. What I do is read the information in the label in order to see if there is a difference from other products that I already know. I always buy the cheapest products; that is the truth. When I plant green peas after potatoes, I usually do not buy other pesticide [products] but instead I apply the leftovers of the pesticides used on potatoes. But if I go to the pesticide shop they will say: "*get this and get that*."
>
> If you don't have money it is more difficult to be impressed by the pesticide sellers because you cannot buy all the products that they offer you anyway. I usually try to produce with the money I have. I only do experiments with my sharecroppers because there is not another way. If my sharecropper contributes pesticides then I go to see the things that he applies. Sharecropping is done in order to produce together, so we have to work together in everything, otherwise we don't learn. I always plant on my own,

> but I try to do sharecropping with somebody that knows something different. Sometimes I prefer to do the applications myself because I want to make sure that the application is done properly. I don't like to see that the crop is getting weak. I can recognize a good crop when it germinates.

Because Gilberto's fields were usually less than a hectare, he bought pesticides in small quantities. This was problematic in that the correct dosages were difficult to calculate. He often made mistakes and applied the wrong amounts. The cheapest pesticides on the market were usually the most toxic. Gilberto's health was at risk because he personally applied high dosages of these chemicals. Carbofuran [87] was an active ingredient in many of these cheap, highly toxic pesticides.

c. Diversifying potato varieties

Gilberto planted two or three small fields of potato every cycle. He planted about five or six potato varieties. He usually selected seed from the potatoes that he got as payment for his work as a labourer or from *recaves*. When sharecropping, his partners often contributed seed as well. Sometimes technicians provided farmers with seed in order to test the new clones in the field. As Gilberto explained, planting many varieties was a strategy to deal with changing weather conditions and fluctuating market prices:

> *Super chola* has a good price but it does not resist the attacks of *lancha* (late blight).[88] I plant different varieties because I know that one of them will produce well and another will get a good price. I usually select the seed from my payments [in kind] when I work on others' land or from *recaves* since those potatoes have the right size and I know the field from which the seed comes.
>
> Sometimes I also plant in sharecropping with an engineer. Last year we planted *Super chola* and Fripapa from INIAP. That seed was really good but everybody criticized me as lazy [vago] because I made it to the harvest with only two pesticide applications. Others said that I was only applying water. Because the engineer could not come here he trusted me. We planted 15 quintals and we got 500 quintals, one of the best harvests I had!

d. The soil: planting small areas and maintaining fertility

In the small fields that his parents assigned to him, Gilberto rotated potato with various legumes such as *chocho* (*Lupinus sp.),* green peas and fava beans.

[87] In Carchi, carbofuran was sold as a liquid that is even more toxic than its pellet form. This was a red label category Ib product according to the World Health Organization (WHO).

[88] The Spanish *Lancha* (late blight in English) is the common name for the effects of *Phitophtora infestans*, a fungus that attacks potato.

The legumes were used mainly for home consumption. Potato was also intercropped with smaller areas of Andean tubers such as *mashua*, *oca* or *melloco*. These were not in high demand in the market, but could often fetch a good price as speciality items. Gilberto did not have cattle and so could not fertilize with manure. Instead, he left the organic matter remaining from the crops in the soil. His labour, and that of his family, was enough to cope with the demands of the small areas they cultivated. He felt that his family was more conscientious in their work than hired labourers. Gilberto's style of farming allowed him to maintain good levels of soil fertility, and he obtained high yields per hectare despite a limited financial investment:

> As you see here [showing the crops in his fields], we plant a little bit of everything because this is the only land we have. Most of these products are for our family to eat. This way we save some money. Although people here have enough land, they only like to go to the market to buy everything, even though the soils in Carchi can produce all kinds of vegetables, like fava beans, onions, *chocho*, green peas. It was like that before, but now people prefer to produce just potatoes. We also plant *mashua*, *oca* and *melloco* after potatoes, but we cannot eat all the production so we sell it and often get a good price since not many people produce those crops anymore[89].

e. Experimentadores' views of soil fertilizer and mechanization

According to Gilberto, being poor was ironically an advantage in one way because he did not have the option of relying on mechanization and using large volumes of soil fertilizer. He knew that these inputs were not good for the soil in the long run, but that it would be tempting to use them if the capital were available:

> Farmers who apply a lot of [soil] fertilizer finish the soils faster than poorer farmers who don't have the money for it. After some time the poorer farmers will apply the same low quantities and are able to produce the same per quintal of seed as the ones that apply a lot of fertilizer. Also poor farmers only have money to pay for one pass of the tractor, when they can pay for that, so their soils do not get as eroded as those of the farmers who have money to make two and even three passes of the tractor. Eventually poorer farmers are able to produce the same as or more than the richer ones. Here there is a family that has their own tractor and they continue to produce a lot, but now, in addition to the fertilizer, they have to apply huge quantities of chicken manure and calcium carbonate, otherwise the soil would not respond to them. That means a lot of money!

---

[89] Espinosa *et al.* (1997) found that Andean tubers are not well appreciated in the market except for melloco.

f. Experimenting to continue farming with low investment

Gilberto viewed experimentation as the only way to continue farming with such low financial investment and limited land:

> If you don't have money the only way to produce potato is making your head work and finding your own way. I mean, we have to experiment or find somebody from whom to learn. The thing is that we have to produce potato because it is our staple food and because it is the main source of money for our family. I try many things so that I only buy a [chemical] product when I see that we really need that, otherwise I will get indebted for nothing. My parents planted without chemicals because they did not produce high quantities for the market, but we have to do something better than our parents, otherwise life is not worth it.

g. The labour process: family labour as the main work force

Gilberto relied on the labour of his family, not only to save money, but for "moral support." Such support was valuable to him because other farmers were often critical of his experimental techniques:

> We mainly work with our family and only a few times we pay a labourer, especially for soil preparation in full tillage or in *wachu rozado*. For harvest we only work with our family. We exchange labour but when one of us needs money we pay 4 dollars per day. Sometimes my brother comes with his father-in-law and his brother-in-law because labour is the capital of the poor. When you have good friends it is easy to get labourers, otherwise you have to contract a complete *cuadrilla*. If you ask an individual from the *cuadrilla*, they won't accept the job because they only work together. When I am trying a new fertilizer or new seed my family gives me moral support. Here everybody criticizes you when you don't spend lots of money on your crop. Without our family we could not continue, plus everything is done better by our kind.

Inputs and potato markets

a. Buying the cheapest inputs in small quantities

Gilberto usually bought agrochemicals from those shops that gave him credit. As he mentioned, he bought small quantities of the cheapest products available. Because he could only afford fractions of litres or kilograms, he paid more money per unit volume.

> I usually buy the [chemical] products from two shops where I get the products in credit. We always go to somebody who can give us credit, otherwise we don't have enough to pay cash immediately. In these shops we can also buy small quantities when we cannot buy the litre.

b. Selling the bulk of the production to good contacts

Gilberto did not often keep commercial varieties for self-consumption. Like most *Experimentadores,* he sold most of his produce because he needed to finance the next planting cycle. He sold his produce only to well known traders who helped him get the best possible price:

> We sell most of our production because with that money we can continue producing again. For food we mainly use the varieties that we like better, but those are not the ones that people like in the market. If it is the variety *Super chola,* we sell it in Quito and if it is the variety Esperanza, we sell that in Ibarra and San Gabriel. If the price is good I go to sell the first class potato in Quito and the rest of potato I sell in Ibarra. In the market in Quito I sell to Bertha Sanchez. We call her *La Mayor* because she gives us one or 1.50 dollars more per quintal than the others. When we have more than 100 quintals the difference is big. We always go to her because she only gets (charges) 50 cents per quintal. If she sells at 8 dollars she will give us 7.50 dollars. Selling ourselves would be very difficult. Firstly there is a single place were farmers can sell their products to the people [retailed] and we would have to be there the whole day until we finish selling 100 or 200 quintals. Instead, Bertha has her own contacts. Her clients will leave her a signed check that she can only change later, but to us she gives cash. Before, when I planted with another sharecropper, we only sold the production to those we called the Arturos in El Angel, but they paid a lot less than in Quito. Instead, Bertha negotiates very hard with her clients until she gets a better price. If her clients don't give her a good price she does not sell the potatoes and we like that.

c. Capital acquisition: sharecropping and working as a labourer

Gilberto sharecropped as a way to build capital. He usually contributed land, labour and pesticides or fertilizers to the partnership. Working with his family was important in a sharecropping operation because they not only provided most of the labour but also contributed money to buy agrochemicals. Gilberto used less agrochemicals when producing without a partner:

> We have sharecroppers but my family works together (*en sociedad*) to contribute with labour and some agrochemicals. If we lose, we all lose one part [of the investment]. The capital depends on the sharecropper that we choose. Now we have a sharecropper that contributes the land, part of the seed, the fertilizer and even the third pesticide application. We only have to contribute the last two or three applications and labour. If we don't have money to pay for the pesticide products, he will leave a check as guarantee in the pesticide shop; then we have to go and pay in one month.

> With my family we put the money needed to pay for the agrochemicals together and we work together in the field. Because we contribute labour we definitely spend more time on the crop. I prefer that because in order to succeed in sharecropping it is important to be close enough to the potato field so that you can check it everyday.
>
> For planting on my own I don't need much capital because I apply less pesticides and fertilizers. I usually work as a labourer in order to get some money, then I try to produce with the money that I have available and I don't need to take loans. Once I took a loan from a *chulco* [illegal lender] and he charged 10% monthly. There are even *chulcos* that charge 20%!

d. Family relations and the future: the common fund and equity

Gilberto and Elena wanted their daughters to study because the land they farmed was very small and did not even belong to them yet. Gilberto did most of the work in the field himself, but Elena participated in as many activities as she could. She played a large role in collecting *recaves* and seed selection and was often involved in weeding and harvesting. Gilberto also participated to a degree in the activities at home and helped raise pigs and guinea pigs.

In contrast to most families in Carchi, the Taimals managed a common fund for the revenue from potato production, breeding livestock and labour. Elena said that they used this fund to cover household expenses and to finance the next planting:

> We want our daughters to finish university, or at least have a technical degree, because we do not own the land we cultivate and it is very small anyway. Women here do not have much of a future so our girls should look for another activity. Even if they come back home they should work as professionals.
>
> In other families men and women work separately, but we manage the money together. We talk about how the money should be distributed, and then I am responsible for keeping all the cents we have because I am the one in charge of daily expenditures at home. With the *dollarization* we ran out of money. The *sucre* was ours even when it did not have much value. It seems that we could do more with that. That is why I have to be very careful with the dollars and keep every cent.

e. Potato production costs and benefits of the Taimal family

Gilberto sharecropped 0.75 hectare of three different potato varieties under full tillage. Table 4.5 documents the costs and benefits of the Taimal family potato field. The figures are extrapolated to represent one hectare.

The monetary cost of production represented 71 percent of the total. Gilberto and his sharecropper split the labour cost. They used 91 labour days per hectare in total. Of the 50 percent that Gilberto had to cover, he only spent money on 10 days of labour per hectare. The rest was covered by the labour of his family. The total number of paid labour days per hectare for both sharecroppers was 55, representing 22 percent of the costs. Gilberto's sharecropper also provided soil fertilizer and helped to prepare the soil. Gilberto contributed pesticide and foliar fertilizer. Soil fertilizer was the second highest monetary cost, at 13 percent. Pesticides represented 12 percent, foliar fertilizer 11 percent and mechanization a further 11 percent. Gilberto made seven applications of foliar fertilizer and seven applications of pesticide, while his sharecropper, as agreed, made only a single application of soil fertilizer. Consensus is important in sharecropping, but in this case it was Gilberto who usually made the decisions regarding inputs. His partner seemed to trust his opinion and respected his experience. The partner did not have his own land and considered himself to be poorer than Gilberto. He was pleased, "Working with Gilberto, one spends money only when it is really necessary."

The non-monetary costs were 29 percent of the total. This included 10 percent for their own seed. They used 1,452 kilograms (32 quintals) of seed per hectare. Of this Gilberto contributed four quintals of the *Maria* variety and three quintals of the *Roja* variety, while his sharecropper contributed 25 quintals of the *Esperanza* variety. Gilberto's labour and that of his family represented 12 percent of the total cost. The cost of lunch for all people who worked on the field represented percent of the total and was included in the non-monetary costing. The cook's labour (5%) was not included in the analysis.

Gilberto and his sharecropper harvested 16,148 kg (356 quintals) per hectare. They sold 100 percent of their production. Their return was 73 percent. This positive figure was due to their high production per hectare and low cost of production, combined with reasonable market prices for each of the varieties planted. They calculated their cost-benefit ratio to be 145 percent (without including non-paid costs).

When calculating the cost-benefit ratio with different minimum and maximum prices, the Taimal family generally had a positive ratio with the minimum price, except for the period 1990-2004. This demonstrates that the Taimal's strategy of production was highly resilient to price fluctuations. Their ratio of "good production" for this field was 1:11, while their ratio of "good practice" was 0.42:1.

Table 4.5. Costs and benefits per hectare for the Taimal family for one potato field

Paid costs	Quantity	Cost USD	Percentage
Mechanization		145.9	11
Labour days	55 days	293.1	22
Pesticides	7 applications	167.7	12
Soil fertilizer	1 application	178.7	13
Foliar fertilizer	7 applications	152.3	11
Other costs		29.8	2
Total paid costs		*967.4*	71
Non paid costs			
Seed	1452	138.6	10
Labour days	36 days	169.0	12
Lunch for labourers	Lunches	91.1	7
Total non-paid costs		*398.6*	29
Total cost		1365.9	100
Cook labour days (not included in the analysis)	57 days	77.8	5
Yield in kg/ha	16148		

Benefits calculated with different potato prices

	Actual price	Max 2004	Max 90-04	Min 2004	Min 90-04
Average price per kg of the varieties *Chola* and *Gabriela**	0.22	0.22	0.51	0.14	0.07
Yield $/ha	2369.7	3552.5	8235.4	2260.7	1130.4
Benefit (USD/ha)	1003.7	2186.6	6869.5	894.7	-235.6
Net benefit	73%	160%	503%	66%	-17%

*Data from the Ministry of Agriculture of Ecuador. Prices for *Roja*, *María* and *Esperanza* were not available

Farmer's calculated benefit with different potato prices

	Actual price	Max 2004	Max 90-04	Min 2004	Min 90-04
Benefit' (Production-Total paid costs)	1402.3	2585.2	7268.1	1293.4	163.0
Benefit'/Total paid costs (%)	145%	267%	751%	134%	17%

Farmer's analysis of production performance

	Obtained	Standard
Harvested potatoes/used seed (quintals)	11	20
Applied fertilizer/seed (quintals)	0.42	2

Use of the harvest: 100 percent sold

Characterization based on production figures

I now present an analysis of production for the families representing the 4 styles. The data are based on production per hectare. Table 4.6 is a summary of the analysis of the production figures and details some of the practices of each family.

Labour use

Table 4.6 highlights the different patterns of labour use in each farming style. The Cruz family (*Tradicionales*) planted in *wachu rozado* and thus required more labour days than the others who cultivated under full tillage. However, after decades of cultivation, *wachu rozado* fields had better soil quality than those under full tillage.

The number of non-paid labour days per hectare reflects the use of family labour and other non-commoditized labour arrangements common in peasant farming. These arrangements allowed farmers not only to save money, but to be directly involved in the progress of the crop cycle. This enabled the farmer to monitor the crop constantly and to quickly make adjustment to the inputs as needed. In addition, most farmers agreed that their family used chemical inputs more carefully than hired labourers. The Taimal family (*Experimentadores*) relied the most (40%) on this form of labour, followed by the Cruz family (*Tradicionales*). Non-paid labour as a percentage of the total cost of production indicates the percentage of money saved by each family by using this kind of non-commoditized labour. The Cruz family (*Tradicionales*), for instance, saved the highest percentage because of their use of non-paid labour. They saved 39.13 percent while the other three families saved around 30 percent. The Olivo family (*Arriesgados*) and the Fuentes family (*Seguros*) showed a tendency towards reducing non-paid labour.

Table 4.6. Summary of the analysis of production figures for each farming style

Details of production	*Tradicionales*	*Seguros*	*Arriesgados*	*Experimentadores*
	Cruz family	Fuentes family	Olivo family	Taimal family
Labour days	139 days	88 days	127 days	91 days
Non-paid labour (days per hectare)	28 days/ha	26 days/ha	23 days/ha	36 days/ha
Non-paid labour (% of total labour cost)	20%	30%	18%	40%
Seed used/ha	36 quintals/ha	38 quintals/ha	30 quintals/ha	32 quintals/ha
Seed variety	*Super chola*	*Gabriela*	*Gabriela*	*Esperanza, Maria, Roja*
Seed acquisition	Paid	Non-paid	Non-paid	Non-paid
Seed as % of total cost	14%	20%	8%	10%
Pesticide (% of the total cost)	9%	19%	19%	12%
Pesticide applications	12 applications	12 applications	11 applications	7 applications
Application pattern	According to observation	According to possibilities	On calendar basis	According to varieties
Soil fertilizer (% of the total cost)	23%	19%	22%	13%
Soil fertilizer applications	3 applications	2 applications	2 applications	1 application
Foliar fertilizer (% of the total cost)	1%	0%	2%	11%
Foliar fertilizer applications	6 applications	None	5 applications	7 applications
Mechanisation	0%	0%	14%	11%
Capital	1781.3	1509.0	1874.0	1365.9
Capital return	57%	35%	-42%	73%
Farmers' calculated benefits	82%	108%	-29%	145%
Productivity per seed quintal	9	9	7	11

Table 4.6. Summary of the analysis of production figures for each farming style (*continued*)

Details of production	*Tradicionales*	*Seguros*	*Arriesgados*	*Experimentadores*
Applied fertilizer per seed quintal	1	0.61	1	0.42
Productivity per labour unit	2.4 quintals per labour day	3.9 quintals per labour day	2.1 quintals per labour day	3.9 quintals per labour day
Production for the market (purpose of production)	77%	82%	75%	100%
Kind of market used	Local cooperative	Organized consumers in big city (Canastas)	Market in big cities	Market in small and big cities

Technology

Seed

Table 4.6 shows that the Fuentes (*Seguros*) used the highest quantity of seed per hectare. They explained that this was due to the fact that they used large potatoes for seed in order to give the growing plants more reserves in poor soils or in the advent of unfavourable weather conditions. The Cruz family (*Tradicionales*) also used large quantities of seed. They explained that planting in *wachu rozado* and on hillsides required more seed than full tillage and flat fields.

The Taimal family (*Experimentadores*) grew three different potato varieties on their field. The other families planted only one commercial variety. Reducing variety in order to produce more of the most marketable strain was characteristic of many farmers in Carchi. Small landholders like *Experimentadores*, however, tended to plant more varieties in order to minimize market and environmental risks (weather, pests and diseases).

Only the Cruz family (*Tradicionales*) bought their seed in 2004. They renewed their seed stock every five years or so. The other farmers planted their own seed or that of their sharecroppers in 2004. This was common practice for many farmers in Carchi because it saved on input costs and reduced the probability of introducing pests or diseases in seed tubers bought from elsewhere.

The figures for seed as a percentage of the total cost show how important this input was in the production process. As an input generated on the farm itself, it represented a significant monetary saving. The Fuentes family (*Seguros*) had the highest percentage seed cost (21.15%), while the Olivo family (*Arriesgados*) had the lowest percentage (8%).

Pesticides

Table 4.6 shows that all the families except the Taimals (*Experimentadores*) made a high number of pesticide applications. The Taimals planted varieties (*Esperanza, María, Roja*) that were not as susceptible to pests and diseases as the varieties selected by the other families.

The application patterns give an indication of the criteria that farmers used to guide their practice of pesticide use. The Cruz family (*Tradicionales*) monitored the crop continually and made applications when they deemed it necessary. The Fuentes family (*Seguros*) were limited by finances but applied pesticide whenever they could afford to. The Olivo family (*Arriesgados*) made applications according to the calendar. Lastly, the Taimal family (*Experimentadores*) varied their application pattern according to the variety under cultivation.

The figures for pesticide use as a percentage of the total cost indicate that this was one of the most financially demanding inputs. The Olivo family (*Arriesgados*) invested most heavily in pesticide, with the Fuentes family (*Seguros*) next in line. There are a number of factors that may account for these families' heavy investment in these chemicals. The Olivo's strategy of continuous application according to the calendar required a sustained input of pesticide. Both families' crops suffered severe pest and disease attacks and this may have been due to their choice of varieties of potato that had little natural pest resistance. Soil quality or dry weather may have promoted outbreaks of pests well. The lower percentages for the Cruz (*Tradicionales*) and Taimal (*Experimentadores*) families indicate that their patterns of application were more effective under the circumstances.

Soil fertilizer

The figures for soil fertilizer use indicate that this input was intensively applied on all the farms. The figures for soil fertilizer, as a percentage of the total cost, need to be analyzed in relation to the number of applications. It is technically recommended that soil fertilizers be applied in numerous doses. The percentage cost of soil fertilizer was highest for the Cruz family (*Tradicionales*). They made three applications. The Olivo family (*Arriesgados*) and the Fuentes family (*Seguros*) each made two applications. The Taimal family (*Experimentadores*) had the lowest percentage, having made only a single application of fertilizer.

Foliar fertilizer

The use of foliar fertilizer was not very common in Carchi in 2000, but by 2004 the use of agrochemicals in potato production had increased significantly in the area and most farmers were using foliar fertilizer. The Taimal family (*Experimentadores*) made up to seven applications of this input, representing 11.15 percent of their total cost. The Cruz (*Tradicionales*) and Olivo (*Arriesgados*) families made six and five applications respectively. Their figures for percentage of total cost were very low (1.37 % and 1.93 % respectively). According to the Taimal family, foliar fertilizer could replace more expensive soil fertilizer in lowlands and in areas with good soils. Only the Fuentes family (*Seguros*) did not use foliar fertilizer on their crops.

Mechanization

Mechanization refers mainly to the use of tractors, particularly in relation to land preparation. This kind of input is significant in Carchi because farmers in the area prepare the land in a direction perpendicular to the slope. This aggravates erosion in the potato fields. Only the Olivo (*Arriesgados*) and the Taimal (*Experimentadores*) families used a tractor to prepare the land in their fields. The former tilled the soil mechanically before every planting and consequently had the highest rates of erosion. The Taimal family only used a tractor when their sharecroppers paid for it. These practices are reflected in the figures for the percentage of total cost for mechanization.

Capital investments

The Olivo (*Arriesgados*) and Cruz (*Tradicionales*) families made the highest capital investments but enjoyed markedly different capital returns. While the Olivo family had the lowest return, the Cruz family had the second highest. The Olivo family explained that such negative returns were more common for them during the present decade due to low market prices and poor production (the result of pests, diseases, and soil and weather conditions). The Olivo family's production had been dropping since 2000 but that year they had a high potato price, which indicates their high market-dependence.

The Taimal (*Experimentadores*) and Fuentes (*Seguros*) families, on the other hand, made the lowest capital investments. Their returns were equally dissimilar. While the Taimals had the highest capital return of the four families, the Fuentes had the third highest. The Taimals maintained that their success was a result of their strategy of planting in small fields with good soil, and of utilizing family labour. This made good production rates possible from low investment. The Fuentes were reasonably satisfied with their return because they did not have to incur debt and had enough produce left over after marketing for consumption and seed.

The farmers' method of calculating returns in Carchi only took monetary expenditures into account. Even using this method, the Olivo family still had a negative return, which indicates a very poor production for them.

Production and productivity

The production figures reflect the results of each family's strategy. The indicator of "good production" referred to by farmers in Carchi was a ratio expressing the relation between the number of quintals of potatoes produced and the number of quintals of seed[90] planted. The fact that the quantity of seed used was of central importance to an evaluation of productivity shows that farmers considered seed to be the real object of labour. This may have been due to the fact that, historically, soils in the area were ideal for potato production. Soil fertility was therefore not an issue for farmers in those days, but seed was something that could be "improved" to boost production. The ideal ratio of production was 1:20, or 20 quintals of production for each quintal of seed. This ideal was increasingly difficult for farmers in Carchi to achieve, but remained a benchmark for comparison.

Table 4.6 shows that the Taimal family (*Experimentadores*) had the highest production per quintal of seed (11.13), followed by The Cruz family (*Tradicionales*), the Fuentes family (*Seguros*) and lastly, the Olivo family (*Arriesgados*). These results suggest that successful production was the result of dynamic combinations of practices and conditions that cannot be understood by a linear analysis.

Productivity per labour unit

The figures for productivity per labour unit give an indication of the efficiency of the use of labour in terms of production. Table 4.6 shows that the Olivo family (*Arriesgados*) had the lowest productivity per labour unit of

---

[90] To calculate production per area, I had to measure the area of each field because farmers only took into account the number of quintals planted and very often did not know the exact size of the field. Moreover, farmers said that production per seed planted was a more accurate indicator because the production per hectare varies according to the field. For instance, they said that in steep fields farmers had to plant more quintals per area.

the four families. The Taimal family (*Experimentadores*) had the highest. According to the Taimals, this was because family labour allowed for careful and continuous observation of the crop and, consequently, good decision making regarding the timing and quantities of inputs.

Fertilizer use as indicator of wealth

The other indicator that farmers commonly used in Carchi was the ratio of applied fertilizer to quintals of seed planted. As a farmer explained, this was an indicator of wealth in the sense that it gauged how much capital a farmer was willing to spend on the crop. Some farmers were of the opinion that one needed to spend a significant amount on fertilizer in order to be considered a "true farmer." These farmers believed that the more fertilizer one applied the better.

Table 4.6 shows that the Olivo (*Arriesgados*) and Cruz (*Traditionales*) families had the highest value for this indicator (they used the most fertilizer relative to seed). The Taimal family (*Experimentadores*) had the lowest value. It is likely that this standard of comparison was of no interest to them.

<u>Purpose of the production</u>

The purpose of the production refers to the main focus of the farm and the strategies employed by the farmers to achieve their production aims. Table 4.6 indicates that the Taimal family (*Experimentadores)* was producing mainly for the market, while the other three families also produced for self-consumption and to retain their own seed. It is often assumed that small landholders are "subsistence" farmers (producing only for self-consumption), but the purpose of production figures show that it is possible for small landholders like the Taimal family to produce exclusively for the market. These farmers need to have other strategies (e.g. *recaves* and labour paid in kind) to provide themselves with food and seed.

The farmers in this study were able to link with other actors in order to create alternative markets for their potatoes. The Cruz family (*Tradicionales*) preferred to sell to a local cooperative that guaranteed them a stable price. The Fuentes (*Seguros*) sold to a consumer group in Quito called the *Canastas*. This group paid a relatively good price for potatoes that had not been sprayed with Carbofuran. The *canastas* ensured that farmers covered their costs and made at least a small profit. The Olivo family (*Arriesgados*) only sold in big markets because they usually produced large quantities that were difficult to sell in small towns. They preferred to travel with their produce to cities like Ibarra and Quito, where it was easier to negotiate a better price, rather than selling from the fields. The Taimal family (*Experimentadores*) sold their potatoes in both small and big cities, depending on the variety and the quality of their produce. This family diversified more by producing other Andean tubers that also fetched a good price in the market.

Commoditization

Commoditization is the process by which elements of production acquire exchange value (rather than use value), usually compensated for in currency. Commoditization rates in this study measure the extent to which the different inputs for potato production acquired a monetary value on each farm. To calculate this I gave non-paid factors the same monetary value as if farmers had to pay for them at the time. The only time that farmers themselves gave a specific value to non-commoditized inputs was when they evaluated their time and labour in a sharecropping arrangement[91]. It was not always simple for them to put a precise value to something like family labour. I asked farmers to try and put a monetary value on specific inputs. One farmer said: "When you cannot find [paid] labourers, the labour of your relatives or friends does not have a price." In hard times such labour could be "priceless" and could only be repaid in kind when the donor was in a similar predicament at some stage in the future. In this case, labour had a value because of its usefulness at a given moment of the production cycle and not because of its market-value.

There has been a legislated shift towards commoditization in agriculture in Carchi over the last decades. A discussion about commoditization processes is still relevant, however, because non-commoditized networks remain central to the sustainability of peasant agriculture.

Table 4.7. Commoditization relations for the four farms studied

	Tradicionales farmers	*Seguros* farmers	*Arriesgados* farmers	*Experimentadores* farmers
1. Paid costs	1536.65	980.3	1515.01	967.35
2. Non-paid costs	244.6	528.7	359	398.63
3. Sold production	2496	1680	837.5	2369.67
Relation A (1/2) Self-sufficiency	6.28	1.85	4.22	2.43
Relation B (1/3) Autonomy	0.62	0.58	1.81	0.41

[91] In this case, farmers gave the same monetary value as the paid labour days to their non-paid labour days.

Table 4.7 contains the figures used to calculate commoditization rates. Van der Ploeg (2003) defines two types of relations through which commoditization can be analyzed. One is through the relation between resources mobilized via markets (paid costs) and resources reproduced in the farm (non-paid costs). This corresponds to relation **a** in the table. The farm's level of self-sufficiency is high when resources are predominantly reproduced on the farm. The lower the value of **a**, the higher the level of self-sufficiency. Looking at the figures in table 4.7, the Fuentes (*Seguros*) had the most self-sufficient farm, followed by the Taimal family (*Experimentadores*). The Olivo family (*Arriesgados*) was the least self-sufficient of the four families.

Van der Ploeg mentions another relation through which to analyze commoditization. This is the relation between purchased resources and sold produce (see relation **b**). A value close to or higher than one represents a relatively high market dependency. The higher the dependency "the more oppressive the relationship between markets and farm will become" (Ibid: 56). The figures show that the Olivo family (*Arriesgados*) was more dependent on the market than the other three families. The Taimal family (*Experimentadores*) was the most independent of the market.

Most farmers in Carchi focused mainly on paid costs and sold production when doing their own accounts. For instance, many farmers were satisfied that the production was "good" when they had money left over after subtracting the costs of labour for harvest from the total value of potatoes sold. This means that relation **b**, or being independent of markets, was a very important consideration when constructing their styles.

Potato production became more difficult in Carchi after 2000. *Dollarization* of the economy pushed up the price of pesticides and fertilizers, but the price of agricultural products, such as potatoes, did not increase proportionally. Consequently, the strategies each family adopted to continue production were critical. These strategies were influenced by social forces and shaped by local perceptions of what constituted "good farming." The different styles of farming are the product of farmers' construction of sociotechnical networks.

For the Cruz family (*Tradicionales*), maintaining knowledge of traditional practices (such as the *wachu rozado* system) was important because they considered such practices to be their heritage. The application of traditional knowledge allowed this family to maintain their resources while adopting certain "modern" technologies. Their idea of good farming involved looking after the environment (the forest and the soil) in order to achieve good production per quintal of seed. They accessed specialized forms of manual labour for certain tasks through their sociotechnical network. In sharecropping, they closely monitored their crops themselves. They adapted technologies in response to their observations, rather than simply following technical recommendations. For them, being a labourer was not something to be ashamed of; it was necessary for good results.

The Fuentes (*Seguros*) based their strategy on values of freedom that arose historically from resistance to the hacienda system. They did not like hiring labourers or working for others as labourers themselves because they considered the relations involved to be unfair, "like slavery." They preferred to use machinery and production systems that did not involve, or at least reduced, the hiring of labour. They did so at the expense of the quality of their land and their productivity. They valued their independence and restricted their investment in inputs rather than taking loans from the banks. They tried to use their own resources where possible (e.g. retaining their own seed). Their farming strategies were based on sociotechnical networks involving their extended family and close friends. These networks gave them access to resources without the need for much capital.

Wealth was important to the Olivo family (*Arriesgados*) and was expressed by the externalization of their farming practices. Their potato production involved the most sophisticated technology available. The process of mechanization had limited non-commoditized relations in their sociotechnical networks. Instead, they maintained specific links with financial and technical institutions. This strategy demanded intensive capital use and did not necessarily result in high yields. Wealth was related to their children's "professionalization," and was seen as a way for the children to move away from farming activities. Risk was necessary to maintain or improve their economic situation. Although potato production was the most important activity for the Olivo family, their continuous losses over the previous decade made them gradually switch to cattle production.

The Taimal family (*Experimentadores*) aspired to a better standard of living than their parents, who were hacienda labourers. They learned to use modern technology to achieve their production goals without being full-time labourers. Their main strategy was to experiment with "modern" technology on small fields in order to produce potatoes for the market with low monetary investment. They had access to small pieces of land in flat areas and protected the fertility of the soil by multi-cropping and crop rotation. This resulted in high production per area. They did not have access to capital and thus relied on sociotechnical networks of family and friends to keep their farm running. They cultivated numerous varieties of potato and other Andean tubers in order to diversify their markets and reduce their risks.

Conclusions

The characterization of farming styles in this chapter leads to a number of conclusions regarding the policies of modernization.

Co-production of farming landscapes

Each community studied owns a particular history and resource base favouring certain farming styles. The history of land acquisition demonstrates that the current resource base is not a given but a construction of its inhabitants. Similar starting conditions have given way to very dissimilar conditions at the present time, such as the case of Mariscal and San Pedro de Piartal. The current farming landscapes are the result of co-production between the farming family and the surrounding community based on their life experiences and evolving perceptions of their history. Therefore, farmers develop different farming styles not merely as a response to their resource base but by moulding their initial asset base -- e.g., by logging the forest, burning or preserving the *páramo*, or transforming such resources into agriculture. Over time, families put into practice their different ideas of "good farming."

The history of land acquisition, in particular, heavily influences the management of the resource base and the development of farming styles. The communities that acquired land prior to agrarian reform were several decades ahead of others in developing their own farming styles. In addition, these communities had access to forests that they could exploit to pay off land debt. Yet, even within those communities diverse farming styles have developed, though their styles have been highly influenced by relationships with the hacienda owners (relatively good or exploitative) from whom they obtained land, and thus the attitudes and values they have provided to the assets they acquired during land transfer. On the other hand, those communities that acquired land after agrarian reform–did not always have access to a resource base (such as a forest) from which to exploit for capital to pay off debts associated with land acquisition. As a result, these farmers were forced to sell off livestock (mainly cattle and sheep) and other resources. In so doing, they were quick to mine their resource base, leaving them vulnerable to the future. For example, families that sold off their cattle lost a source of manure-based fertilizer and became dependent on chemical fertilizers for soil fertility. While farmers in the later generation of communities had less of an opportunity to develop their own unique farming styles, they did. Furthermore, it was possible to find examples of all the farming styles in between the early and later generation communities. This implies that, even under highly prohibitive conditions and circumstances, farmers still find ways to creatively manage their physical and social contexts, diversifying activity, practice and strategy in their community. This is consistent with Wartena's (2006, 23) assertion that there is no mechanical relationship between demography and ecology.

Contested assumptions

The study of farmers practicing the *Tradicionales* style shows that traditional methods of farming can be applied, in combination with certain "modern" practices, to market-oriented production. These farmers were not driven by modernization to reduce their labour inputs and increase mechanization. Rather, the *Tradicionales* hired specialized labourers who worked as organized groups, charging less than individual farmers. Labour was central to their style of farming, particularly for those practicing *wachu rozado*. They adapted their traditional practices to enable them, even after the crisis of *dollarization*, to continue farming in a "modern" way.

A study of the *Seguros* farming style shows that not all farmers prioritize production for the market. The *Seguros* valued freedom from the kinds of relationships that were common in the hacienda system. As a result, they avoided dependence on commoditized inputs. Production for the market was less important to them than production for self-consumption and for seed. As in the case of the Fuentes, *Seguros* looked for secure markets and developed cattle production to give them more financial stability in the long term. *Seguros* did not have capital, but they usually had plenty of land that they dedicated increasingly to cattle production. The size of the farms, in this case, was not directly proportional to the level of market incorporation. Some of these large farms were producing potatoes for subsistence.

The farming style of the *Arriesgados* represents the model promoted by modernization policies in Ecuador. This style proved to be unsustainable. The breakdown of non-commoditized relations of production made farmers highly dependent on all kinds of markets. After agrarian reform, *Arriesgados* were provided with land (mainly flatlands), agrochemicals, access to mechanization and credits so that they could produce potato for the market. This strategy worked well for a decade or more but, even before the advent of *dollarization,* the soils were already severely eroded, acidified and susceptible to disease and pests. After *dollarization*, potato prices decreased, resulting in continuous losses for *Arriesgados*. Many of these farmers continued their unproductive practices in the nostalgic hope that they would once again be fruitful.

The prevalence of the *Experimentadores* style contradicts policy assumptions that small landholders utilizing high levels of non-commoditized forms of labour are exclusively subsistence farmers. The *Experimentadores* studied were small landholders who produced mostly for the big markets. They did not necessarily produce the most marketable potatoes, but rather a variety for specific markets in different places.

Detailed and continuous observation of the crop was an important element of successful production. This was characteristic of both *Tradicionales* and *Experimentadores*. Farmers' own labour and that of their extended families was important in order to apply their knowledge of resources, inputs, and techniques to the farming process. Following standardized technical recommendations did not guarantee good production.

In conclusion, not all farming families in Carchi were organized around commoditization, and market forces were not necessarily pushing them in this direction. Most farmers who participated successfully in the market did so directly through specialized buyers, such as cooperatives, consumer organizations or industries demanding particular varieties of potato. It became evident that organizing around the market did not automatically lead to greater levels of "development". On the contrary, market dependency appeared to make farmers more vulnerable to price fluctuations. This was clearly illustrated by farmers' experience after the national *dollarization* policy.

Calculation of profits and *calculus*

The farmers' calculations of profit documented here resemble those compiled by Mayer (2002) in the highlands of Peru. He established that "the question of whether profits have been realized is a feature of the flow of money but not of the total resources needed to procure money" (Mayer 2002: 207). The farmers' method of calculation does not follow the same procedure or represent the same meaning as the "profit"[92] of classical accounting. My argument may be clarified by the discussion about commoditization and "autonomy" in this chapter. Farmers commonly

[92] The discussion of Mayer about the different uses of the Spanish verb '*ganar*' (Mayer 2002: 207) is also applicable in my study as it refers to "ways in which money can be earned" and "to win".

measure their financial resources as a function of their autonomy from markets in the process of reproducing a new production cycle. Because value of the exchange of non-commoditized resources is locally embedded, peasant farmers can manage and control such exchange arrangements to a greater extent than they could the exchange of commoditized resources outside their controlled domains (for instance, the price variations for individual commodities). Some potato farmers, however, manage to effectively stabilize market prices by selling their harvests to a cooperative or a group of consumers.

I agree with Mayer (2002) that farmers are generally aware that their labour and other on-farm resources are not factored into their accounting procedures. Mayer mentions that such calculation "is the result of a conscious strategy to separate commercial and subsistence spheres" (Ibid: 229). My study revealed, however, that this strategy was mainly limited to the *Seguros*. For the remaining styles, potato production was commercial, although they did make use of different levels of non-commoditized resources and labour in the production process. The distinction between commercial and subsistence spheres was unclear in these farming styles.

Farmers' consciousness of their conditions of production, as well as of their profits or losses, is reminiscent of Giddens' (1990: 79, 90) explanation that people are generally aware of the new conditions of modernity, yet they exhibit different attitudes towards dealing with its conditions and foreseeable consequences. The study of farming styles provides further resolution on these differences. Farmers who lose money in their potato fields are essentially aware of their losses, but they regard the possibility of explicitly knowing an accounting balance of their activity as "unlucky." Giddens (1990: 111) explains that "where risks are greatest…*Fortuna* tends to return." Generally cognizant of the economic risks inherent in potato farming, farmers' rationalization can be viewed as a form of faith in a better future. In contrast, other farmers aim at avoiding or reducing risks through juggling a suite of alternative practices, such as adjusting planting dates, monitoring crops, and selling to a cooperative. Rather than isolated actions, these correspond to farmers' constructions of what van der Ploeg (1990) describes as the unique *calculus* of farming styles:

> We defined and researched a calculus as the structure in which a farmer specifies goals and means and their mutual relations within which labour as well as interrelations between farm and environment are regulated. A calculus is constructed and reproduced through repeated processes of observation, interpretation, understanding and adaptation. Thus a calculus symbolizes a particular structuring of farm labour (van der Ploeg 1990: 271).

About technology

From the cases studied it was possible to see that agrochemicals could be used in multiple ways, as per the particular aim of a farming style. *Tradicionales* and *Arriesgados* made similar investments in agrochemicals, but their patterns of application were different. Regarding pesticides, *Tradicionales* usually planted potatoes in more humid conditions and in *wachu rozado,* causing them to carry out additional fungicide applications against late blight, which proliferated under these conditions. *Arriesgados* instead planted in drier areas and in full tillage. They had more problems with pests, especially the Andean weevil and the potato tuber moth. They usually made less pesticide applications and applied on a calendar basis. The same applied for soil fertilizer, since *Tradicionales* tended to apply similar amounts of fertilizer more often than *Arriesgados*.

Seguros and *Experimentadores* made similar investments in agrochemicals (although less than the other two groups of farmers). The main difference between these two groups was that *Seguros* applied more soil fertilizer because their soils were of lower quality than that of *Experimentadores*; while the latter made more applications of foliar fertilizer.

In general, it could be said that more numerous applications of agrochemicals usually implied that farmers were trying to use them more efficiently, because they based their applications on continuous observation.

Wachu rozado

Traditional practices, such as *wachu rozado,* should be analyzed in context. Farmers who had been producing within this system continually for many decades, could see the benefits of this practice for the soil. When the system was implemented only occasionally farmers said that it produced less than full tillage while requiring more labour. However, it was not possible to plant continually in *wachu rozado* unless the weather conditions were wet, such as in the *páramo* or the Interandean forest. Although *wachu rozado* reduced favourable conditions for Andean weevil attacks, and consequently the number of soil disinfections with pesticides, it was also more conducive to late blight attacks. More periodic foliar pesticide applications were therefore necessary when susceptible varieties were planted.

Family values and history shaping farming styles

This chapter shows that heterogeneity in the four farming styles was the result of different combinations of practices based on farmers' different perceptions of "good farming." The values that shaped each farmer's decisions over labour, technology and markets were forged according to their history and personal experiences. Thus, farming styles did not depend only on the factors of production, but on how family decisions (based in their culture and context) affected the economic, ecological, and social arrangements of farm management. Moreover, farmers' different farming styles shape the continuity or transformation of local practices. Closer relations with the market, for instance, influence intensifying land use (fewer rotations and fallow periods) and the abandonment of practices, such as the *wachu rozado* system, regarded as "traditional".

Variability in farming strategies also reveals farmers' unique perceptions about technologies. Such perceptions cannot be directly related only to economic efficiency, but must also be understood through cultural identities ("*papero*s," "true farmers," "labourers." etc.).

Chapter 5

Quantitative Analysis of Potato Farming Styles

This chapter presents a quantitative study of farming styles in Carchi. The analysis disaggregates the practices of a large population of farmers into the heterogeneous practices of particular subgroups. In this way, it is able to reveal multiple assemblages and patterns of practices within a region, which Arce and Long (2000) have called "localized modernities." In order to interpret the results of this chapter, I have relied on my own observations and discussions with farmers in their fields as well as on interviews with agricultural scientists who provide their own technical explanations for farmers' practices. The interpretation of the results shows that different farming strategies are not the outcome of individual decisions. Rather, they are an integral part of particular sociotechnical networks created and recreated through convergent and divergent histories over decades.

Data origin

The qualitative data presented in Chapter Four guides the organization and analysis of farming styles presented in this chapter. The general methodology for data collection in the field is explained in Chapter Three. In sum, the quantitative data used in this chapter originates from repeated visits to 94 potato fields for the duration of one potato production cycle that spanned a six-month period between 2003 and 2004. I made these visits with a team of four farmers, one from each community, who helped me to compile a register of daily activities performed by the different individuals on each farm. The 94 potato fields were all located in the four communities of Mariscal, San Pedro, Santa Martha and San Francisco. Ninety-two of the fields belonged to 92 individual farmers, and two fields belonged to two farmers' groups.[93] I refer to all 94 fields as "farmers' fields" in this chapter, and to the patterns of practices documented on these fields as "farmers' practices." For the purpose of analysis, I have distinguished farmers' practices by field characteristics and farming tasks and tabulated this information in the following spreadsheets:

- Field description
- Labour use

[93] Two groups of farmers began producing together after receiving training in farmer field schools.

- Planting system
- Production and its distribution
- Pesticide use
- Fertilizer use
- Equipment use
- Costs and benefits

These data sheets contain the disaggregated information about farmers' practices on each of the 94 fields. If a farmer made seven pesticide applications during the potato cycle, for instance, the data sheet would contain the following information for each one of the seven applications: the date of the application (or the number of days after planting), the name of the commercial products applied, the active ingredients contained in the pesticide, the dosage and the price that the farmer paid for the product. This level of detail is a very important factor in the analysis of the different patterns of pesticide use that is presented in Chapter six in which I will use the same spreadsheet structure for fertilizer, labour and equipment use.

In order to conduct different statistical analyses in this chapter, I have also aggregated data for each farmer's field. This makes it possible to compare the practices of all the farmers in a single data sheet (flat file). In the example of the seven pesticide applications cited above, the flat file would contain the total of all seven pesticide applications, rather than the details of each one. Table 5.1 shows how the aggregated data on fertilizer use makes it possible to compare, for example, the total number of fertilizer applications made on farmers' fields, i.e., the total number of kilograms of nitrogen (N), phosphorus (P) and potassium (K) used, and the total cost of fertilizer applied per hectare.

Table 5.1. Example of aggregated data on fertilizer use from farmers' fields

Farmers' fields	Total no. of applications of fertilizer	N (kg/ha)	P (kg/ha)	K (kg/ha)	Total cost (US$/ha)
1	2	144.70	324.32	188.24	390.50
2	2	113.40	340.19	113.40	290.88
3	1	134.19	226.80	226.80	297.92
4	2	111.45	298.07	220.32	318.57
5	2	110.71	307.52	184.51	305.08

In order to use non-numeric variables (n=39) in the analysis, I have converted these variables using different methods. Nominal and dichotomous variables have been converted into metric variables by means of the Minimum Alternant Square method, while the ordinal variables have been transformed into continuous variables through the Optimum Quantification method (OQM). Although this kind of conversion skews the data, or the non-normality of variables, the advantage of using transformation methods is that they allow variables to be included in a quantitative analysis. The total number of variables obtained after these conversions are listed in Appendix 5.1.

Analyses performed

All the analyses have been performed in SAS 9.1, with the assistance of an expert in this programme. In order to identify different styles of farming on the basis of database analysis, we first performed a factor analysis to reduce the 39 variables observed in the 94 farmers' fields. The aim of factor analysis in this study is to identify groups of highly correlated variables, which together form factors. Each factor represents a specific pattern in which the variables come together in a farming practice (e.g. the factor relating to pesticide use combines high pesticide costs with high quantities of different pesticide active ingredients applied per hectare). Since each farmer scores differently on each factor, we also conducted a cluster analysis so that farmers with similar patterns of scores are grouped together (e.g. farmers who score high in factors one, four and seven and low in the other factors form one sub-group, or cluster).

In the following sections, I will explain the processes involved in carrying out the factor and cluster analyses, the significance of the factors that have been identified and the rationale according to which farmers have been grouped in each cluster. The concept of farming styles is used to explain heterogeneity in farming practice.

Factor analysis

The determinant of the correlation matrix of variables in this study is 5.4 x 10-17, which shows that there are linear dependencies between variables and also that there is a high probability of finding common underlying factors. I have chosen ten factors, arrived at by combining the Kaiser-Guttman rule, the percentage of variance, the scree test and the interpretation of the results of the previous qualitative study. Table 5.2 shows that ten factors explain 72% of the variations. Figure 5.3 shows the scree field of the eigenvalues of this study, where the clear elbow occurs at ten factors. Notice that the eigenvalues for the first factors drop rapidly but their decline gradually levels off after the tenth factor. The scree field suggests a maximum of ten factors as well.

A priori *hypothesis for the number of factors*

The results of the research conducted into economic tradeoffs by Crissman *et al.* (1998), suggests that most peasant farmers in Carchi relied on external inputs for potato production. However some of the results from the Crissman study (see Figures 2.1 and 2.2 in Chapter 2), reveal that patterns of pesticide application were not consistent. The qualitative research that I conducted in 2001 (Paredes 2001) attempted to explain these differences in pesticide use by relating them to farmers' perceptions of the effect of pesticides on human health The more recent qualitative research that I carried out in 2003-2004 reveals great variation in pesticide use in relation to number of applications, dosage, price, formulation, forms of acquisition and the particular combinations used. Other differences relate to the use of foliar or soil pesticides, the use of foliar or soil fertilizers, and the use of labour and equipment).

While the study of Crissman *et al.* (1998) did not distinguish between full tillage and *wachu rozado* (19% of their sample) and also showed that there was little use of foliar fertilizer (0.8% average of the total cost), my research has explored the differences in production which are due to different tillage systems (full tillage and *wachu rozado*). I have also documented farmers' increasing use of foliar fertilizer (3.29 % average of the total cost). I anticipated finding five major factors in which variations would occur: pesticide use, soil and foliar fertilizer use, equipment and labour use. In addition I expected to find variations in another three factors that were related to costs, benefits and planting systems. This resulted in a total of eight factors that I expected to find. To confirm this hypothesis, I ran a factor analysis. When I combined this analysis with the other methods I have already mentioned, ten factors emerged as requiring attention. These are shown in Table 5.3.

The interpretation of each factor in my study took into account all the variables that loaded significantly (0.3 and more) on a factor, including the size and sign of the loading as well as the concept of farming styles. I used the variables with the highest factor loading as a guide when naming each of the following ten factors:

Factor 1. Fine-tuning
Factor 2. Pesticide use
Factor 3. Fertilizer use
Factor 4. Labour use
Factor 5. Market-oriented production
Factor 6. Yield and benefit

Factor 7. Equipment cost
Factor 8. Soil disinfections
Factor 9. Foliar fertilizer cost
Factor 10. Seed use

The first group of factors displays greater variability than the ones at the end because they are comprised of a higher number of correlated variables.

Table 5.2. Eigenvalues of the correlation matrix

Factors	Eigenvalue	Difference	Proportion	Cumulative
1	7.11	2.79	0.18	0.18
2	4.32	1.30	0.11	0.29
3	3.02	0.10	0.07	0.37
4	2.92	0.22	0.07	0.45
5	2.70	0.62	0.06	0.51
6	2.07	0.20	0.05	0.57
7	1.88	0.20	0.04	0.62
8	1.68	0.36	0.04	0.66
9	1.31	0.10	0.03	0.69
10	1.21	0.10	0.03	0.72
11	1.12	0.10	0.03	0.75
12	1.02	0.10	0.03	0.78

The combination of factors

When farmers have high scores in a given set of factors and low in others, a specific farming strategy or style of farming is indicated. For instance, high factor scores for Factor one (*fine-tuning*) and low factor scores for Factors two and three (pesticide and fertilizer use respectively) would show that farmers were trying to reduce costs on these inputs.

Each combination of factors results in different yields and monetary benefits that invites a specific explanation of the rationale behind the appearance of a particular combination. Farmers do not plan, for instance, to have a low yield, but yield is one indicator among others that farmers set as a priority when deciding how to manage their available resources and networks. Scarcity of labour would result in a different strategy from one which would result from scarcity of land and/or capital. Scarcity and abundance are not just quantitative concepts, but also social concepts, which can be regulated within networks (e.g. sharecropping or family labour).

Figure 5.1. Scree plot of eigenvalues for each factor

```
Scree Plot of Eigenvalues

 120 +
   |
   |
   |
   |     1
   |
 100 +
   |
   |
   |
   |
   |
   |      2
  80 +
   |
E  |
i  |
g  |
e  |
n  |
v 60 +       3
a  |
l  |
u  |
e  |
s  |        4
   |
  40 +
   |
   |
   |         5
   |
   |          6
   |
  20 +
   |
   |           78
   |
   |            9
   |             0 1 2
   |                3 4 5 6 78
  0 +                     9 0 1 23 4 5 6 78 9 0 1 23 4 5 6 78 9
   |
   +--------+--------+--------+--------+--------+--------+--------+------
        0    5     10   15    20    25    30    35    40

                         Number
```

Table 5.3. Factor analysis based on Heywood's Maximum Verisimilitude method

Rotated Factor Pattern	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
Pesticide applications number	0,82	0,45	0,15	-0,01	0,14	-0,06	-0,15	0,05	-0,09	-0,03
Active ingredients applications number	0,80	0,47	0,11	0,05	0,11	-0,02	-0,08	0,02	-0,15	0,00
Crop system (highest value = *wachu rozado*)	0,64	0,06	0,10	0,18	0,02	0,06	-0,12	-0,06	0,04	-0,04
Field area	0,59	-0,23	-0,09	-0,19	0,16	0,11	0,21	0,02	-0,02	-0,01
Foliar fertilizations number	0,53	0,05	0,15	-0,09	0,04	0,08	0,13	0,10	0,47	-0,10
Paid days of labour per hectare	0,53	-0,06	0,14	0,21	0,37	0,35	0,15	0,01	-0,14	0,11
Fertilizations number	0.40	0,08	0,22	-0,07	-0,09	0,16	0,20	0,11	0,08	-0,03
Organochlorine compound (kg of a.i/ha)	0,28	0,09	-0,04	0,20	-0,06	0,25	0,05	0,11	0,14	0,13
IPM (applied at least one IPM practice)	-0,37	-0,08	-0,18	-0,06	0,04	-0,03	0,02	-0,09	0,03	-0,30
Resistance of planted seeds (highest= resistant)	-0,39	-0,21	-0,07	0,02	-0,03	-0,06	0,09	-0,03	-0,15	0,17
Pesticides (cost of) (%)	0,13	0,91	-0,08	-0,12	-0,03	-0,10	-0,23	0,23	0,00	-0,10
Thiocarbamate (kg of a.i./ha)	0,26	0,80	0,32	0,12	0,07	-0,02	-0,03	0,01	0,07	0,10
Cymoxanil (kg of a.i./ha)	0,03	0,75	0,15	0,19	0,06	-0,01	0,03	0,06	-0,05	0,04
Other type (kg of a.i./ha)	0,21	0,44	0,13	-0,12	-0,01	0,22	-0,07	-0,28	-0,02	-0,02
Carbamate (kg of a.i./ha)	-0,01	0,42	0,21	-0,01	0,03	-0,02	0,07	0,37	0,34	0,13
Pyrethroid (kg of a.i./ha)	0,19	0,30	0,09	0,03	0,04	-0,01	-0,08	0,00	0,09	-0,17
Phosphorus (kg/ha)	0,15	0,12	0,79	0,07	0,07	0,05	0,05	0,13	0,00	0,00
Fertilizer cost (%)	0,06	-0,05	0,78	-0,42	-0,08	-0,12	-0,29	-0,08	-0,29	-0,08
Nitrogen (kg/ha)	0,14	0,12	0,76	-0,00	0,04	0,08	0,04	0,08	-0,01	0,06
Potassium (kg/ha)	0,22	0,25	0,60	0,14	-0,11	-0,11	-0,14	0,11	-0,03	0,03
Total cost per hectare (US dollars)	0,20	0,38	0,51	0,48	0,09	0,26	0,29	0,10	0,27	0,28
Total labour days per hectare	0,11	0,09	0,16	0,91	0,09	0,15	-0,11	-0,02	0,04	0,08
Labour cost (%)	-0,16	-0,43	-0,37	0,65	0,03	-0,03	-0,31	-0,01	-0,21	-0,29
Paid wages for pesticide applications (%)	0,23	-0,27	0,11	-0,40	0,19	0,13	0,28	0,25	0,05	-0,04
Sold production (%)	0,03	0,08	0,02	-0,01	0,98	0,18	0,02	-0,05	0,00	-0,04
Number of planted varieties	-0,20	-0,06	0,10	0,08	-0,27	-0,05	-0,01	0,03	0,10	-0,07
Production for seed (%)	0,02	-0,02	0,03	-0,05	-0,54	0,20	-0,12	0,05	-0,24	-0,03
Production for consumption (%)	-0,09	0,01	-0,07	-0,05	-0,70	-0,25	0,05	-0,05	0,07	0,08
Benefit per hectare (US dollars)	0,25	-0,10	-0,05	-0,12	0,20	0,89	0,02	-0,18	-0,05	-0,09
Yield (kg/ha)	0,01	-0,00	0,11	0,26	0,15	0,77	0,25	-0,07	0,16	0,01
Equipment cost (%)	0,05	-0,15	-0,06	-0,10	0,09	0,24	0,93	-0,03	0,05	-0,19
Soil preparation (highest value = mechanized)	0,26	0,24	0,09	0,32	0,01	0,06	-0,43	-0,01	-0,11	0,06
Soil disinfections (number of)	0,30	0,04	0,20	-0,21	0,06	-0,01	0,00	0,81	-0,04	-0,03
Total wages for pesticide applications (%)	-0,23	0,28	0,25	0,22	-0,12	-0,21	-0,04	0,61	0,07	-0,09
Organophosphorus compound (kg a.i/ha)	0,08	0,32	-0,07	0,30	-0,12	-0,04	-0,02	0,37	-0,07	-0,18
Foliar fertilizer cost (%)	-0,01	-0,01	-0,20	0,01	-0,00	0,07	0,05	-0,04	0,95	-0,13
Seed cost (%)	-0,01	-0,17	0,00	-0,08	-0,07	-0,18	-0,25	-0,09	-0,14	0,91
Seed (kg/ha)	-0,33	0,03	0,45	0,16	-0,01	0,13	0,01	-0,05	0,03	0,46
Crop rotations (number of) during 4 crop cycles	0,03	-0,14	-0,02	-0,07	-0,11	-0,19	0,01	0,27	0,03	-0,31

In relation to farming styles, farmers who practice an intensive style of farming will combine high scores for *fine-tuning* with high scores for factors that reflect high productive results per hectare (*yield and benefits*). They will obtain low scores for factors that relate to the use of tools and technologies (such as *fertilizer use* and *pesticide use*). Extensive styles of farming, on the other hand, would instead combine low factor scores for *fine-tuning* with high scores for factors that relate to the use of tools and technologies, and low use of labour units per hectare.

<u>Factor One: Fine-tuning</u>

Fine-tuning refers to refined practices that allow farmers to use available resources efficiently. The variables which compose this factor demonstrate that farmers' decisions have been taken carefully, based on frequent observation of the crop as well as on management of the crop, its environment and the social relations of production.

The *fine-tuning* factor comprises 26 percent of the total number of variables that have been included in the factor analysis. A detailed explanation of its variables is important, therefore. I will first describe the composition of variables in this factor and then explain how the variables contribute to *fine-tuning*.

Fine-tuning (see Factor 1 in Table 5.3) is a combination of the following variables: the pesticide applications number, the active ingredients application number, the foliar fertilization number, the fertilization number, the crop system (where the highest value corresponds to *wachu rozado*) and the field area (where the highest value corresponds to bigger fields). Thus farmers planting on bigger fields and using the *wachu rozado* method also tend to apply pesticides and fertilizers frequently and to use a diversity of active ingredients.

It is important to emphasize that the variables that relate to the number of applications of inputs (i.e. pesticide and fertilizer) in this factor are separated from the variables that relate to the quantities and costs of these inputs (see the composition of Factors 2 and 3). This shows that numerous applications do not necessarily equate to higher quantities and costs, and that farmers can combine these factors in different ways.

In addition, Factor one also includes the "IPM" variables, which show whether "Integrated Pest Management" practices have been applied at least once to the potato field: a high positive value means that IPM practices have not been applied.[94] The "resistance of planted seeds" variable shows whether farmers have planted varieties that require less pesticide applications: a high value means that resistant varieties have been planted.

The factor loadings of these two variables are significant and negative. This means that farmers who have a high factor score in *fine-tuning* always apply at least one IPM practice, although they also plant less resistant varieties.

Explanation of each of the variables that compose the Fine-tuning Factor

The following explanation of each of the different variables combined in Factor one provides an understanding of the complexity of knowledge that farmers who scored high on this factor have to possess in the different domains in order to produce potatoes with *fine-tuning*.

How do rates of pesticide applications and active ingredients contribute to fine-tuning?

In the particular case of Carchi, the number of pesticide applications is primarily related to late blight infection, and thus to the use of **fungicides** (used to control fungal pathogens that cause diseases), rather than to **insecticides** (used to control insect pests). Under ideal conditions in Carchi, *Phytophtora infestans* (the fungal-like pathogen that causes late blight) can complete its life cycle[95] in three days (Pumisacho and Sherwood 2002, *Cáceres et al.* 2007; Oyarzún 2008, *pers. comm.*). As a result, the most successful fine-tuning farmers uniquely study the weather and respond accordingly, often with preventative sprays at strategic moments. If it rains immediately after an application (before cymoxanil can translocate into a plant's tissues), these farmers may even apply daily.

Technicians consider that numerous applications of fungicide in the recommended dosages are a good way to control late blight when the weather conditions are conducive for the spread of the infection. However, in extreme cases, such as a prolonged period of very wet weather, even numerous applications cannot save the crop (Oyarzún 2008, *pers. comm.*). This means that appropriate control of late blight does not just depend on the number of applications of fungicide, but requires the use of other

---

[94] The scale for IPM practices has been reversed (yes=1 and no=2) and this is not purposeful. In Likert-type instruments, some items are often negatively worded so that high scores on these items actually reflect low degrees of the attitude or construct being measured (http://www.utexas.edu/cc/docs/stat53.html#fn).

[95] The characteristics and the duration of the life cycle of a pest or disease are important because pesticide applications are meant to stop the cycle in order to avoid pest or disease reproduction in the plant.

practices as well. This is why the number of pesticide applications has been included in the same factor as the other variables that also contribute to fine-tuning pest and disease control. A high number of paid days of labour, for example, shows that a farmer has used more manual labour days. However, for labour to be available at the right time, farmers need to manage specific relationships with their labourers, because intensification of labour during periods when labour is scarce involves more than a requirement for higher capital investments by the farmer concerned; it usually also demands relationships of trust so that contracts and agreements are respected. A related issue here is the labourers' knowledge of specific practices such as *wachu rozado*, which is used to control soil humidity, a condition that is conducive to late blight attacks.

The other variable regarding pesticide use in Factor one is the active ingredients application number. This variable deserves a detailed explanation because pesticides are usually applied in Carchi in different combinations. Each pesticide application could consist of a mix of different commercial products (often referred to as a "pesticide cocktail"), with different objectives. Table 5.4 shows some of the patterns observed in this study and the different effects of each combination. However, it is also possible to observe different combinations of the three strategies presented in Table 5.4 in the field.

A way of measuring the effectiveness of a pesticide application strategy is to add up the number of different active ingredients included in each application. This helps to obtain the total number of active ingredients applied over the course of a potato production cycle. Farmers who apply numerous different active ingredients generally also display a tendency to use a range of pesticides with different modes of action at different times in order to control the same pest or disease. Alternatively, they might reduce the labour costs associated with pesticide applications by applying several ingredients together. It is important to mention that farmers need to know about the compatibility of different active ingredients if their mixtures are to be effective.

The variable used in this study measures the diversity of active pesticide ingredients used. A high diversity can be related to efforts to reduce the likelihood of pests or diseases developing resistance to any one pesticide. In this case there is a strong likelihood that the farmer would use pesticides with different modes of action[96]. Nevertheless, this variable needs to be

[96] Pesticides can control pests either by contact or by ingestion, resulting in the collapse of

combined with a careful pest control strategy. Such a strategy might include, for instance, the correct identification of the pest or disease attacking the crop and knowledge of the duration of the pest's life cycle. For this strategy to be effective, farmers should monitor the crop themselves and make the decision about which pesticides to apply.

Why numerous fertilizations contribute to fine-tuning?

The potato plant is best able to take advantage of artificial chemical fertilizer (i.e. nitrogen, phosphorus and potassium) applied to the soil when the total amount of fertilizer used is applied in several applications, rather than in just one or two. This is especially true for nitrogen and potassium, where a significant amount can be lost to the air[97] (Valverde 2008, *pers. Comm.*). The plants also absorb foliar fertilizer better when the total amount is applied at different times. This is especially true of foliar fertilizers, which contain nitrogen, potassium and microelements (such as sulphate minerals) (Ibid). When the soil conditions are too acidic, foliar applications can also increase the plant intake of micro and macro elements from the soil.

Farmers who apply fertilizer several times usually monitor the crop in order to decide how to divide up the total amount of fertilizer into smaller doses. Each of these doses will be applied when the farmer considers it will be most effective (according to the development of the plant and the environmental conditions present at the time). Foliar fertilizations, for example, are known to reduce the effect of stress produced by drought (Ibid).) For this strategy to be effective, farmers usually use their own labour so that they can monitor the effectiveness of the interventions themselves.

What does wachu rozado have to do with fine-tuning?

The use of *wachu rozado* is an indicator of fine-tuning, because it involves the use of reduced tillage[98], green manure and intensive labour. These practices

---

one or more of the internal systems of the pest or disease in question. The forms of application and process by which the pesticide moves within the plant also vary from pesticide to pesticide. When using pesticides to control a given pest or disease, it is considered good practice to alternate pesticides with different active ingredients to make it harder for the insect or pathogen to develop resistance to any one pesticide.

[97] Phosphorus is not volatile and can be applied only once during planting (Valverde 2008, personal communication).

[98] The practice of *wachu rozado* is not considered minimum tillage because the soil is removed to a large extent (Oyarzun 2008, *pers. comm.).* Less soil is removed, though, than is the case with the other soil preparation options (full tillage by hand, animal and tractor) that are practiced in Carchi.

require a farmer to know about a number of combinations of variables, which are related to grass quality, seed varieties and soil conditions in addition to their usual knowledge of land preparation.

Table 5.4. Different combinations of pesticides applied in Carchi

	The same active ingredients for the same pest or disease	Different active ingredients for the same pest or disease	Different active ingredients for different pests and diseases
Different commercial pesticide products	• Farmers tend to buy everything that is promoted in the shop or in advertisements but do not know what active ingredients the pesticide contains • This kind of application tends to result in higher doses of pesticide than is required and the development of pest or disease resistance.	• Farmers usually know about the different active ingredients contained in the various commercial products. • Sometimes they also know about the modes of action of these ingredients. • This kind of application helps to avoid the development of pest or pathogen resistance.	• Farmers tend to reduce labour costs by controlling different pests and diseases in the same application. • This kind of application is effective when farmers know whether or not the different active ingredients in the mixture are compatible.

The practice of *wachu rozado* requires humid conditions. It is usually applied on steep soils (see more details in the section that follows). Under these conditions, it is a crop system that controls soil humidity and soil erosion. Furthermore, *wachu rozado* has the benefit of maintaining conditions, which are relatively harsh for soil insects (such as the Andean weevil). It also produces a microclimate, which renders late blight attacks in wet soils less likely. The practice of *wachu rozado* in Carchi is closely related to high yields because it maintains soil fertility better than full tillage does and reduces the incidence of soil pests and diseases when it is practiced over a long period of time

However, the humid weather conditions in the locations where *wachu rozado* is usually practiced are conducive to late blight attacks, the effective management of which requires frequent applications of fungicides in a short period of time. This may explain why *wachu rozado* appears in the same factor as the variable “pesticide applications number.”

Since it is only possible to use *wachu rozado* if the soil is prepared by hand, i.e. not with the use of animals or machinery,[99] the labour demands of this system are higher and more intensive than is the case with other systems. This explains why this crop system appears in the same factor as the variable “paid labour days per hectare.”

According to farmers, only certain potato varieties can be planted using the methods of *wachu rozado* because only they are resistant to the specific microclimate conditions that are associated with this system. Only a few of these varieties are commercially viable. *Wachu rozado* farmers generally grow “*super chola*” for the market, a variety that is susceptible to late blight attacks. This variety has a longer production cycle (6 months) than other commercial varieties (4 months), which can be sold for less. Growing *super chola* requires a more continuous application of fungicides and also two extra months of late blight treatment than other varieties do. This explains, to some extent, why *wachu rozado* appears with the variable “resistant varieties,” but with a significant negative score.

Labour as a central feature of fine-tuning

Numerous pesticide and fertilization applications and the practice of *wachu rozado* imply that farmers continuously monitor their crops in order to take immediate decisions. However, farmers' decisions do not relate only to the crop and its environment but also to their social relations. They have to ensure that labour is available when needed. As explained before, labour availability requires that farmers foster good relations with labourers. The labourers must also have the specific skills that a task requires. A high labour input, therefore, shows a farmer’s ability to combine access to sociotechnical networks with knowledge of the specific quality of labour that will be needed at a specific time.

A good indicator of the *fine-tuning* of labour is that the number of pesticide and fertilizer applications (in Factor 1) does not directly relate to higher fertilizer or pesticide costs and quantities, because these variables are separated in Factors two and three (see Table 5.3). This means that farmers’ strategies for the application of these two inputs will differ in relation to the frequency of applications when greater or lower quantities and costs are also taken into account.

[99] Mechanization of *wachu rozado* may be possible but it has not been researched in Ecuador.

Numerous applications of pesticides and/or fertilizers by farmers who have a high score in *fine-tuning* require the intensification of labour. These tasks are mostly performed by the farmers themselves and their families, since farmers believe that they use pesticides and fertilizers more efficiently than other labourers would. This efficiency contributes to *fine-tuning* the use of these inputs. *Wachu rozado* farmers sometimes rely on additional labour, however, since they cultivate large fields of a hectare or more. They usually contract organized groups (*cuadrillas*) of labourers who have experience with *wachu rozado* methods to prepare the soil. This is usually efficient and inexpensive since *cuadrillas* do not demand food and complete their work within a fixed period of time.

Integrated Pest Management practices and fine-tuning

IPM practices include seed selection and disinfection, cutting down mature plants, applying calcium carbonate (in acidic soils) and setting Andean weevil and yellow traps. Although most farmers in Carchi employ one or more of these practices, only the farmers who continuously monitor their crops are in a position to implement IPM practices at specific times.

The variables included in Factor one form a specific combination. The variables that compose this factor have to be continuously regulated in order to produce high yields and benefits. The complementary factor, therefore, that relates and confirms farmers' *fine-tuning* is Factor seven (*yield and benefits*). This means that the farmers with high scores in both factors are those who possess a high degree of technical efficiency and who tend towards labour intensification rather than the intensification of tools and technologies. Intensive styles of farming are, therefore, indicated.

<u>Factor Two: Pesticide use</u>

Pesticide use entails the use of a high quantity of active ingredient (in kg/ha) and incurs high relative costs on the farm (with respect to the total cost per hectare of production). This factor involves most of the active ingredients in the pesticides used in Carchi. *Pesticide use*, therefore, is one of the factors that provide a measure of the degree of externalization of farm production. A farmer's score in relation to *pesticide use* usually depends on his/her management of the specific pests and diseases prevalent in the region and in the potato field, which in turn depends on a combination of other elements (e.g. climate, soil, fertilizer, etc.).

Table 3 shows the variables that make up Factor two: "Pesticide cost" is the percentage of the production cost that is due to pesticide use (factor loading

0.91). The variables show that the principal WHO pesticide toxicity groups[100] used in Carchi in kilograms per hectare are "Thiocarbamate" (factor loading 0.80), "Cymoxanil" (factor loading 0.75) and "Carbamate" (factor loading 0.42). This factor also includes the variable, "Other types of pesticides," which corresponds to the total number of active ingredients of pesticide which have not been individually classified due to the low amounts of each active ingredient applied (factor loading 0.44). The use of these particular pesticide groups is related to the control of the main pest and disease problems present in Carchi.

Thiocarbamate and cymoxanil are usually (but not always) combined in similar commercial products[101] which are used to control late blight (*Phytophtora infestans*). The use of high quantities of these active ingredients indicates that conditions on the potato field have made it susceptible to late blight, which in favourable conditions can complete its life cycle in as little as 3 days. Under these circumstances, daily applications are recommended for good control. Good management of late blight consists of a combination of practices, such as the control of soil humidity, with numerous applications of the correct dosage of pesticide when the weather favours the development of the disease.

The active ingredient in the group of Carbamatescarbofuran, is used mainly to control the Andean potato weevil (*Premnotrypes vorax)*. The use of high quantities of carbamates shows that the soil is infected with numerous Andean weevil larvae.[102] Above a certain threshold, however, the presence of high quantities of the active ingredient demonstrates that a farmer has applied an overdose of the pesticide. Since *Premnotrypes vorax* has a life cycle of more than 400 days,[103]a maximum of three applications per potato cycle

---

[100] WHO classifies the active ingredients in pesticides according to chemical type or group. As some pesticides may contain two different active ingredients from two different chemical types, the quantities are calculated by percentage and added together with their correspondent chemical group.

[101] Cymoxanil is a translaminar fungicide that works systemically and is usually combined in commercial products with preventive fungicides such as mancozeb.

[102] Most farmers in Carchi only recognize the Andean potato weevil when it is in its larval stage, the stage when the insect causes damage to the potato tubers, rather than earlier or later in its lifecycle. Andean potato weevil eggs are too small to see and tend to be hidden in straw or other plant debris, whilst the adult weevils remain hidden during the day beneath soil clods, stones, dry leaves or in cracks in the soil near the potato plants (Alcázar and Cisneros 1997-1998).

[103] Research done in Ecuador and Colombia has found that *Premnotrypes vorax* can produce more than one generation a year under conditions of continuous potato cropping (Gallegos 1995 and Calvache 1986 cited in Alcázar and Cisneros 1998).

is recommended in a dosage of one litre per hectare (Vademecum 2004).[104] Over-application of carbamates in Carchi results from the desperation felt by farmers when they experience high levels of larvae infestation during soil preparation or in the potato tubers themselves. The situation is exacerbated when farmers miscalculate the quantity of pesticide required for fields of less than one hectare. Farmers who work smaller fields are more likely to apply an overdose of carbamate active ingredients. Since pesticides belonging to the carbamate group are the cheapest available on the Ecuadorian market,[105] farmers tend to use them for a wide variety of pests. This means that high quantities of thiocarbamates and cymoxanil (which are used to control late blight) are most likely the result of the numerous applications that are recommended by technicians, while high quantities of carbamates (which are mainly used to control the Andean weevil) point to an overdose of pesticides in fewer applications.

The variable, "Labour cost," (from Factor 4) is negatively correlated with the Factor *pesticide use*, which means that labour costs decrease when *pesticide use* increases. High pesticide use, therefore, is related to the extensive use of labour. Farmers have a high factor score for *pesticide use* when they apply large quantities of thiocarbamates, cymoxanil, carbamates and "other types of pesticides," at the same time as expending relatively large amounts of money on these inputs. When farmers have high values for only one or a few of these variables, their score on this factor is low. Farmers with high scores for *pesticide use* tend to externalize their production in terms of high pesticide use (in kg/ha) and high relative costs per hectare. On the other hand, low scores for this factor are an indicator of strategies that reduce externalization through the use of low cost pesticides in lower quantities.

Factor Three: Fertilizer use

Fertilizer use measures the degree of externalization of soil fertility through the use of high quantities of synthetic fertilizer and its relative cost. Factor

---

[104] Applications to control the Andean potato weevil are meant to kill the adults (so that they cannot lay more eggs) rather than the larvae, because larvae are more difficult to reach since they live inside the potato tuber. However, farmers do not always realize that the larvae and the adult are in fact the same insect, in different stages of its lifecycle. Most farmers told me that the pesticide controlled larvae attacks by killing the larvae in the soil. The only time that this might occur would be during the very short period of time immediately after the eggs hatch and the larvae make their way from the surface of the soil to the potato tubers.

[105] The carbamate that is mostly used in Carchi is carbofuran. It was created by Bayer, but is no longer under patent, and is therefore imported from Thailand, China and other countries that sell it at low prices.

Three combines five variables with high factor loadings (more than 0.5). These variables are related to the amount of fertilizer used and its total cost (see Table 5.3). Phosphorus, nitrogen and potassium are closely related because these three ingredients are usually provided together in the same commercial products, though in different formulations and varying percentages.

The variable, "total cost per hectare," is also included in this factor (factor loading 0.51). This variable also has significant factor loadings in Factor Four (*Labour use*) and Factor Two (*Pesticide use*). This means that "total cost per hectare" increases primarily according to *fertilizer use* and secondarily according to *labour use* and *pesticide use.*

Additionally the variable "Seed" (seed used in kg/ha) has a second significant factor loading in *fertilizer use.* Thus *fertilizer use* increases with the number of kilograms of seed used per hectare. Taken together, these two factors are a possible indication of poor soil quality.

High scores for the *fertilizer use* factor might be indicative of low soil quality being compensated for by the externalization of soil fertility (through the purchase of synthetic fertilizer), while low scores might indicate a tendency to increase farming autonomy through achieving and maintaining good soil quality.

In Carchi, farmers who use a high number of fertilizer applications (a variable in Factor One) but low per hectare quantities of fertilizer or low per hectare expenditure on fertilizer (variables in Factor Three) practise a fertilizer cost reduction strategy, which is also labour intensive (more labour is required in order to apply smaller quantities of fertilizer more frequently). The opposite applies to farmers who implement a low number of fertilizer applications, use high fertilizer quantities and have high costs per hectare. In this case, farmers spend money on large quantities of fertilizer and make a few applications to reduce the labour costs associated with fertilizer application. This results, however, in a less efficient uptake of fertilizer by the crop. There are also farmers who use low quantities of fertilizer per hectare in a few applications because they lack financial resources.

<u>Factor Four: Labour use</u>

This factor refers to the patterns of labour used on the farm. Two variables are the most important in defining this Factor (see Table 3): "total days of labour per hectare" and "labour cost" as a percentage of the overall cost of production (factor loadings 0.91 and 0.65 respectively).

The variable, "Paid wages for the application of pesticides," (factor loading -0.40) is also part of this factor and is inversely correlated. Thus, farmers tend to use less paid labour for the application of pesticides when *labour use* increases on the farm. As explained earlier, the use of family member's labour is a strategy that seeks to make the most efficient use of pesticides.

On the other hand, Table 5.3 shows that the variable "labour cost" is inversely related (second significant and negative factor loadings) to Factors Two, Three and Seven: pesticide, fertilizer and equipment use respectively. This means that the externalization represented by these factors is a strategy to reduce labour.

A high score in *labour use* indicates an intensification of labour and relatively high labour costs. This intensification is, however, not always achieved via externalization; we need to distinguish between commoditized and non-commoditized forms of labour. A high score for *labour use* demonstrates a tendency to reduce externalization, and is thus an indicator of autonomy. Low scores for this factor instead show a tendency to externalize farm production, with a central focus on tools and technologies (instead of on labour) and, therefore, on a more market-dependent system of production on the input side[106].

Factor Five: Market-oriented production

This factor shows the level of integration with the market on the output side. "Sold production" is the percentage of the potato harvest that is sold on the market, and is the variable that mostly defines this factor (factor loading 0.98 in Table 5.3).

There are two variables that have an inverse relation (negative factor loadings) with *market-oriented production*: "production for consumption" or the percentage of the harvest retained for the family's own consumption and "production for seed" or the percentage of the potato harvest which is kept for seed. In other words, when production is mainly market-oriented, the proportions retained for consumption and/or seed decrease.

High scores for this factor show a high degree of incorporation into the market for production outputs, with possibly less room for manoeuvre regarding prices and the condition of the potatoes to be sold, and lower levels of farm autonomy with respect to the production for seed and the retention of part of the crop for the family's own consumption.

---

[106] Production can also be market-dependent on the output side, as explained in the section on Factor five in the following paragraph.

Factor Six: Yield and benefit

This factor represents the output of the production process and is composed of only two variables: "Benefit" per hectare in US dollars (factor loading 0.89) and "Yield" in kilograms per hectare (factor loading 0.77). This means that despite the wide variation of potato prices in the markets, the benefits (in monetary terms) vary greatly according to the yield obtained. Looked at in another way, a good yield can help farmers withstand high price fluctuations.

High scores for this factor indicate intensive styles of farming in which both production and benefits (total production minus total costs) are high. This denotes efficient use of the inputs and factors of production. Low scores for this factor, on the other hand, either indicates an extensive style of farming, and/or inefficient use of inputs.

Factor Seven: Equipment use

Equipment use refers to the use of tractors, oxen, cars, horses and spraying pumps in the production process and is inversely related to the "labour cost" (a variable in Factor 4). The most important variable in this factor is "Equipment cost," expressed as a percentage of the total costs of production (factor loading 0.93 in Table 5.3). The variable, "Soil preparation," has a negative correlation with this factor. When this variable is transformed, a high value for it corresponds to manual soil preparation. This obviously indicates that high levels of mechanization do not correlate with manual soil preparation and thus to high labour use.

High scores for this factor indicate the externalization of production through the use of equipment for soil preparation and other tasks in order to reduce labour input. However this strategy, as it is used in Carchi,[107] tends to reduce soil quality and, consequently, soil fertility as well, resulting in more use of chemical fertilizer. Thus, high scores on *equipment use* usually imply high *fertilizer use* while low scores for this factor generally denote the intensification of labour.

Factor Eight: Soil disinfections

This factor relates mainly to the intensification of pesticide use, especially where soil quality is poor due to erosion, compaction, pest infestations and/or pest resistance. The variables that define *soil disinfections* and its factor

[107] Tractors usually prepare soil by ploughing up and down inclines rather than across them.

loadings are shown in Table 5.3: "number of soil disinfections," "total wages for applications of pesticide" and the use of "organophosphorus compounds."

High numbers of soil disinfections relate mainly to a high incidence of the Andean potato weevil (*Premnotrypes vorax*), though more recently the incidence of potato tuber moth (*Tecia sp.* or *polilla guatemalteca)*[108] has increased. The fact that soils which are of poor quality for potato production are especially susceptible to soil pest attacks also has to be taken into account. Elements that can contribute to this situation include acid soils and nutrient erosion.

Pesticides that belong to the organophosphorus group of compounds were first used in order to control foliar pest attacks, many of which have emerged over the course of the last few decades as a result of pesticide resistance and potato monocropping. More recently, organophosphorus compounds have also been used to control the potato tuber moth in its adult stage and also to disinfect soils and seeds infested with its pupae and larvae. Applying pesticides for the control of the potato tuber moth is not recommended. [109] Nevertheless, desperate farmers in Carchi tend to apply the same pesticide compounds that they use to control foliar pests, but in higher quantities and usually mixed with carbamates, to try and reduce infestations of potato tuber moth. In fact, the variable "carbamate" (from Factor 2) has a second high factor loading in *soil disinfections*. Since the potato tuber moth only reproduces well when there is a long period of warm, dry weather,[110] the use of these pesticides also indicates that the potato field in question is located in an area that is prone to drought (usually Santa Martha).

High overall expenditure on wages for pesticide application is more common in San Francisco, especially among farmers who contract outside labour for this task. The reason is that in San Francisco a day's labour is one hour shorter than in the other communities (i.e. 7 hours instead of 8). As a

---

108 Farmers in this study said that they apply carbamates and organophosphorus compounds to the soil in order to control the Andean potato weevil in the larval stage and the potato tuber moth in its adult stage. In fact, the adults of both pests usually remain in the ground close to potato stalks. The technical literature, moreover, reports that none of these chemical compounds can control the potato tuber moth when applied to the soil.

109 Recommendations to control attacks of the two species of *Tecia sp.* are mainly cultural and preventive practices combined with hormone traps.

110 At 10 °C the Central American potato tuberworm (*Tecia solanivora)* is able to produce 2 generations a year while at 25 °C it can produce 10 generations a year (Gómez 2000 cited by NPAG 2006:2)

result, more days of labour are needed to finish the same task. Furthermore, in all the communities studied, a day's work applying pesticides is considered complete when the task is finished. This means that farmers who contract labour for pesticide applications might pay for an entire day of labour even when it is not needed. In Carchi the applications are made by the time the crop stage has been reached. The pesticides are mixed in 200 litre tanks and applied with manual pumps, each of which holds 20 litres. Farmers often complain that labourers untie the pump nozzle to allow the pesticide to come out faster (and without applying much pressure on the pump). This gets the job finished more quickly. The labourers, on the other hand, say that they apply pesticide in this way because the landowners like to see that the plants are completely covered, with pesticide dripping from the leaves. It is clear, however, that using contract labour to apply pesticides is less efficient than when the farmers and their families perform the task themselves.

To summarize: a high score for Factor eight is evidence of increasing levels of soil pests such as the Andean potato weevil. It often indicates a problem with the potato tuber moth in dry areas. Poor quality soils, resulting from compaction, acidity and/or the erosion of fertility, might also contribute to high scores for this factor.

Factor Nine: Foliar fertilizer use

Foliar fertilizer use refers to a new pattern of fertilizer use, which was emerging in Carchi at the time of this study, in which foliar fertilizer replaces soil fertilizer to a certain extent. This factor is represented by the "Foliar fertilizer cost" variable, which is expressed as a percentage of the total production costs. Although this Factor is a "singlet" (composed of only one variable), there are two other variables that have a second significant factor loading in this factor: "Foliar fertilization (number of)" (from Factor One) and "carbamate compounds" (from Factor Two).

A high score for this factor indicates a tendency to reduce the use of soil fertilizer, probably due to its high cost,[111] and replace it with foliar fertilizers. This is a different form of externalization, whose aim is to reduce fertilization costs. The second loading on carbamate compounds shows that, along with foliar fertilizer, farmers have a tendency to use cheaper pesticides, probably as a replacement for more expensive ones.

---

[111] Due to increases in oil prices, 18-46-0 (NPK) fertilizer increased in price from US$15 in 2006 to US$70 in 2009.

Factor Ten: Seed cost and use

This factor refers to seed cost and quantities (in kg/ha). The variables that correlate positively with this factor, therefore, are "Seed cost" as a percentage of total production costs and "Seed" in kilograms per hectare (factor loadings 0.46 and 0.91 respectively).

The variable, "Crop rotations," has a negative correlation with this factor (factor loading -0.31). This variable has been transformed (into numeric). A high value represents more crop rotations. This means that farmers who rotate their crops more frequently also tend to use less seed per hectare and spend less per hectare on seed, therefore, than farmers who do not practice crop rotation as often. This can be explained by the fact that infrequent crop rotation reduces soil quality, which means that farmers have to use more seed per hectare in order to ensure plant density.

At the same time, the variable, "seed," in (kg/ha) has a second significant and negative loading on Factor One (*fine-tuning*) and a second significant and positive loading on Factor Three (*fertilizer use*), which indicates a tendency to use seed extensively.

In conclusion, a high score for Factor Ten indicates extensive styles of farming, based on the use of high quantities of seed and high seed cost, which in turn tends to result in an increased use of fertilizer and low scores for *fine-tuning*.

Summary of the factor analysis

Fine-tuning as a main factor explaining variability in farming styles

Fine-tuning provides a significant degree of explanation of the differences between different farming styles. The characteristics of fine-tuning, however, are also to some extent defined by the crop system that farmers use. Whether farmers cultivate by means of *wachu rozado* or full tillage defines the degree to which *fine-tuning* can be performed and also the way in which this factor will combine with the others.

Factors that show externalization of production

Factors Two, Three, Four, Seven, Eight, Nine and Ten relate to the costs and quantities of inputs and technologies used on the farm, per hectare of production (i.e. the use of pesticides, fertilizers, labour, mechanization, soil disinfections, foliar fertilizer and seed). The variables that make up each of these factors mostly show relative costs (in percentages) and quantities (in kg/ha) of a given input disaggregated into its different classes or types (for instance, the different groups of pesticides or fertilizer active ingredients). These factors measure, therefore, the intensity of the inputs used in quantities (as opposed to intensity in numbers of applications made, which is shown by Factor One) and the quality of the inputs used.

With the exception of Factor Four (labour use), these factors correspond to inputs that in Carchi are mainly obtained off-farm, and usually in the marketplace. Even if sharecroppers or other intermediaries provide these inputs, these arrangements are usually based on a market price for the inputs concerned (i.e. these inputs have a fixed monetary and exchange value). Thus, these factors are more directly indicative of the level of externalization[112] of production. Farmers with high scores for these factors tend to focus on one (or more) tool or kind of technology, on which they spend most of their capital. High levels of externalization for these inputs are usually designed to reduce the use of labour per hectare, and in this case are related to extensive styles of farming.

Factors Four and Ten differentiate between the quantities of labour and seed obtained in the market and those obtained by other means outside the market (such as sharecropping arrangements, provision by the nuclear or extended family, etc.). This difference is important because the monetary value of non-commoditized[113] labour or seed in Carchi is difficult to calculate according to market prices since it depends on the relative value given to it by the actors involved. For example, the wage rate for family

[112] Externalization refers to the tendency to increase the use of inputs sourced from beyond the farm gate in order to achieve agricultural production, rather than using inputs resulting from farm reproduction processes. A farmer may choose to externalize the inputs required for managing soil fertility, or pests, for example, by buying fertilizer or pesticides. The externalization of potato production in Carchi occurred as a result of a number of converging events. The availability of land on the market to hacienda servants gave rise to a population of peasant farmers who were automatically indebted to the banks for loans to buy the land, which had to be repaid on a monthly basis. In order to service their debts, farmers sold their livestock and began producing crops for the market. This meant that farmers lost their access to animal manure, which was their main source of soil fertility. In Carchi, this resulted in farmers having to buy synthetic fertilizers in order to boost their commercial potato production. Potato was preferred to other crops because it could always be sold in large quantities as a staple food in Colombia and Ecuador. Its production cycle of 6 months (4 months for some varieties) is shorter than for other local crops (such as chocho or quinua). In addition, potatoes respond best to the climatic and soil conditions of the land to which peasant farmers have been given access (wet, acidic, at high altitude and subject to a cold climate).

[113] By commoditization of labour and other inputs, I mean the process of converting these inputs into commodities, thus giving them an exchange value (usually fixed monetarily).

labour is not fixed and sometimes this value is weighted, depending on the degree (or otherwise) of labour availability at the time (e.g. in periods of labour shortage, family labour is considered "invaluable"). Sometimes family labour might be exchanged for another commodity or service, such as seed. Thus, *labour use* and *seed use* also helps us to indicate the level of the externalization of production, though always in relation to the level of un-commoditized production, (production based on inputs that do not have a direct exchange value) or autonomous production (production based on inputs produced on the farm itself).

High scores for *labour use* are characteristic of labour-intensive styles of farming but they can be externalized to a greater or lesser degree according to the ratio between commoditized and non-commoditized labour. The same applies to Factor Ten regarding seed use, which can also be commoditized and non-commoditized. Seed use, however, is negatively related to crop rotation, so it might also be an indication of intensive soil usage and the monocropping of potatoes.

The outcome of the factor analysis demonstrates that the different variables that indicate the levels of externalization shown by farmers are not part of a single factor, as is assumed in a "modernization" pathway (the increasing and uniform incorporation of peasant farms into input markets). The variables that correspond to different inputs belong, instead, to different factors. This shows that peasant farmers in Carchi have "deconstructed" the modernization package of tools and technologies, breaking it down according to their particular objectives. In practice, different groups of farmers will have high scores for different patterns of factors (see cluster analysis section). Moreover, high scores in factors related to inputs have to be broken down according to the multiple purposes for which these inputs are used. For example, two groups of farmers might apply pesticides a similar number of times, but each group might apply different pesticides, in different dosages, labour arrangements and costs.

Market-oriented production versus yield and benefit

The separation of the factors *market-oriented production* and *yield and benefit* shows that market-oriented production is not directly related to (high or low) yields and benefits. Contrary to what tends to be regarded as a rule of modern agricultural development (for instance the focus on commodity chains), higher yields and benefits are not always related to higher percentages of marketed production. This is because farmers take benefits into account apart from those that relate to monetary revenue alone. For example, in San Pedro, they tend to save seed from their own harvest, even when potato prices are high, because seed is seen as a mode of "capital saving" for the next planting season. Thus the provision of seed outside the marketplace (and from within the farm gate) is regarded as a benefit that is as important as money.

Wachu rozado *or not* wachu rozado

When analyzing the variables used in the factor analysis, I found that "crop system" heavily influences subsequent decisions regarding production strategy. I therefore grouped the variables according to the two crop systems present in the 2004 study (see table 5.5), similar to Sherwood's global analysis of 1998 data (see table A2 in Appendix 4.2). Sherwood found significant differences for the following variables: altitude of the field, field area, labour, mechanization, seed and insecticides used per hectare. I found additional differences associated with fertilizer applications and the use of seed. When potato fields planted using the *wachu rozado* method are compared to with those planted under complete tillage in both periods (1998 and 2004), it emerges that each production system is in effect part of a "construction" within a broader production process, even though their yields are similar.

Wachu rozado is a planting system that involves reduced tillage, the use of grass sod as green manure and intensive labour. When practiced over decades, *wachu rozado* limits soil erosion, and conserves soil fertility, thereby leading to consistent yields. Additionally, *wachu rozado* contributes to achieving a balance between some of the contradictory factors that characterize conventional tillage regimes, such as the imperative to plant commercial but susceptible varieties and the utilization of the humid conditions which favour both production and late blight disease. The decomposing sods that *wachu rozado* practices promote are antagonistic to Andean weevil damage on tubers. As a result, farmers using *wachu rozado* can manage environmental conditions to suit most commercial varieties, while controlling worrisome diseases and pests. This means that the ecological and economic risks of planting according to *wachu rozado* methods are fundamentally different from those that pertain to full tillage practices. Yet, the conditions needed for using *wachu rozado* must be established through a set of long-range practices (possibly over decades) rather than within the context of the year-to-year production cycle (see the details of this practice and its benefits in appendix 4.2).

Farmers explain that the *wachu rozado* planting system is today confined to wet and hilly regions, where other kinds of soil preparation are practically impossible. The data in Table 5.5 shows that most fields in both systems are situated on steep slopes. The main difference, therefore, between the *wachu rozado* and the other fields is water runoff and drainage. Sherwood (2009) and Chapter Four of this thesis show that Mariscal Sucre (a community in which the main cultivation system is *wachu rozado*) and San Pedro (a community where most farmers cultivate using full tillage) had quite similar origins in the 1950's. Both obtained their land before land reform. They were both located adjacent to one another on the Occidental mountain chain of Carchi and surrounded by a large *Interandean* forest. At the turn of the century, nevertheless, a large area of forest remained as a reserve next to Mariscal, whereas the area around San Pedro had lost practically all its forest. As reported in Paredes (2001), I witnessed the last patches of forest in San Pedro being burned down by their owners. Once degraded, a fragile highland environment cannot be easily restored. Thus, the present-day opportunity (or lack thereof) to plant in the *wachu rozado* system has been shaped by the impact of historical events on the local management of natural resources. Through the foresight embedded in generations of production practice, certain communities in Carchi have been able to conserve their natural resources, giving them multiple options in the future.

About 20 percent of farmers in Carchi continue to plant according to *wachu rozado* methods. It must be remembered that planting potato in this way is not the only factor that influences whether or not a farmer achieves a good yield. 36 percent of the sample who planted using this system actually ended up with negative benefits. As stated earlier, *wachu rozado* can deliver ecological and economic advantages, but farmers must combine its use with other factors. Factor One shows that the system is closely correlated with the frequent use of pesticides and soil and foliar fertilizers for the duration of the whole potato cycle, a phenomenon that is related to *fine-tuning* the use of inputs. Furthermore, the cluster analysis in the following section demonstrates that a specific combination of factors is required if farmers are to succeed when planting in the *wachu rozado* style.

In contrast with the data presented by Sherwood (1998) in table A2 in Appendix 4.2, Table 5.5 in this chapter shows a large difference between the benefits of *wachu rozado* ($526.94) and full tillage ($99.87) practices, despite similar yields per hectare for each system (15,281.60 kg/ha and 14,403.55 kg/ha respectively) and the higher (labour) costs associated with *wachu rozado* ($1,928.33 versus $ 1,640.76 for full tillage). The difference in net benefit can be explained by real prices, since Sherwood's study draws on average prices for potato (across the two tillage regimes) and mine on the actual prices paid to the farmers per unit weight of potatoes sold. This is an important difference. Based on my 2004 study, the following points summarises the reasons why farmers producing in *wachu rozado* obtain higher prices than those practising total tillage:

1. Farmers who produce larger volumes of potato, such as those producing in *wachu rozado* (field area average 1.29 ha compared to 0.74 ha for farmers producing in full tillage), have more room to manoeuvre. Farmers who sell full trucks of potatoes on the market (up to 300 quintals) are able to demand a better price from women traders[114] than those who sell smaller quantities, since women traders earn a commission per quintal ($0.50 per quintal in average). Farmers describe this by saying that women traders always "ran for the bigger trucks and for the best potato."

2. Farmers producing on larger fields are not under the same pressure to sell their crop as those who are dependent on income from smaller areas of land. Thus, farmers producing on bigger fields (usually under *wachu rozado)* can wait a few days or weeks until prices improve. A relevant factor here is that the Andean weevil (*gusano blanco*) is less likely to attack potatoes produced on *wachu rozado* fields than on those that are under full tillage. This permits *wachu rozado* farmers to keep their potatoes in the fields longer.

3. Some farmers from Mariscal, where most farmers produce using the *wachu rozado* system, sold their crop to a cooperative at a fixed price of $12.5 per a 100-pound sack (see Chapter 4). This was possible because the cooperative had fixed-price agreements with big supermarkets and industrial companies. This cooperative also benefited from storage facilities, so the crop could be stored until the quantities required by big buyers had accumulated.

4. Farmers generally agree that the quality of potatoes produced in *wachu rozado* is visibly better than that of those produced under full tillage (see table A1 in Appendix 4.2). Potatoes produced under *wachu rozado* are clean because they have limited contact with the soil, whereas potatoes produced under full tillage tend to be muddy, especially when they have to be harvested in the rain (which is frequently the case in Carchi). Farmers also argue that the colour of the red potato varieties produced under *wachu rozado* is stronger than is the case with those produced under full tillage. This helps them to negotiate a good price on the wholesale market. Although potatoes

[114] The 'women traders' referred to here are 'middlemen' – that is, they sell the product on to the final consumer, rather than using it themselves.

produced under the *wachu rozado* system do not automatically command a higher price, the traders value better quality and "good looking" potatoes (up to $2 per quintal sack) as they can be sold faster.

5. *Super chola* brings the highest market price of any potato variety in Ecuador. Not all farmers, though, can produce this variety due to its need for highly favourable field conditions, high levels of soil moisture and a good supply of nutrients. Since the *wachu rozado* method conserves humidity and provides a high nutrient supply, it is uniquely suited to achieving high yields of *Super chola* potatoes. This results in the farmers' obtaining a high price per weight of potato on the market.

Cluster analysis

The second phase of the statistical analysis consists of grouping the data on farmers' fields. Because cluster analysis identifies as many clusters as the total number of observations (in this case 94 farmer's fields), I have drawn on the qualitative analysis presented in Chapter Four as a guide when defining the number of clusters. Four clusters have been identified as a result of this process. The collection of quantitative data from the 94 farmers' fields includes the fields of the 20 families with whom I worked closely (in order to understand the qualitative differences presented in Chapter Four). I therefore expected to find the characteristics of each of the four farming styles (which I have described in Chapter Four) in each of the four clusters that are included in this quantitative analysis. Table 5.6 shows the composition of the four clusters and the correspondence I find with the farming styles. The pattern of practices from farmers who form Cluster one (represented by their factor scores shown in Table 5.7) correspond to the *Tradicionales* farmers, the pattern of practices from farmers in Cluster two corresponds to the *Seguros* farmers, the pattern of practices of farmers in Cluster three corresponds to the *Arriesgados* farmers and the pattern of practices of farmers in Cluster four corresponds to the *Experimentadores* farmers. Appendix 4.3 compares the qualitative and quantitative analyses according to the number of cases studied for each and classified by farming style, by cluster and by community. In the following section, I explain the ways in which the four clusters correspond to each of the farming styles.

Table 5.5. Variables ordered by crop system for a sample of 94 potato fields in 2004

	Wachu rozado	Full tillage	*Wachu rozado* **minus** full tillage in (%)
Fine-tuning variables			
Number of pesticide applications	10.23	6.44	37.05*
Number of active ingredients per application	56.32	31.82	43.50*
Total amount of pesticide (a.i. kg/ha)	30.20	22.11	26.79
Number of foliar fertilizations	5.64	3.71	34.22*
Paid days of labour per hectare	100.52	64.93	35.41*
Number of soil fertilizations	2.27	1.97	13.22*
Organochlorine (kg a.i./ha)	0.06	0.00	100.00
Plot characteristic variables			
% of fields on steep slopes (gradient > 20%)	77.27	73.61	4.74
Field area (average)	1.29	0.74	42.64*
IPM variables			
% of farmers applying at least 1 IMP practice	50.00	34.72	30.56
Resistant seeds planted (% of farmers)	13.64	73.61	-439.66
Pesticide use			
Pesticide cost (%)	16.23	14.71	9.37
Thiocarbamate (a.i. in kg/ha)	17.77	13.49	24.09*
Cymoxanil (a.i. in kg/ha)	0.43	0.50	-16.28
Other type (a.i. in kg/ha)	8.09	5.30	34.49*
Carbamate (a.i. in kg/ha)	1.81	1.48	18.23
Pyrethroid (a.i. in kg/ha)	0.08	0.09	-12.50
Fertilizer use			
Phosphorus (a.i. in kg/ha)	396.19	328.31	17.13*
Fertilizer cost (%)	21.34	20.37	4.55
Nitrogen (a.i. in kg/ha)	163.42	145.73	10.82
Potassium (a.i. in kg/ha)	196.06	148.19	24.42*
Total cost per hectare in US dollars	1928.33	1640.76	14.91*
Total fertilizer (a.i. in kg/ha)	763.30	628.52	17.66*
Labour use			
Total days of labour per hectare	129.75	109.29	15.77*
Labour cost (%)	33.46	33.14	0.96
Paid wages for application (%)	36.47	38.17	-4.66

Table 5.5. Variables ordered by crop system for a sample of 94 potato fields in 2004 (*continued*)

	Wachu rozado	Full tillage	*Wachu rozado* **minus** full tillage in (%)
Potato sales			
% of crop sold	81.77	79.25	3.08
% of crop retained for own consumption	9.28	9.64	-3.88
% of crop retained for seed	8.95	7.16	20.00
Number of varieties planted	1.05	1.38	-31.43*
Yield and benefit			
Benefit (US$/ha)	526.94	99.87	81.05
Yield (kg/ha)	15281.60	14403.55	5.75
Equipment use			
Equipment cost (%)	9.37	10.57	-12.81
Manual soil preparation (% farmers)	95.45	33.33	65.08*
Soil disinfections			
Number of soil disinfections	1.95	1.60	17.95
Total wages for pesticide application	21.88	28.56	-30.53*
Organophosforus compound (a.i. kg/ha)	1.95	1.26	35.38*
Foliar fertilizer cost (%)	3.49	3.25	6.88
Seed use			
Seed cost (%)	14.52	15.04	-3.58
Seed (kg/ha)	1603.13	1690.72	-5.46
Crop rotations (transformed)	2.09	1.97	5.74
Use of their own seed (% farmers)	72.73	59.72	17.89*

*Significant mean differences between *wachu rozado* and full tillage at $p<0.05$ expressed in %

Table 5.6. Clusters of 94 potato fields[115]

Cluster	Corresponding style of farming	Frequency	Percentage	Cumulative frequency	Cumulative Percentage
1	*Tradicionales*	24	26	24	26
2	*Seguros*	38	40	62	66
3	*Arriesgados*	26	28	88	94
4	*Experimentadores*	6	6	94	100

[115] Two of the fields belong to groups of Farmer Field Schools; both in Cluster 2 (*Seguros*).

Analysis of clusters according to factor scores and farming styles

Table 5.7 presents a comparison of the clusters and corresponding farming styles according to their average factor scores.[116] Farmers in Cluster one have high average factor scores with regard to *fine-tuning*, *labour use* and *yields and benefits*. This pattern of practices corresponds to the *Tradicionales* style of farming described in Chapter Four, because this style is typically based on the continuous and long-term practice of the labour-intensive *wachu rozado* planting system (used by 62.5% of the farmers in this cluster), combined with *fine-tuning* in the use of inputs, which produces high yields per labour object. Farmers in Cluster one show a tendency to reduce input costs by using them efficiently because they combine numerous applications of agrochemicals *(fine-tuning)*, with low scores on all the factors related to external input use.

Table 5.7. Average factor scores per each cluster

	Cluster			
	1. *Tradicionales*	2. *Seguros*	3. *Arriesgados*	4. *Experimentad.*
	Mean	Mean	Mean	Mean
Fine-tuning	1.02*	-0.23	-0.45	-0.67**
Pesticide use	0.22	-0.15	-0.05	0.28
Fertilizer use	-0.27	0.02	0.36	-0.58
Labour use	0.46	-0.42	0.21	-0.13
Market-oriented production	0.03	-0.24	0.27	0.27
Yield & benefit	0.56	-0.20	-0.27	0.20
Equipment use	-0.19	-0.38	0.87	-0.64
Soil disinfections	-0.04	-0.27	0.43	0.03
Foliar fertilizer use	-0.25	-0.29	-0.02	2.87
Seed use	-0.22	0.46	-0.32	-0.63

*Highlighted average scores correspond to the highest value of the row (factor)
**Underlined scores correspond to the lowest value of the row (factor)

While *Tradicionales* base their style on the efficient use of inputs in order to reduce costs, *Seguros*, on the other hand, aim at reducing the use of all external inputs to a minimum. This pattern corresponds to Cluster Two (low scores but *pesticide use*, *labour use*, *soil disinfections* and *foliar fertilizer use*, but not for *seed use*). As explained in Chapter Four, *Seguros* practise a style characterized by low costs and also low yields and monetary benefits.

[116] The sum of the average factor scores for the total sample is 0, however for this table the averages must be weighted according to the number of observations for each cluster. Then total= [(average cluster 1 x number of observation of cluster 1) + (average cluster n x number of observation of cluster n)] / total number of observations.

Farmers' low scores in *yield and benefits* in Cluster Two show this. The high score with regard to the *seed use* Factor is explained in chapter four. *Seguros* use large potatoes for seed and rely on seed that they produce on-farm themselves or that their sharecroppers provide. The perception of the *Seguros* is that, "Bigger seeds can better endure more difficult conditions, just as fatter cows can." Difficult conditions for *Seguros* mainly consist of a lack of rain and low soil fertility due to their reliance on full tillage.

The pattern of factor scores in Cluster three resembles the Arriesgados style of farming. This indicates an externalization of production based primarily on mechanization (equipment use, fertilizer use and soil disinfections) and the orientation of the production process towards the market (high scores on market-oriented production), with low yields as a result (low scores on yields and benefits). The low production levels of farmers in this cluster indicate a sustainability crisis in terms of resource management, especially with regard to all the factors relating to soil quality. As I explained in Chapter Four, this crisis is connected to the Arriesgados' aim of increasing production for the market through the use of all the "modern" inputs available. Farmers have been using mechanized tillage for several decades, and the levels of acidity in the soil have reached such high levels that fertilizers, even those applied in large quantities, are sometimes unavailable to the crops due to fixation. Furthermore, the soil structure no longer retains humidity well, so the soils dry quickly. These soil conditions are conducive to soil pests and diseases, which means that soil disinfections are needed on Arriesgados' fields more than they are on other farmers' fields. By 2004, therefore, Arriesgados' yields per unit area had decreased, in some cases to nothing at all due to drought, pests, and/or disease outbreaks. Dollarization117 exacerbated this situation significantly, leading to a doubling of input prices and an influx of cheaper potatoes from Colombia and Peru. This resulted in the price of potatoes dropping to below the levels at which the Arriesgados could cover their costs.

Cluster Four shows the strategy of the *Experimentadores* who practise an extensive style of farming that tends to reduce costs (as does the style of farming practised by the *Seguros*). *Experimentadores* achieve this through the use of high dosages of foliar fertilizer and cheap pesticides (although in very few applications) on which they spend their scarce capital (see high factor scores on *foliar fertilizer use* and *pesticide use*). The name *Experimentadores* arises

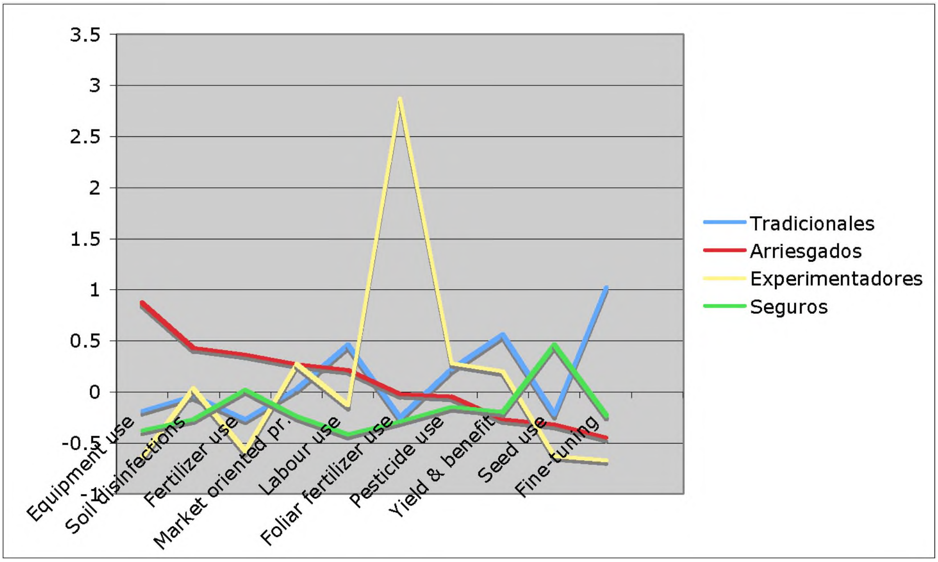
[117] Dollarization refers to the switch of the Ecuadorian currency to the US dollar, which took place in 2000.

from these farmers' willingness to experiment with different inputs in order to keep producing for the market (denoted by high scores on *market-oriented production*), thereby drawing as little as possible on their financial resources.

As described in Chapter Four, the *Experimentadores* farmers' style of farming is characterized by potato production in small fields, allowing these farmers to produce manually through full tillage[118] and to be more attentive to their potato crops by using their own labour or that of family members. As a result, their yields and benefits are relatively high (see *yield and benefit*).

When comparing the four farming styles on the basis of their average factor scores (see also Figure 5.2), *Tradicionales* score higher in *fine-tuning* than on any other factor, confirming that their use of inputs is efficient. The average factor scores also show that the pattern of practices of *Tradicionales* is labour intensive and produces higher yields and benefits than the other styles.

Figure 5.2. Average factor scores on different farming styles



Seguros, on the other hand, demonstrate autonomy from the market with regard to inputs (except for fertilizer). This can be understood as providing compensation in the form of a non-monetary benefit (among others), since the yields and monetary benefits for this group of farmers are relatively low.

118 Manual full tillage generally reduces soil erosion, compared with full tillage (whether mechanized or achieved by animal traction). This is especially so on steep soils due to the fact that there is less soil movement and less depth.

The *Arriesgados'* style has become dependent on both the input and the output markets and is characterized by low yields and benefits. As risk takers, farmers who practice this style effectively play the lottery by spending as much money as possible on external inputs and hoping that high potato prices will allow them to recover their investments; something that has occurred less and less often in Carchi in the last two decades.

Finally, the style of the *Experimentadores* farmers clearly involves prioritizing the use of foliar fertilizers, combined with high pesticide use and production for the market. Interestingly, farmers in this group produce high yields and benefits, but on small fields of land, which quite possibly explains their unusually efficient use of labour.

Farming styles according to a test of differences in the variables composing each factor

This analysis attempts to disaggregate each factor into its original variables (not transformed) in order to understand each farming style in detail. In Table 5.8, the differences of means of one-dimensional variables[119] are tested by making use of the Tukey test (the GLM procedure in SAS), and the differences of multidimensional variables are tested through the Chi-square test. The significance level for both tests is 0.05. As I have shown below, high average factor scores for each farming style correspond to high significant values for the specific variables that constitute each factor. Table 5.8 shows the values of the original variables that formed each factor. The qualitative observations summarized in chapter Four are used to explain the specific combination of variables.

Tradicionales

Table 5.8 shows that *Tradicionales* have the highest significant values for six of the ten variables that compose the factor, *fine-tuning,* and score higher with regard to three other variables of the same factor. *Fine-tuning* in relation to these variables can be explained when analyzing them in combination with the values of related variables in the other factors. An indication of *fine-tuning* for the factor, *pesticide use,* is that *Tradicionales* have the highest number

---

[119] *One-dimensional variables* are those in which only one measurement is possible for each observation. For instance, in the variable *number of pesticide applications* it is possible to have only one average for each farming style. *Multidimensional variables* are those in which different measurements are possible for each observation. For instance, in the variable "soil preparation" it is possible to have the percentage of farmers preparing soil 1) manually, 2) with oxen, 3) by tractor or, 4) mixed.

of pesticide applications combined with "average" values on the variables of the factor, *pesticide use*, since there are no significant differences for these variables among farmers' groups (see kg/ha applied of pesticide active ingredients from the groups of thiocarbamates, cymoxanil, other types of pesticides, pyrethroids and total applied pesticide active ingredients). Instead, *Tradicionales* use significantly lower amounts of carbamates, a more important indicator of exaggerated pesticide use. It is notable that IPM practices –as part of *fine-tuning*– are more common among *Tradicionales* than among farmers in other clusters, even those farmers who have received IPM training. This shows that IPM practices are embedded in the rationale of a farming style and may not be able to be promoted effectively as isolated practices or packages of technology.

Tradicionales demonstrate *fine-tuning* in *fertilizer use* ey make a high number of fertilizer applications but spend less on fertilizers com other farmers (in factor, *fertilizer use*). *Fine-tuning* in *labour use* can be attributed to *Tradicionales'* preference for planting in the *wachu rozado* style (62.5% of *Tradicionales*). This explains why they score the highest for the variables *labour use* (see "*percentage of farmers doing manual soil preparation*" and their corresponding low score on factor *mechanization*), *total labour days per hectare* and *yields and benefits* (see yield in kg/ha and benefit in kg/ha including all costs).

Seguros

Table 5.8 shows that *Seguros* use lower amounts of carbamates, thiocarbames and pyrethroids. In addition, they apply less active ingredients in kg/ha. Under the factor *soil disinfection, Seguros* have the lowest values for "total wages for pesticide applications" and for "organophosphorus compounds." They have the lowest value for the variable "foliar fertilizer by percentage cost" within the factor, *foliar fertilizer use*. For the factor *labour use*, they show the lowest values for "total labour days per hectare" and "labour cost in percentage."

Table 5.8 also shows that *Seguros* have a low but important level of *fine-tuning*. This includes planting resistant varieties, IPM, employing family members as specialized labour and, in the case of a few farmers, planting in *wachu rozado*. *Seguros* also have the lowest values for the variable "percentage of sold production" and the highest for "percentage of consumed production," showing that their production is not market-oriented.

Seguros also have the lowest yield per hectare (in the factor, *yield and benefit*). This is explained by the poor quality of the soil on which they farm. This results from their practice of full tillage, which they carry out using either manual labour (used by a small percentage of farmers) or oxen or mechanization (used by most farmers). This practice creates dry soil conditions. *Seguros* also plant potatoes without rotating them much with other crops (see the lowest number of "crop rotations in 4 crop cycles"). These practices also mean that *Seguros* have relatively high costs when it comes to fertilizers (see *fertilizer use*). Finally, *Seguros* have the highest significant value in "seed cost in percentage" and the highest in "seed in kg/ha" which, according to the farmers in this group, is a way to respond to harsh weather and poor soil conditions.

Arriesgados

Arriesgados' highest significant value, "equipment cost expressed as a percentage" (in factor *mechanization*), is due to their preference for preparing the soil with tractors (in fact, this group of farmers spend most of their money on equipment). The fact that *Arriesgados* obtain the highest significant value for the use of phosphorus in kg/ha and the highest value for "applied nitrogen" (in the factor, *fertilizer use)* is explained by the way in which they prepare the soil. Large quantities of soil are removed (estimated in Sherwood (2009) at between 80-120 tonnes/season) and dry conditions are created because they usually till in the direction of the slope. Dry soil conditions and full tillage provide an environment conducive to tuber pest attacks because these conditions favour reproduction and mobility in the soil and around the field, especially for the Andean weevil (*Premnotrypes vorax*) and the Guatemalan tuber moth *(Tecia sp.*). The result of years of mechanization by *Arriesgados* means that their fields are subject to a higher degree of infestation of soil pests than those of other farmers, which is why *Arriesgados* farmers score high in "soil disinfections" (in *soil disinfections*).

Arriesgados' highest value for "total wages for pesticide applications" is the result of paying for labour days that are shorter than those for which other farmers pay. This means that more labour days per hectare are needed to complete tasks (this was especially so for the *Arriesgados* from San Francisco.[120]) This pattern of practices, implemented over long periods of time, results in low yields and significantly low and negative benefits (see *yield and benefit*). *Arriesgados* therefore practise an extensive style of farming that, through the use of "modern" practices, has resulted in soil degradation and the lowest yields of all the groups in this research.

[120] Not only was a day's labour in San Francisco a maximum of only 7 hours, but it ended when the pesticide mixture was finished. Parts of days worked had to be paid for by the farmers as full days.

Table 5.8. Variables for each factor, according to farming styles

	Tradicionales	*Seguros*	*Arriesgados*	Experiment.	Total
1 Fine-tuning					
Pesticide application number	10a*	7b	6b	6b	7
# a.i. x each application	55a	33b	30b	25b	38
Wachu rozado (% farmers)**	63	13	4	17	23
Field area (ha)	1.24a	0.71b	0.86	0.36b	0.87
Number of foliar fertilizations	5	4	4	6	4
Paid labour days per hectare	108 a	60 b	71 b	30 b	73.26
Number of fertilizations	2.25	1.92	2.08	1.83	2.04
Organochlorin (a.i. kg/ha)	0.06	0.00	0.00	0.00	0.02
MIP practices (% farmers)**	54	39	31	0.00	38
% farmers plant resistant varieties	8	32	27	17	23
2 Pesticide use					
Pesticide cost (%)	17	14	14	17	15
Thiocarbamates (a.i. kg/ha)	17	13	15	14	14
Cymoxanil (a.i. kg/ha)	0.56	0.43	0.51	0.41	0.48
Other type of pesticide (a.i. kg/ha)	7	6	5	6	6
Cabamate (a.i. kg/ha)	1b	1b	2	3a	2
Pyrethroids (a.i. kg/ha)	0.15	0.05	0.07	0.10	0.09
Applied pesticide (a.i. kg./ha)	28	22	23	26	24
3 Fertilizer use					
Applied phosphorus (a.i kg./ha	340	317b	405 a	266	344
Fertilizer cost (%)	19b	23 a	20	15b	21
Applied nitrogen (a.i kg./ha)	145	144	171	115	150

Table 5.8. Variables for each factor, according to farming styles (*continued*)

	Tradicionales	*Seguros*	*Arriesgados*	Experiment.	Total
Applied potassium (a.i kg./ha)	174	152	164	128	159
Total cost/hectare in USA dollars	1870b	1489 a	1865b	1766	1708
4 Labour use					
Total labour days per hectare	132 a	102b	116	113	114
Labour cost (%)	36	32	33	32	33
Total Jpag for pest applic in %	38	31	50	30	38
5 Market oriented production					
Sold production (%)	83	74	84	86	80
# of planted varieties in the field	1	1	1	2	1
Production used for seed (%)	10	9	6	0	8
Production for consumption (%)	6	13		8	10
6 Yield and benefit					
Benefit including all costs	925 a	-7b	-167b	199	200
Yield kg/ha	17247 a	12350b	14984	16742	14609
7 Mechanization					
Equipment cost (%)	10b	8b	15 a	9	10
% farmers who prepare soil manually)**	83	37	31	50	48
8 Soil disinfections					
Number of soil disinfections	2	1	2	1	2
Total wages for pesticide applic	23b	22b	37 a	33	27
Organophosphorus (a.i. kg/ha)	2.0 a	0.9 b	1.7	1.2	1.4
9 Foliar fertilizer cost in %	3b	2b	3b	14a	3
10 Seed use					
Seed cost (%)	13b	18a	12b	10b	15
Seed Kg/ha	1524	1764	1697	1548	1670
Crop rotations in 4 crop cycles	2	2	2	2	2

*__a__ and **b** show that the differences are significant in the Tukey test of medias at the 0.05 level. The **a** values are the basis of difference (for instance in the variable, "area of the field," the differences were significant between *Tradicionales* and *Seguros* and *Tradicionales* and *Experimentadores*). The other possible comparisons are not significant)
** The differences are significant in the Chi-square test at the 0.05 level.

Experimentadores

Experimentadores have the lowest values for most variables under the factor, *fine-tuning*, except for their high number of foliar fertilizer applications. They score the highest with regard to the relative cost of this input (see *foliar fertilizer use*). This is combined with the highest value for the variable, "carbamate compounds," and a high value for "pesticide cost" (under the factor, *pesticide use*).

Experimentadores explain that they use high levels of foliar fertilizer to replace the use of more expensive soil fertilizers (see low values on *fertilizer use*), by applying micro-, and sometimes macro-, elements directly to the plants several times. Farmers choose to apply fertilizer in this way because the acidic soils in *Experimentadores*' fields, which are commonly located at high altitudes (especially in San Francisco), mean that fertilizers applied to the soil become fixed and unavailable to the plant. As result, these farmers use foliar fertilizers to strengthen the crop's capacity to resist drought and to enable the direct take-up of nutrients into the plant.

These conditions also explain why farmers in this group have high scores when it comes to *pesticide use*. Foliar pests are very common under dry conditions when there is good plant development (due to foliar fertilization). Since *Experimentadores* generally lack capital, they tend to apply pesticides with a small number of active ingredients, each of which belongs to a wide spectrum. These pesticides are usually cheap because the active ingredient is no longer under patent. Unfortunately, they are often also highly toxic.

Nevertheless, high scores for *pesticide use* and *foliar fertilizer use* are also due to *Experimentadores*' miscalculation of dosages of these inputs required for the areas of land they are farming (their field areas are the smallest of all the groups of farmers). Most technical recommendations are given on a per hectare basis, and farmers find it difficult to calculate the fractions of required dosage, favouring over-application when in doubt. Thus *Experimentadores*' use of carbamates and foliar fertilizer appears exaggerated and contributes to their high relative total cost of pesticide and foliar fertilizer (Chapter 6 presents further details of this situation).

Experimentadores farmers have the lowest value for "seed cost in percentage" (in *seed use*) and the highest value for "number of planted varieties in the same field" (in *market oriented production*). Because *Experimentadores* tend to produce mostly for the market (see highest values for "percentage of sold production"), they acquire potatoes for seed and for their own consumption during *recaves*[121] when working as labourers. As a result, *Experimentadores* make use of the different varieties that are available at the planting date instead of buying seed.

Experimentadores also have the highest value for "crop rotations" in four crop cycles, which demonstrates that they do not rotate with pasture (usually two years with cattle) but with cash crops. The strategy employed by *Experimentadores* is interesting since it is a unique semi-extensive style that produces high *yields and benefits*, comparable to those of the *Tradicionales*. This is explained by their low total costs (mainly achieved through input replacement), compared to the total costs of *Seguros*. The *Experimentadores* produce mainly for the market (as do the *Arriesgados*) on small fields and with non-commoditized labour (their paid labour days are the lowest of all the groups of farmers).

The production process

When analyzing the three elements that constitute the production process – the objects of labour, the tools or instruments and the labour force– it is possible to observe that *Tradicionales* focus on labour force, *Seguros* on seed (object of labour), *Arriesgados* on mechanization (instrument) and *Experimentadores* on foliar fertilizer (instrument). The relation between these different areas of focus and the other factors of production explains the difference in the yields that each farming style produced in 2004.

In Carchi, farmers regard seed as their objects of labour.[122] Table 5.9 shows that the relation of quintals harvested for each quintal planted was 11 for *Tradicionales* and *Experimentadores*, nine for *Arriesgados* and seven for *Seguros*. Yet, the relations between the elements of the production process in each farming style suggest that differences in production are connected to soil quality rather than to seed quality. Table 5.8 indicates that there are not significant differences between the farming styles when it comes to the percentage of farmers who plant resistant varieties, number of planted varieties or percentage of production used for seed.

According to farmers, there were no clear differences in the soil quality of fields[123] in the 1970s when commercial potato production started. Potato

---

121 *Recaves* are potatoes left over from the harvest, which are given to the labourers for free.
122 In Carchi, farmers' standards of potato production are calculated by quintal of seed and not by the area of land planted. Chapter Four shows that the desirable production for farmers is 20 quintals per each quintal of seed.
123 Sherwood (2009: 23-24) describes soils in the potato production area of Carchi as "exceedingly arable" with "surface horizons of one to three meters of dark topsoil

seed was more important than soil quality. The use of synthetic fertilizer without soil analysis became very common. Because there is a widespread belief, reinforced by modern agricultural education, research and extension systems, that the most important way to increase production is through the use of synthetic fertilizer, tractors and "improving" the genetic make-up of seed, other aspects of seed management, such as storage, pest control or good selection have received less attention in general. This section shows, though, that farmers do not all follow a single route with regard to these matters. Different farming styles emphasize different combinations of the elements that comprise the production process.

Intensification versus extensification of production

Table 5.9 shows that, compared to the other styles, *Tradicionales* practice a more intensive style centred on achieving high productive results per labour object, whether this concerns potato seed or land (see relation 1 and 2). In this case, the quantity and quality of labour is very important as *Tradicionales* rely on a lot of labour who are experienced in the ways of *wachu rozado* farming and who are usually organized in *cuadrillas*. The same goes for *Experimentadores*, who tend to practice an intensive style and use family labour for both land preparation and the management of seed. On the other extreme, *Seguros* practice an extensive style of farming in which the organization and development of the farm is centred on the use of tools such as soil fertilizers. Soil fertilizers are used to enable the farmer to manage as many kilograms of seed or as large an area of land per day of labour as possible (see relations 3 and 4). In the *Arriesgados*, who also practice an extensive style, leading to reliance on "mechanical technology."

Table 5.9. Agronomic relations of production for different farming styles

	Tradicionales	*Seguros*	*Arriesgados*	Experiment.	Total
Prod./seed (Kg/ha)	11	7	9	11	9
Prod./land (Kg/ha)	17247a	12350b	14984	16742	14609
Seed/labour day	12	17	15	14	15
Hectares/labour day	0.008	0.010	0.009	0.009	0.009

composed of high quantities of organic matter" and "particularly apt for agriculture". Yet he also describes how the soils have changed rapidly after three decades of land reform and "modern" technology use in potato production. The use of tractors on hillsides, especially, has exposed the sub-soil on a growing number of farms (Ibid: 37).

Production levels and benefits

A comparison of farming styles according to their levels of production (see table 5.10), reveals that 82 percent of the *Tradicionales*, 37 percent of the *Seguros*, 46 percent of the *Arriesgados* and 17 percent of the *Experimentadores* achieve high or very high production per hectare levels. These percentages coincide with the comparison of farming styles in terms of their positive and negative benefits (see table 5.11). 71 percent of *Tradicionales*, 45 percent of *Seguros*, 46 percent of *Arriesgados* and 50 percent of *Experimentadores* achieve a positive benefit. This suggests that there is a high level of correlation between levels of production and monetary benefits. Here it is relevant to remember that the high yields and prices obtained by *Tradicionales* can be explained by their practice of *wachu rozado*, a planting system that contributes to minor fluctuations in production per area and also to conditions, which are conducive to negotiating a better price in the potato markets.

Table 5.10. Farming styles compared according to different levels of production

Production		*Tradicionales*	*Seguros*	*Arriesgados*	*Experiment.*	Total
1.Very low	Frequency	1	12	7	3	23
	Percent	1	13	7.	3	24
	Row Pct	4	52	30	13	
	Col Pct	4	32	27	50	
2. Low	Frequency	3	12	7	2	24
	Percent	3	13	7	2	26
	Row Pct	13	50	29	8	
	Col Pct	13	32	27	33	
3. High	Frequency	10	8	6	1	25
	Percent	11	9	6	1	27
	Row Pct	40	32	24	4	
	Col Pct	42	21	23	17	
4.Very high	Frequency	10	6	6	0	22
	Percent	11	6	6	0	23
	Row Pct	45	27	27	0	
	Col Pct	42	16	23	0	
	Total	24	38	26	6	94
	Percent	26	40	28	6	100

Table 5.11. Farming styles compared according to positive and negative benefit

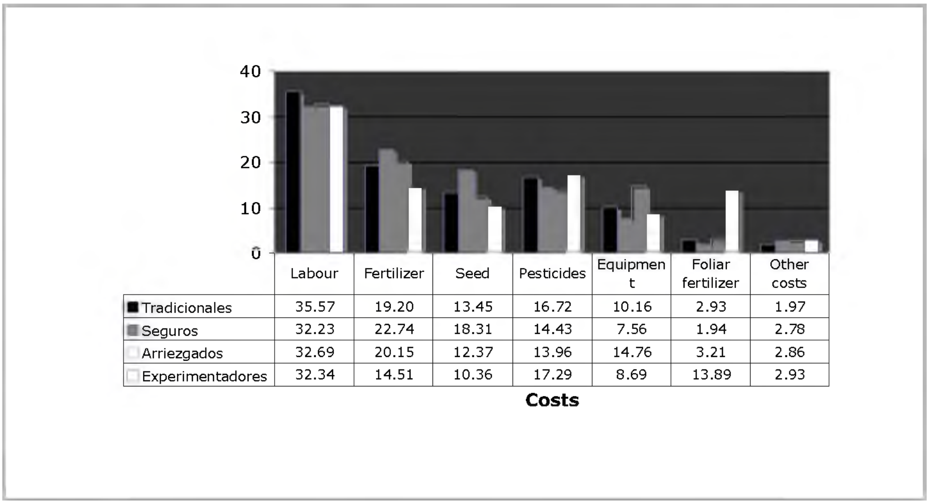
Benefit		*Tradicionales*	*Seguros*	*Arriesgados*	*Experiment.*	Total
Negative	Frequency	7	21	14	3	45
	Percent	7	22	15	3	48
	Row Pct	16	47	31	7	
	Col Pct	29	55	54	50	
Positive	Frequency	17	17	12	3	49
	Percent	18	18	13	3	52
	Row Pct	35	35	24	6	
	Col Pct	71	45	46	50	
	Total	24	38	26	6	94
	Percent	26	40	28	6	100

Comparison of farming styles by costs and commoditization levels

<u>Allocation of resources</u>

Figure 5.3 shows how each group of farmers allocates resources to the different aspects of crop production. For the reasons explained before, *Tradicionales* tend to spend more on labour than the other groups, whereas *Seguros* invest more on fertilizer and seed. *Arriesgados* spend more on equipment, while *Experimentadores* spend more on foliar fertilizer and pesticides.

Figure 5.3. Breakdown of the allocation of resources by percentage for each of the farming styles. (Figures given are the averages for each group.)



Levels of commoditization

As explained in Chapters Three and Four, commoditization refers to "the processes by which the notion of 'exchange-value' –not necessarily at the expense of 'use value'– comes to assume an increasingly important evaluative and normative role in the discourse and economic life of a given social unit (e.g., household, village, region, or national economy)" (Long 2001: 21). While externalization is defined by the degree of incorporation into the market (on the supply side), commoditization is more difficult to define. This is because the factors or inputs of production may acquire different values (i.e. different from the exchange value) in each phase of the production cycle, and may continue to do so even after commercialization. An example would be the extra rations that are distributed during social events such as fiestas. Labour is valued according to the circumstances and the style of farming. *Arriesgados* prefer to pay as low a labour rate as possible for most tasks, whereas *Tradicionales* prefer to do the work themselves or to ask family and friends to do the work so that external inputs are applied more effectively. When potato prices are low, *Arriesgados* might pay wages in potatoes at harvest time, but when prices go up they prefer to pay wages in cash. Thus the value of a day of labour is evaluated in various different ways, depending on the circumstances and the style of farming (i.e. the values and priorities of the family contracting and organizing the labour). As a result, "a day's labour" cannot simply be converted to a monetary value.

In Chapter Four, I present two types of relations through which commoditization can be analyzed according to van der Ploeg (2003) (Please see relations **a** and **b** in figure 5.4 and the values used for calculation in the table below that)[124]. Relation **a** in Figure 5.4 represents the relation between resources mobilized via the markets and the resources reproduced on the farm. When resources are mainly sourced on-farm, the farm's level of self-sufficiency is high. Relation **b** in Figure 5.4 represents the relation between purchased resources and sold produce. The closer the ratio gets to one, "the more oppressive the relationship between markets and farm will become"

---

[124] Self- sufficiency or relation (a) has been calculated by dividing the non-commoditized costs (that for this purpose are given the same monetary values as the commoditized ones and include non-commoditized labour, non-commoditized seed and non-commoditized equipment use) by the commoditized costs, which represents the monetary expenditure and includes paid labour, paid seed, paid equipment, paid soil fertilizer, paid foliar fertilizer, paid pesticide and other paid costs.
Market dependency or relation (b) has been calculated by dividing the money acquired from the sale of the produce by the commoditized costs or the cost of the purchased resources.

(Ibid: 56). In this case, we can see that *Tradicionales* are less market-dependent than the rest of the groups, while *Arriesgados* are the most dependent of all on the market.

Relations **a** and **b** show farmers' different aims according to their resource base and their ability to work with the markets. While *Seguros*, who lack capital and good quality soils (but not land), prioritize retaining a high degree of self-sufficiency to avoid any indebtedness that might result from their low yields, *Tradicionales* (who have enough good quality land and enough capital) prioritize a low dependency on the market. Farmers in both groups are searching for what van der Ploeg calls "farming freedom" (van der Ploeg 1990: 266, 2003: 63). In practice, in the case of *Seguros*, freedom consists of their autonomy from input and output markets, while for *Tradicionales*, freedom is the room to manoeuvre in both kinds of markets. *Experimentadores*, who lack capital and land, try to achieve a balance between a relatively high degree of self-sufficiency and a relatively low dependency on the market. Farmers in this group have a small resource base (especially with respect to land) and prioritize production for the market, but with as high a degree of self-sufficiency as they can manage on the supply side. Finally, *Arriesgados* have a low degree of self-sufficiency and the highest degree of dependency on the market of all the groups. This reveals an imbalance with respect to market-related risk on the supply and output sides.

Figure 5.4. Self-sufficiency and market-dependency for different farming styles

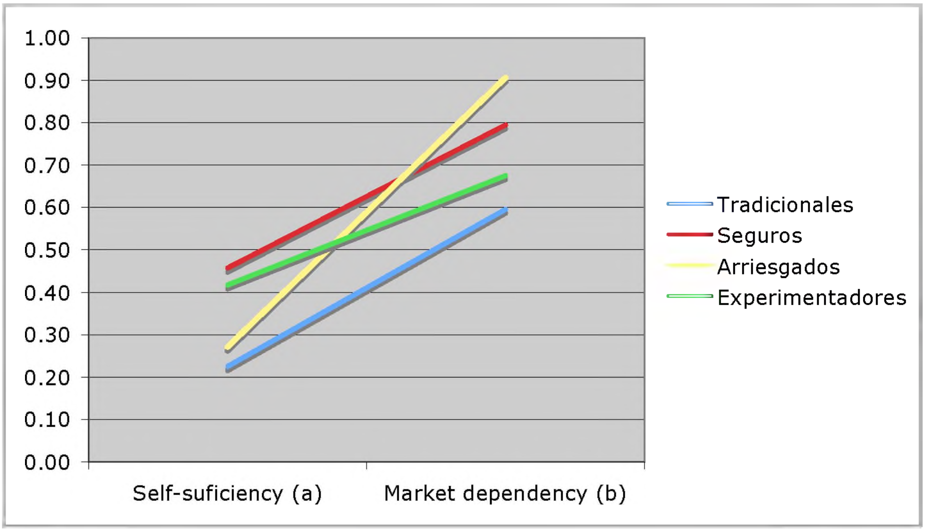
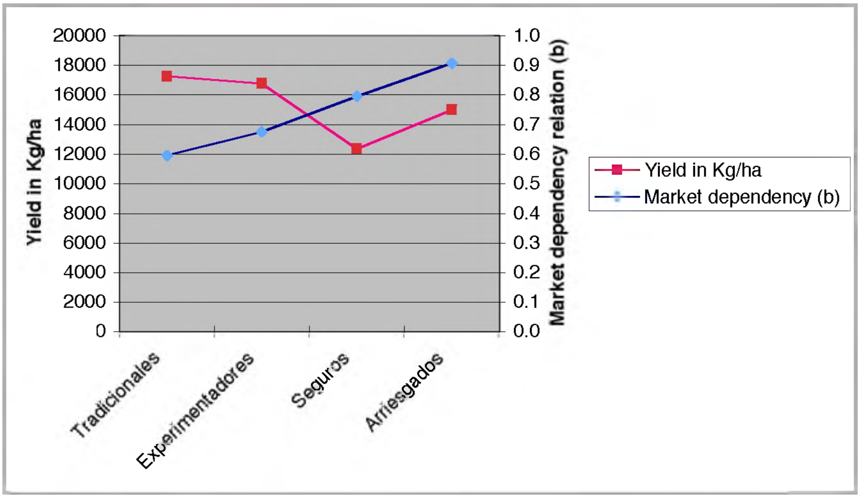


Figure 5.4. Self-sufficiency and market-dependency for different farming styles (*continued*)

Farming style	1. Non-commoditized costs $/ha	2. Commoditized costs $/ha	3. Sold produce/ha	1/2. Self-sufficiency relation a	2/3. Market dependency relation b
Tradicionales	344.55	1525.22	2561.21	0.23	0.60
Seguros	467.76	1021.29	1286.22	0.46	0.79
Arriesgados	399.48	1465.96	1618.01	0.27	0.91
Experimentadores	521.03	1245.34	1843.95	0.42	0.68

Figure 5.5 shows the values ordered according to the market-dependency relation combined with the values for yields for each farming style. It demonstrates that yields tend to decrease at higher market-dependency values. This is a trend that is confirmed by other studies (van der Ploeg 1990, Hebinck 1995, Sherwood 2009). It shows that the modernization theory of increasing yields through farmers' incorporation into markets of inputs and factors does not work in the long term. The same trend can be found in the communities studied by Mayer in Peru (Mayer 2002: 217).[125] Farmers whose styles include so called "traditional" practices (e.g. *wachu rozado*) and non-commoditized arrangements for labour and production seem to achieve more consistent yields after decades of modernization.

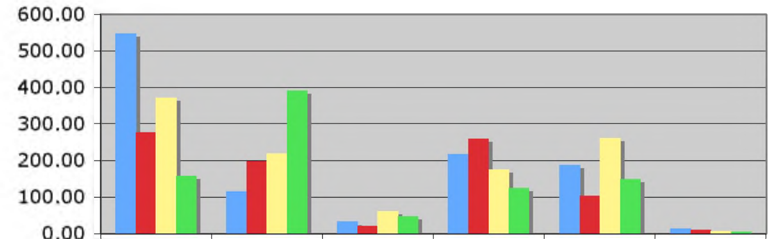
Figure 5.5. Market-dependency and yields for different farming styles



[125] In a study in two regions of the Peruvian highlands, Mayer finds that gains in productivity and modern technology in past decades have not been sustained. A return to more traditional systems of production has become a better option, especially in times of crisis (Mayer 2002: 217).

Figure 5.6 shows the composition of the costs involved in the different farming styles in real quantities, disaggregated into commoditized and non-commoditized inputs.[126] In general, all the farmers in this study tend to rely on non-commoditized circuits for the provision of labour, seed and equipment (in order of importance). The use of non-commoditized circuits is one of the most important characteristics of peasant modes of production and analyzing how these circuits work heterogeneously provides us with insights into the sociotechnical networks that are important if the peasant sector is to be able to continuously innovate and subsist.

Figure 5.6. Commoditized and non-commoditized inputs for the different farming styles in USD/ha (average for each group)



	Com. Labour	Non-com. Labour	Com. Seed	Non-com. Seed	Com. Equipment	Non-com. Equipment
Tradicionales	546.38	114.41	32.58	216.49	186.16	13.66
Seguros	277.01	198.17	21.32	259.29	102.11	10.30
Arriesgados	372.64	218.25	61.26	174.78	261.21	6.45
Experimentadores	156.53	391.57	46.67	124.40	149.25	5.07

Commoditized and non comoditized inputs

Whilst the highest percentage of non-commoditized inputs corresponds to labour use in Figure 5.6, the use of this input should be analyzed according to the goal that the farmer wishes to achieve by using it. In Table 5.8, for instance, we can see that although *Tradicionales*, *Seguros* and *Experimentadores* use the lowest percentages of paid labour in order to apply pesticides, there are differences between them in the way non-commoditized labour is used, especially in terms of yield and differences in health risks. *Tradicionales* use non-commoditized labour for pesticide applications because the high levels of humidity in their fields mean that they are susceptible to late blight attacks. They have to continuously monitor their fields, therefore, and make

126 The value for non-commoditized inputs is imputed from the costs of commoditized inputs. An unpaid day of labour for the farmer or his/her family, therefore, has the same monetary value as the wage the farmer pays to a labourer. This same procedure has been applied to seed and equipment use.

numerous applications of pesticides in order to prevent outbreaks. They have to use their own labour and that of their families since they cannot predict when they will need labour to apply pesticides. *Seguros*, on the other hand, want to make sure that the pesticides which are applied in a few applications are applied as effectively as possible. *Experimentadores* aim at decreasing the monetary costs of labour as far as possible. They use family labour to apply pesticides so as to cut costs. They also use the cheapest, and most toxic, pesticides (see the value of the carbamate compounds used by these farmers in Table 5.8). Unfortunately this puts themselves and their families at risk of being poisoned by pesticides. *Arriesgados*, on the other hand, rely on hired labour for pesticide applications (see Table 5.8). They also achieve the lowest yields of all the groups. One of the reasons for this is that the priority for paid labourers is to finish a task as soon as possible, rather than to monitor the crop or to check that the applications they make are effective. Thus, the differences in the efficiency of pesticide applications between different farmers depends not only on the kind of labour used but also on the way in which the labour is used and the relationship that is established between the farmer and labourers (whether paid or not) as well as on the types of pesticide used. Comparing the yields achieved by each style of farming shows how these factors influence the end result.

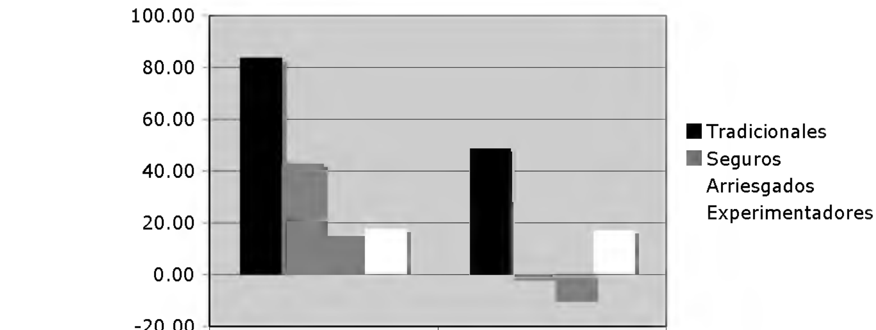
Farmers' calculations of benefits

Based on the discussion about farmers' calculations of benefits in Chapter Four, Figure 5.7 indicates two cost/benefit relationships: the costs on the right-hand include all the inputs while those on the left include commoditized inputs. On average, farmers in all the groups have a positive cost/benefit relationship when only commoditized inputs are included in the balance. This is the calculation that most farmers make in their heads (no farmers in my study had account books!). This means that the most important relationship for farmers in Figure 5.4 is that between monetary expenditure and total sales (market-dependency).

The cost of the inputs that are acquired on non-commoditized circuits represents between 19 and 31 percent of the total costs (depending on the style of farming). This means that when these costs are included in the calculation of the cost-benefit ratio, 46 percent of the farmers show a negative balance. Yet when I asked farmers about how they saw the balance between costs and benefits in their production cycle, most farmers said they achieved a positive overall result. Thirty five percent of the farmers, however, said they thought their balance was negative ("perdimos"). Most of those farmers were from Santa Martha and San Pedro. This percentage corresponds to the calculation obtained on the left-hand side of Figure 5.7. Once the value of the non-commoditized costs is subtracted from the total only 30% of the farmers appear to be losing money. This means that the average cost/benefit ratio is positive for farmers in all of the groups.

The calculation of positive benefits is one of the main reasons why farmers in Carchi continue to produce potatoes despite the price crisis or the crisis resulting from the dollarization of the national currency. It is as if non-commoditized circuits were part of another sphere of influence, where things are not valued in terms of money but according to cultural or family values. A *Seguro* farmer in San Pedro, for example, regards *family labour* as the responsibility of all the members of his or her extended family, and of the community as a whole, rather than as a cost. Exchanging labour is part of the order of things, such as "going to mass." Charging a family or a friend for labour when he or she most needed it would be against their principles. For an *Experimentador* farmer, family labour is the "capital of the poor"; it is their biggest resource. They "would not dare to charge for labour when others were in need."

Figure 5.7. Cost-Benefit of the different farming styles (expressed as percentages)



	Benefit/paid costs	Benefit/total costs
Tradicionales	83.62	48.82
Seguros	42.82	-0.85
Arriesgados	16.38	-8.97
Experimentadores	17.66	17.07

Benefit

Seguros use a high percentage of the harvest for their own consumption (13%) and for seed (9%). These are considered to be invaluable "benefits" of the production cycle. Accordingly, *Seguros* calculate the monetary benefits of their potato farming by subtracting the cost of the labour contracted for harvest (harvesting the potatoes being one of the tasks that require extra labour) from the profits that result from their sales. *Arriesgados* calculate their benefits in the same way, explaining that the positive benefits that result from this calculation encourage them to continue working in the following crop cycle. This way of calculating profits in highly monetized, market-dependent styles such as *Arriesgados* effectively hide adverse resource maintenance and sustainability problems, an issue that has been raised by Mayer (2002: 231) in relation to potato farming in Peru.

Handling of the unique gender relationships associated with the reproduction of particular farming styles can influence the outcome of cost-benefit analysis. For instance, farmers from all four styles consider the work of the lunchtime cook as part of the family duties. Nevertheless, when food is not included in the arrangement, the cost of a day of labour increases by one dollar for each individual labourer hired.[127] Including the cost of the cook's labour in the calculation of the costs of potato production can result in an increase in these costs of five percent or more, a margin that very often can lead to a negative net benefit. Nevertheless, farmers clearly see things differently. As a *Seguro* farmer explains:

> We look at things differently from you [i.e. the researcher]. When we marry, we do not make a list of what everyone has, we both know that we will try our hardest to do the best for our children and we are not going to pay each other for that. We [men] are made to work in the field, and that is why we won't ask women to go out with a hoe [to work in the potato fields] unless they want to produce their own vegetables. What would you think if one day you found my wife working in the potato field and me cooking in the kitchen?

<u>Production relationships in peasant farming</u>

As mentioned before, non-commoditized circuits for the provision of inputs on the farm is one of the main characteristics of the peasant mode of production in Ecuador. The most important inputs obtained through access to non-commoditized circuits by peasants in Carchi are labour (which amounts to 30 percent of the total costs) and, to a lesser extent, seed (which comes to about 15 percent of the total costs). *Experimentadores* and *Seguros* have the highest percentage of non-commoditized inputs.

Another characteristic of the peasant potato production system in Carchi is the level of market integration, with the *Tradicionales* and the *Experimentadores* having the lowest level of dependency on the market. Other features of the

---

127 This is not the case when *cuadrillas* (work teams) are hired, because they bring their own food.

peasant mode of production identified in Carchi for each farming style are presented on Table 5.12.

Production arrangements (production ownership) and land tenure indicate the extent to which peasant farmers make non-commoditized arrangements for access to land and for the production of potatoes. If we look at the ownership of production, most farmers in all four farming styles rely to some degree on sharecropping arrangements (the highest percentage is 79 percent for both *Tradicionales* and *Seguros*). Land tenure indicates who contributes the land itself. *Arriesgados* and *Experimentadores* are the groups who most commonly contribute land, but for very different reasons. While *Arriesgados* prefer to control the production process (especially with regard to inputs) through the contribution of land and capital, *Experimentadores* usually contribute their land as part of a sharecropping arrangement with poorer farmers or labourers (usually from their own family) because they do not have enough capital to grow potatoes in partnership with richer farmers. Although *Tradicionales* produce on bigger fields, the land is not generally their own. Farmers in both this group and that of the *Seguros* manage to grow potatoes through sharecropping arrangements, using others' land (only 29% of farmers in each of these two groups produces on their own land). Once again, though, the arrangements and conditions are different for the two groups. *Tradicionales* can grow potatoes on other people's land and still control the production process because their main contribution is capital. They generally get high financial returns from their farming efforts. *Seguros*, on the other hand, tend to sharecrop using land that belongs to a family member, enabling them to reduce costs.

It is important to explain here that sharecropping is a "delicate" arrangement. The different parties involved need to trust each other in order to feel that there is a reasonable balance of power between them. The relationships into which *Tradicionales* and *Seguros* enter are usually characterized by a high degree of trust. This enables them to maintain a reasonable balance of power within the sharecropping arrangement. *Arriesgados* and *Experimentadores* are more likely to encounter power imbalances in their sharecropping arrangements. As a general rule, those who have capital or land are regarded as having the most power in the decision making involved in potato production. These differences are related to the history of a community (Table 5.12).

This section demonstrates that there is not a single model for the peasant mode of production. Farmers in each of the four styles identified here make use of non-commoditized circuits and social relationships in different ways.

Heterogeneity of arrangements and relationships with markets seem to be the rule among peasant farmers in Carchi.

Farming styles within communities

Table 5.13 shows significant differences found through the Chi-square test of differences in relation to community and soil preparation. Although all the farming styles are represented in each community, there is a significant tendency for one style to predominate in a specific community. *Tradicionales* are most common in Mariscal (75%), a community where *wachu rozado* farming is feasible because of the humid soil and weather conditions. A high percentage of farmers in Mariscal also prepare the soil manually. *Seguros* are mainly from San Pedro (63.16%). They either prepare the soil manually or with oxen. Most *Arriesgados* live in San Francisco or Santa Martha (34.62% in each) and prepare the soil mechanically or manually. Finally, more *Experimentadores* live in San Francisco (50%) than in any of the other communities. They prepare their land with tractors and by hand. Chapter Four explained how the history of each community's land acquisition and the relationship between its labourers and the hacienda owners favoured the development of a particular farming style. In the following paragraphs I will present a short summary of this process.

Table 5.12. Land tenure and ownership of the different aspects of potato production for different farming styles in Carchi

	Tradicionales	*Seguros*	*Arriesgados*	*Experimen-tadores*	Total average
*Land tenure****					
Own land (% of farmers)	29	29	54a	50b	37
Using others' land via a sharecropping arrangement (% of farmers)	71a	58b	23	17	49
Land which is rented and under the control of the tenant during production (% of farmers)	0	13	23b	33a	14
Total	100	100	100	100	100
Ownership of production					
Individually owned (% farmers)	21	21	38	33	27
Shared with co-producers (% farmers)	79	79	62	67	73
Total	100	100	100	100	100

*** Differences are significant in the Chi-square test of differences of means at 0.05 level. The highest average is represented by values followed by **a**, and the second highest by values followed by **b,** when these are significantly different from the group average.

Initially, the peasant farmers (mostly ex-hacienda servants) who lived in San Pedro and Mariscal farmed on land with very similar ecologies. Today, however, only Mariscal farmers can still farm in the *wachu rozado* manner. Farmers from San Pedro cannot follow this practice anymore because the area has become completely deforested, resulting in low levels of rainfall and the loss of soil moisture. A similar situation has occurred in Santa Martha and San Francisco. These communities both had access to *páramos* (high wetlands), while a part of the *Interandean* forest fell within Santa Martha's community boundary. Both communities acquired their land in the late 1970s after land reform. Santa Martha was considered the "community with the best land." It was one of a handful of communities that acquired land in the valleys as a result of the land reform process. At the time that this research was conducted, there was no native forest reserve or *páramo* land left in the vicinity of Santa Martha. The soil has been subjected to mechanized ploughing as the topography allows for this. The weather has become drier as a result of deforestation and the burning of the *páramos*. San Francisco's farmers, on the other hand, only have access to land in a highland area. The nearby *páramos* form part of the ecological reserve of "El Angel." This reserve was created to protect a part of the *páramos*, since these areas had become increasingly colonized for potato production in the previous 15 years. Initially, land preparation was carried out only by hand in the new *páramo* areas because of the steep slopes and very difficult conditions. However, after a few potato production cycles and seasons of using grass for cattle, the land dried up and became firm enough for farmers to use machinery to prepare the land. The use of tractors in San Francisco only started in the late 1990s, and has recently intensified. Despite the move towards mechanization, the soil and the weather are still more favourable in San Francisco than in Santa Martha, where soil preparation has been mechanized for many years.

Farmers from Mariscal and San Pedro have developed their styles over a long period of time, since they bought land in the 1930s. Farmers made their land payments to the hacienda owners by means of the sale of forest products (wood, wood coal, etc.) and gradually started cultivating potatoes with the resources available at that time (native seeds, family labour and/or animal power, etc.). Farmers from Mariscal maintain part of the traditional system of production such as the *wachu rozado* practices, while farmers from San Pedro, who experienced punitive relationships with the hacienda owners, avoid farming systems that require large amounts of labour.

Table 5.13. Farming styles differentiated according communities and modes of soil preparation

	Tradicionales	*Seguros*	*Arriesgados*	*Experiment.*	Totals
*Communities****					
San Francisco (% farmers)	4	8	35b	50a	17
San Francisco (# farmers)	1	3	9	3	16
Santa Martha (% farmers)	8	18	35a	17	20
Santa Martha (# farmers)	2	7	9	1	19
San Pedro (% farmers)	13	63a	23	17	36
San Pedro (# of farmers	3	24	6	1	34
Mariscal (% farmers)	75a	11	8	17	26
Mariscal (# of farmers)	18	4	2	1	25
*Soil preparation****					
Manual (% farmers)	83a	37b	31	50	48
Mechanized (% farmers)	4	18	35a	17	19
Animal (% farmers)	8	37a	12	0.00	20
Mixed (% farmers)	4	8	23	33a	13

*** Differences are significant in the Chi-square test of differences of means at 0.05 level. The highest averages are followed by **a**. The second highest average is followed by **b** when this is significantly different from the group average.

In contrast, farmers from San Francisco and Santa Martha bought their land during land reform in the 1970s (about 40 years later than the other two communities). They had to make a large initial payment, followed by monthly payments to the national development bank (Banco de Fomento).This led them to use technological packages in order to ensure that they had a surplus to sell on the market after they had put aside what they required themselves. Most farmers sold their animals in order to meet their initial payments, resulting in the loss of their sources of animal manure and/or animal power. They turned, therefore, to chemical fertilizers, mechanization, pesticides and "improved" potato varieties.

Table 5.14 shows the variables used in the factor analysis ordered according to communities. It can be seen that to a certain extent farming in the community of Mariscal follows the same pattern of practices as the *Tradicionales* (labour intensive with high yields and benefits), whereas farming in the community of San Pedro follows a pattern similar to that typical of the *Seguros* (intensive use of seed with low costs, and low yields and benefits).

Table 5.14. Variables according to factor analysis across communities

	Mariscal	San Pedro	Santa Martha	San Francisco	Total average
1 Fine-tuning variables					
Pesticide applications (number or #)	10.44a	6.76bd	7.00bd	4.06bc	9.05
Main crop system	W. rozado	Full tillage	Full tillage	Full tillage	N/A
Field area (ha)	1.31a	0.62b	0.53b	1.09	0.87
Foliar fertilizations (number)	5.76a	2.97b	4.16	4.19	4.16
Paid labour days per hectare	102.29	66.80	50.93	68.16	114.08
Fertilizations (number)	2.36a	1.82b	1.95	2.13	2.04
2 Pesticide cost (%)	17b	15b	15b	10a	15.07
3 Fertilizer use variables					
Applied phosphorus (a.i kg./ha)	382.75	335.22	347.24	299.76	344.25
Fertilizer cost (%)	21	21b	22b	17a	20.60
Applied nitrogen (a.i. kg/ha)	159.77	154.74	142.77	132.81	149.93
Applied potassium (a.i. kg/ha)	194.93c	143.83bd	199.54a	89.58bd	159.45
Total cost per hectare in USA dollars	1948.11a	1579.05b	1757.42	1548.54b	1708.06
4 Labour use					
Total days of labour per hectare	127.94a	113.04	113.63	95.17b	114.08
Labour cost (%)	33	33	34	34	33.23
5 Market-oriented production					
Sold production (%)	84%	80%	71%	83%	0.80
Number of planted varieties in the field	1.08	1.32	1.53	1.31	1.30
Production used for seed (%)	9%	8%	7%	6%	0.08
Production for consumption (%)	7%	11%	10%	10%	0.10
6 Yield and Benefit variables					
Benefit (USD/ha)	534.26b	147.51b	-559.17a	689.72b	199.82
Yield (kg/ha)	15345.9	13732.6	12357.1b	17994.4a	14609.05
7 Equipment cost (%)	10b	8b	8b	18a	10.31
8 Soil disinfections (number)	2c	1bde	3af	1bd	1.68
9 Foliar fertilizer cost in %	3	2b	3b	6a	3.29
10 Seed use					
Seed cost (%)	14b	18a	15	12b	14.91
Seed kg/ha	1553.49	1782.35	1763.48	1503.57	1670.22

*** Differences are significant in the Tukey test at 0.05 level. The highest averages are followed by **a**, and the second highest averages are followed by **b**. When there are additional differences, these are signalled by the following pairs of letters: **c** and **d,** and, **e** and **f**. Averages followed by the same letters are statistically similar.

The highest yields and benefits observed in this research, however, are not achieved by the *Tradicionales* in Mariscal, but by farmers in San Francisco, where the values of some (but not all) of the variables resemble the *Experimentadores*' practices, with others resembling the practices of the *Arriesgados*. Farming in Santa Martha, on the other hand, resembles many of the *Arriesgados*' practices. This shows that there has been a tendency to develop a specific style of farming in each community. Nevertheless, it always possible to find farming styles other than the dominant one in each community.

Several conclusions can be drawn from a consideration of the trajectories followed by the four different communities. In the first place, the fact that farming has tended to develop into a specific style in each community demonstrates once again the importance of the ways in which local history influences farming practice. This history consists of the quality of local natural resources and farmers' access to them. It also includes farmers' relationships with each other and the hacienda owners or the national institutions operating in the area as well as their relationships with material resources such as land, soil, forest, water, agrochemicals and machines.

In the second place, both the historical relationships and the collective decisions of the farmers interact continuously with the natural resources available for farming. This is why it is possible to find different styles of farming in communities that initially had the same resource base (such as Mariscal and San Pedro), or similar styles of farming in communities that currently have access to different resources (such as the *Arriesgados* style of farming that can be observed in Santa Martha, San Francisco and San Pedro).

Finally, it is remarkable that it is the farmers from the two communities that were formed long before land reform and modernization who have developed farming styles that either include traditional practices and/or distance themselves from the markets as far as they are able to. Thus the *Tradicionales* farmers, living for the most part in Mariscal, and the *Seguros* farmers, living in San Pedro, practise styles of farming which are characterized by low levels of dependency on the market and by more autonomy than the styles developed in the other two communities. In San Francisco and Santa Martha, on the other hand, modernization and land reform have played a critical role in shaping the farming styles. San Francisco, where modernization was introduced later than Santa Martha, has the better resource base of the two communities. All the farming styles have succeeded better than they have in Santa Martha.

As mentioned by Long (2001), "agency" (the capacity to make a difference) is not only (or always) a characteristic of individual actors but can also be a characteristic of organized groups. Peasant farmers in Carchi made a huge and historical difference when they organized themselves into groups to acquire land from the haciendas. Many hacienda servants in other areas of the highlands only acquired land in the late 1980s and some never did. Nevertheless, there were differences within the groups that acquired land from the haciendas in Carchi. Some peasants sold their land or stopped participating in peasant organizations once the land was assigned. The peasants who remained on the land often had different reasons for doing so. These differences persist in the form of varying present day objectives, which are evident in their different styles of farming.

Table 5.15 shows the averages for each farming style in each community. Note that the averages in brackets should not be taken into account because they are based on figures that are derived from fewer than five farmers. This means that the averages for *Tradicionales* and *Experimentadores* in the different communities cannot be compared. The significant differences denote that *Arriesgados* in San Francisco tend to spend less money than those in Santa Martha and San Pedro; while in Santa Martha the *Arriesgados* have the lowest yields and benefits. This shows that the soil quality and conditions for potato production in San Francisco are better than they are in Santa Martha and in San Pedro. Another indicator of poor soil quality and conditions in those communities are the low yields and negative benefits for *Seguros*, where the averages are similar with low yields.

Table 5.15 also demonstrates that the practice of the same farming style produces significantly different results in different communities. These differences can be explained by the state of the natural resource base of each community, which in turn depends on the historical decisions of the community as a whole. This chapter and chapter Four show that the history of land acquisition and the relations that hacienda workers had with the hacienda owners influenced the quality of land to which hacienda workers had access. These differences shaped the perceptions about farming and how natural resources should be managed in each community. However, the presence of different farming styles besides the dominant one in each community shows that some farmers are able to build new networks.

Table 5.15. Differences in potato farming styles between and within communities

Community	Monetary expenses	Yield (kg/ha)	Benefit
San Francisco			
Tradicionales	[2701.20]	[41004.75]	[2842.80]
Seguros	[1026.15]	[12398.19]	[303.30]
Arriesgados	1554.33a	18294.52b	511.40b
Experimentadores	[1669.35]	[15020.39]	[893.40]
Mariscal			
Tradicionales	1927.13	15671.71	709.57
Seguros	[1796.82]	[13936.00]	[441.32]
Arriesgados	[2178.48]	[16556.12]	[-15.48]
Experimentadores	[2470.08]	[12700.59]	[-1150.08]
Santa Martha			
Tradicionales	[1532.33]	[14477.68]	[424.52]
Seguros	1642.14	12476.59	-280.08
Arriesgados	1870.59	9766.23a	-1056.29a
Experimentadores	[1995.94]	[30596.45]	[-6.06]
San Pedro			
Tradicionales	[1473.40]	[20623.33]	[1908.86]
Seguros	1450.97	12042.37	-40.28
Arriesgados	2220.03b	17320.93b	98.02b
Experimentadores	[1124.16]	[12095.80]	[-332.50]

*Differences are based on a comparison of the same cluster between communities (differences should be read by column). The letters **a** and **b** show that the differences are significant in the Tukey test of medias at the 0.05 level (for instance *Arriesgados* from San Francisco have significantly different monetary expenses from *Arriesgados* from San Pedro. The numbers between the brackets correspond to averages for less than five farmers and thus are not included in the comparison test.

Conclusions

Analysis and major findings

Building on the qualitative analysis of farming styles presented in Chapter Four, this chapter provides a quantitative study of the broader farming population of Carchi. Using potato fields as the unit for analyzing farmers' practices, I have identified patterns of practice that are consistent with the different farming styles discussed in earlier chapters. This has enabled me to isolate ten factors, which explain 72% of the variation.

I have then looked at four farming styles in the cluster analysis to compare these clusters with the farming styles described in Chapter Four. While I find similar patterns of practice, the introduction of additional information sheds light on the different ways in which the *wachu rozado* farming practices contribute to more sustainable farming since they are connected with the use of other sustainable practices, such as IPM, and more limited reliance on external fertilizer and pesticide inputs. Overall, I have found that the qualitative and quantitative analyses complement one another well.

W*achu rozado* and traditional farming practices as more sustainable farming

The *wachu rozado* planting system is an essential variable when analyzing farming styles of potato production in Carchi. In this study, important variables have been found to be significant when comparing this system with full tillage. Nevertheless, a low percentage of farmers in Carchi on the whole practised *wachu rozado*. This can be attributed to the fact that conditions conducive to this practice in the province are scarce. In addition, this system is not easily accommodated within the commercial framework promoted by the agrochemical companies, which involve technological packages that include full tillage. Farmers who practise *wachu rozado* tend to be *Tradicionales*, a group that produces higher yields and benefits from their fields than the other groups. *Tradicionales* consider "tradition" to be a heritage and forests to be an important resource for potato production, both essential components of *wachu rozado* practice.

The use of *wachu rozado* methods, as shown by this study, can be linked to better soil quality, which is indicated by high yields. Nevertheless, a decision to plant according to *wachu rozado* principles is influenced by long-term decisions that affect both the general environment of the farm and community resources. A decision to conserve a piece of *Interandean* forest in the past, for example, allows farmers to continue practising *wachu rozado* systematically, rather than in part and intermittently.

The intensive labour involved in *wachu rozado* farming potentially produces high yields and benefits. Better soil health and structure result when farmers prepare soil manually rather than mechanically. The use of manual soil preparation is not the only essential ingredient, however. This study shows that *wachu rozado* farmers need to combine specific patterns of practice in order to obtain high yields. The *wachu rozado* system provides more organic matter to the plants and better conditions for "clean" tuberization (potato tuber formation), not only in terms of mud-free and nicely coloured potatoes, but also because the potatoes seem to suffer less pest damage. As a result, the *wachu rozado* system of potato cultivation appears to increase the per unit return of labour.

Farmers achieve high yields when they follow "traditional" practices such as sharecropping and *wachu rozado*. This is most clearly demonstrated by the *Tradicionales* style of farming. When the use of "traditional" practices decreases, the level of resilience as well as yields, drop. The style of the *Arriesgados*, for example, shows that increasing externalization and input intensification does not combine well with mechanizing production. As a result, *Arriesgados* have the lowest yields and cost/benefit ratios of the four farming styles. The style of the *Tradicionales*, on the other hand, is indicative of various characteristics of sustainable farming. The specific combination of factors associated with farmers in this cluster shows that intensification of production is possible without total externalization or total commoditization of the farm production process. In this case, *wachu rozado*, seems to be a pre-condition for "modern" practices to be effective, since its practice results in the conservation of soil structure and fertility, whilst at the same time resulting in less favourable conditions for the development of most pests and diseases. A combination of *fine-tuning* of "modern" technologies such as agrochemicals and so-called traditional practices can, therefore, be very effective.

Both traditional and integrated ways of managing pests have been taken into account when designing integrated pest management (IPM) strategies. This means that the retention of practices such as reduced tillage and green manures is encouraged. IPM training is less effective in cases in which these practices are not in use.

<u>Different use of agrochemicals in different farming styles</u>

Pesticide and fertilizer *fine-tuning* is related to the capacity to apply them at the right times. This is best accomplished when farmers and their families continuously monitor the crop and apply agrochemicals when needed, rather than on a calendar basis. This is how *Tradicionales* operate. When farmers cut back on their own labour and contract labourers to apply pesticides and fertilizers, these inputs are not used efficiently, as is generally the case on *Arriesgados*' farms.

Experimentadores, especially, tend to apply too much pesticide because they often miscalculate the dosages of the cheapest (and unfortunately the most toxic) pesticides used in Carchi. This has the effect of increasing the relative cost of pesticide.

The climatic conditions of the area in which a field is located influence the kind of pests and diseases that will be present. Humid conditions promote late blight attacks, while dry conditions promote Andean weevil and *polilla* attacks. It should be remembered, though, that the historical development of different farming styles in different areas has influenced local climatic conditions. *Tradicionales*, for instance, have developed a style that promotes humid conditions and regulates them.

Fertilizer use and mechanization as indicators of low soil quality

The intensification of the use of soil *fertilizer*, combined with low scores for *yield and benefit*, is largely indicative of areas where the soils have been eroded and, as farmers would say, "the soils do not respond" to external inputs anymore. This is the case for *Arriesgados*, who also score high on *soil disinfections* and *mechanization*. *Mechanization*, in turn, is a measure of the intensity of soil erosion, since the way in which tractors are used in Carchi (in the direction of the slope, rather than across it) produces high per hectare erosion rates and results in a higher fertilizer demand for each successive production cycle.

Experimentadores' high use of *foliar fertilizer* as a substitute for expensive soil fertilizers shows that farmers in this group probably lack the capital needed for soil fertilizers. Thus the externalization of soil fertility for capital-poor farmers is achieved through input substitution –an expression of farmers' construction of their own modernity.

Market-oriented production is not related to entrepreneurship

Market-oriented production is not an indicator of the "entrepreneurship" of commercial farmers. The percentages of sold production have to be compared with the other end uses of the farmers' overall production. In this research, farmers who sold most of their produce were the *Experimentadores* and *Arriesgados*, each group doing so for different reasons. *Experimentadores* need money for most of their day-to-day requirements and usually sell all their produce. Although *Arriesgados* also produce for the market, they retain a small proportion of their produce for seed and for self-consumption. *Seguros* keep a larger percentage of their produce to use for *seed,* for self-consumption and for payments in kind. *Tradicionales* sell the lowest percentage of their potato crop, but their higher yields mean that the actual quantities of potatoes they sell are still relatively high. *Tradicionales* need to retain a lot of their own potatoes in order to feed themselves and their labourers. Even *Tradicionales* who sell large amounts of potatoes (but low amounts if expressed as percentages of their overall production) rely on autonomous potato seed production strategies, similar to those of *Seguros*.

Commoditization

Van der Ploeg (1990: 266) asserts that commodity relations "are related to farming freedom, to control over the labour process, and to the distribution of wealth." This section on commoditization argues that, in some farming styles in Carchi, "farming freedom" is related to a farmer's ability to distance himself, or herself, from the ties entailed by input and output markets (as in the case of *Seguros*) as well as their room to manoeuvre in both markets (as in the case of *Tradicionales*). Analysis of commoditized and non-commoditized inputs and factors of production reveals, moreover, that non-commoditized labour is important for all styles of farming, but in different degrees. This is because non-commoditized labour, in particular family labour on potato production, is not just a way of reducing financial expenditure. It is one of the means by which peasant farmers control the production process and its quality (expressed, for example, by an effective pest control strategy, good selection of seed or appropriate soil preparation and conservation), rather than just the present production cycle, in order to ensure the future of their farms. In the case of *Arriesgados*, once labour becomes a function of market and price relations, the quality of labour for future production cycles loses importance. Finally, the kind of labour and technology used in each style defines the level of its incorporation into the market (i.e., degree of production externalization). It also defines the patterns in which wealth created is distributed among actors and institutions outside the farm.

Contrary to the assumptions of modernization theory, the levels of commoditization shown in this research cannot be related directly to "prosperity" and "development." In fact, the opposite is true for the *Arriesgados*. It is also clear that high levels of non-commoditization do not automatically indicate a high degree of "backwardness." The opposite is found to be true for the *Experimentadores*. In this study, all the farming styles show important levels of non-commoditized costs, largely based on non-commoditized relationships. This is one of the main features of peasant farming in Carchi, though they are used in different ways and for different resources (labour, seed or services). One of the main reasons for farmers continuing to grow potatoes even after different crises (especially those resulting from dollarization and the imports of cheaper potato) has been the fact that peasant farmers are able to rely on non-commoditized relationships and have attained a degree of autonomy from the market.

Farming styles and national agricultural policies

The modernization of agriculture accompanied the development of the *Arriesgados* style of farming (i.e. production based on external inputs and machinery). The *Seguros'* traditional opposition to the hacienda system continues to influence their style of farming, which could be characterized by an aversion to most "modern" recommendations and a reliance on non-commoditized relations of production. The style of the *Tradicionales*, on the other hand, has developed as a combination of traditional and modern practices. Finally, the style of the *Experimentadores* shows that farmers who are resource-poor (as a result of the economic crisis and land fragmentation) are not necessarily subsistence farmers producing for their own consumption; they may well be producing for the market. These trends show that farmers have taken different paths through the modernization process, creating their own realities outside the "limits" of the "expert system" *en route*.

The community and its role in the development of farming styles

The differences between the communities studied are extremely significant. Most styles can be clearly differentiated by community. This can be explained by looking at the end result of the interaction between the landscape, the climate and the social conditions prevalent in each community. In each case, the climate and resource base have been modified as a result of the process of settlement, but the current situation in each community depends chiefly on past decisions regarding the continuation of traditional practices and the use of natural resources. Thus, the conditions for the development of a given farming style are not simply a result of the decisions of individual farmers, but are also influenced by those of the community as a whole, both now and in the past. Nevertheless, each of the four styles of farming can be found within each community, which also shows that farmers differentiate within their communities as well.

Chapter 6

Farming Styles and Pesticide Use

In the conditions of modernity, trust exists in the context of (a) the general awareness that human activity – including within this phrase the impact of technology upon the material world – is socially created, rather than given in the nature of things or by divine influence; (b) the vastly increased transformative scope of human action, brought about by the dynamic character of modern social institutions.

- Anthony Giddens (1990: 34)

This chapter continues to examine the patterns of pesticide use identified in Chapter Five, by describing pesticide use in the field and investigating farmers' perceptions of poisonings. Through participant observation and narrative analysis, I differentiate local practices and perceptions and explore their implications for farm production and family health.

Patterns of pesticide use

Chapter Five draws on quantitative analysis to compare farmers' patterns of pesticide use. Their practices differ in terms of the number of applications, the number of labour days employed in application and the type of pesticide used. I found a number of general differences between farming styles.

In terms of pesticide use, the *Tradicionales* differed significantly from the other three styles in three main ways: 1) They made the highest number of pesticide applications over the length of a potato crop cycle. On average they made 10.04 applications per cycle; 2) They applied the highest number of active ingredients (total number of active ingredients used in all applications was 55.08); 3) They applied the most organophosphorus compounds per hectare by weight (kg).

Seguros, *Arriesgados* and *Experimentadores* were similar to each other in terms of the number of applications made during the planting season (on average, 6.71, 6.15 and 5.50 respectively). The number of active ingredients used was also similar (33.39, 30.46 and 24.50 respectively). These sets of figures are significantly lower than for the *Tradicionales*. There was, however, no significant difference between the four styles in terms of the cost of pesticide as a percentage of the total cost. There was also no significant difference between the four styles in terms of the total weight (kg) of pesticide applied per hectare. *Arriesgados* employed significantly more labour days for pesticide application while *Experimentadores* applied more carbamate compounds in kg/ha than the other three groups.

In the following section I refer to notes from my observations while working with farmers applying pesticides in their fields. I use these observations to develop an understanding of different pesticide management practices.

Farmers' practices of pesticide use

The examples presented here are drawn from the case studies of families representing typical examples of particular farming styles:

> *Tradicionales:* the Cruz family from Mariscal
> *Seguros:* the Fuentes family from San Francisco
> *Arriesgados:* The Espin family from San Francisco, the Olivo family from Santa Martha and the López family from San Pedro
> *Experimentadores*: the Chávez family from San Pedro

Tradicionales apply pesticide according to observation

During a visit with the Cruz Family, I arrived in the late afternoon, as Glenda prepared dinner. She informed me that Norman was in the field:

> My old man (*mi viejo*) is still working. If you go across the river you will find him adoring his potatoes (laughter). He is with his cousin who is also obsessed (*temático*). If you find them, please bring them home.

I followed her directions to the field, but I did not find the men. I walked to another of Norman's fields. He and his cousin were there, wearing rubber pants and boots. Their pesticide pumps and plastic ponchos were on the ground. The field had been fully tilled a few days earlier. I noticed cardboard traps for the Andean weevil laid out on the perimeter of the field. The men were bending down, as if genuflecting, inspecting adult weevils that had been captured the night before. Norman explained:

> I don't use Furadan [the commercial name for carbofuran], but I have to control the *gusano blanco* [Andean weevil] with traps because if the potatoes have worms nobody wants to buy them. Even my wife doesn't want to use those potatoes. I learned about the traps from some engineers from INIAP. The problem with using Furadan is that we kill the *gusano blanco,* but we kill ourselves as well. When people buy potatoes, they can see the *gusano blanco,* but they don't see Furadan. Some farmers think that the only way to produce clean potatoes is by using Furadan, but those potatoes are actually dirtier than the ones that have *gusano blanco*. For my own health I prefer to use traps.

Norman's cousin said:

> The biggest problem here is pesticide. Furadan is the one that people apply the most. There are [Furadan] three and four. Four is the strongest. When I applied the first tank, it always made my lips numb (*amortiguados*). Now that we use these traps, I don't need to spray. One of my brothers continues to apply Furadan, and he always gets poisoned. Here people don't care (*la gente es confiada*). Furadan is applied to the soil during planting and then two or three times more. Other farmers apply it to the plant very copiously because they think that a good application is when the pesticide drips from the top of the plant to the ground.

I asked Norman why they had taken with them the backpack sprayers, to which he answered:

> We had to apply to the potatoes on my other field this afternoon because I noticed that there were some plants that already had [the symptoms of] *lancha* [late blight].

I asked Norman how much he would have to pay his cousin for applying pesticide for a few hours:

> My cousin and I help each other every time we have an emergency. You see that it is important to have family that we can trust; otherwise we would just lose the potatoes. Even if we had the money to pay labourers tomorrow, it would be too late.

I also asked Norman about the clothes they used for pesticide application:

> Here we use only rubber pants and plastic ponchos, as well as rubber boots. We don't use masks, only these scarves because the masks are very uncomfortable, the same with the gloves. We hope that we do not get too poisoned because we know that we are affected after many applications, so we try to apply only when it is needed. If we did not care for ourselves or for the labourers we would just apply according to the calendar. That is why it is important that we come to the field every time we can during the day so that we try to see if the disease is already present. For the agrochemical shops it is more useful if we don't observe our potatoes, otherwise how could they profit? Similarly, the [medical] doctor wants people to see him every month so that his business goes well.

On the following visit, I found a technician from an NGO talking to Norman about a number of sacks of a new potato variety that he had delivered. When the technician left, Norman commented:

> Here there are representatives from all the companies that are interested in selling us their products and they usually invite people for training. Even the Agriculture Ministry or INIAP now have extension workers who come here. Nevertheless, because they have a fixed salary they don't come as much as the

> pesticide sellers, but it's good that they come since they give us different information than the others. Before, the public organizations only worked for the big farmers. Now they come here to ask for a volunteer who lends his land to plant ten quintals of a new potato variety, but there are no farmers interested.

On another visit to the same field, I encountered three labourers applying pesticide in the potato field. I recognized one of them as Norman's nephew, Marco. I asked him if he often worked for Norman, and he replied:

> I usually come for the applications. Norman also comes to help in our [Marco's family] fields when needed. I came with them [the two labourers] because this field is large, and we want to finish the application today. Norman only pays them while I'm here on an exchange basis (*en mano vuelta*). Norman asked me because he has to go to Huaca and we always need somebody from the family to see that the application is done properly. Labourers sometimes care more about finishing the mixture than about the crop, but it is different when somebody from the family is present.

The following is a verbatim transcription of my observations from that visit:

It is 8:00 a.m. and the weather is cold and humid. Miguel, a labourer, is carrying water from a creek to fill a two hundred-litre tank. Manuel, the other labourer, is opening the pesticide bags. He wears rubber gloves and a scarf that covers his nose and mouth. This is one of the few times I have seen someone wearing gloves while handling pesticides, so I ask him if he always uses this equipment. Manuel replies:

> No, it is only here that don Norman has gloves. I only use them for preparing the mixture because gloves are very uncomfortable to wear the entire day; my hands get wet and numb (*se requeman*) because of the heat. For the application, we use only a hat and rubber boots, he [Norman] loans us a pair of rain jackets that he uses for this job.

Manuel mixes Curacron and Curathane (see table 6.1) in the tank. The men start applying the mixture at 8:30 a.m.; they each wear rubber boots, a raincoat, a hat and a scarf. Marco also wears a pair of gloves. At 9:00 a.m. Marco leaves the spray tank on one side of the field and washes his hands in the stream. When he returns, he offers the two labourers some wheat tortillas and coffee that are in a bag hanging from a tree next to the field. The two labourers take a few minutes to empty the tank and then head to the stream to wash their hands. While they are absent Marco comments:

> On one occasion, a labourer working in a field owned by my other uncle almost died without washing his hands after applying pesticides. This worker was his grandson, and as you might imagine, my uncle was very upset by this. Since then, we ask labourers to wash their hands before eating, but they only

do that when we are present. My uncle Norman also provides them with those jackets but they don't like them either. I understand why, because it is also uncomfortable for me, but at least we try.

Table 6.1. Pesticides applied to a potato crop by a *Tradicional* farmer

Pesticides	Active ingredient	Pests treated	Doses recommended	Doses applied	WHO toxicity class
Curacron P*	Profenofos	Epitrix spp.	0.8-1 l/ha	0.50 l/ 200 l tank	II Moderately hazardous
Curathane S*	Mancozeb & cymoxanil	Phytophtora infestans	2kg/ha or 500 gr/200 litres	1kg/ 200 l tank	III Slightly hazardous

* P= pesticide; S* systemic trans-laminar fungicide

After a few minutes rest, the labourers go back to work. It is hot at 11:30 a.m. and Manuel and Miguel remove their rain jackets. Manuel wears a sweater, but Miguel only a t-shirt. Marco keeps his jacket and gloves on. They finish the job at 12:45 p.m. and walk to the stream where they rinse their hair and wash their hands and faces. The men use a small pot to gather water for rinsing the pumps and throw the water onto the side of the path. They then take all the equipment back to Norman's house. The next day, I asked Norman about the pesticides used in the application:

> I mainly use two products at this stage (35 days after planting). I have my own technique: while the companies offer litres or kilograms per hectare, I only use dosages for each tank of 200 litres [of water]. If the plants are small, we use one or maximum two tanks per hectare like today. For pests, I use Curacron for the first application, chlorpirifos for the second, and Ambush for the third. This prevents the pests from getting resistant because the molecules are completely different.
>
> I control pests when I see a high number of flea beetles (*pulguillas or Epitrix spp.)* and the weather is warm like today. When there are no pests, I don't apply insecticides; other farmers, such as Pedro Alban, apply every eight days for a total of 16 applications, whether it is raining or not. Thus, he spends 4.500 dollars per hectare when it should be between 2.500 and 3.000 dollars. For late blight, I rotate Manzate with Clorothalonil. Since I don't like to use only one fungicide, I vary the cocktails [pesticide mixtures]. In the rainy season, I control late blight more often than most farmers. It's because here [in Mariscal] it rains almost every day after it has been sunny, creating conditions that promote fast fungal growth. Sometimes, if we see that the fungus is growing again, we have to apply one day after the other. For the control of late blight, observing the crop is more effective than applying by calendar.

Seguros apply on their own

The Fuentes did not apply pesticides very often, but I was present on a day when they did spray. This is a transcription from my notes:

At 6:30 a.m. I find Hugo in a room in the back of the house where he stores the pesticides and equipment. All the equipment is stored on a shelf in the same room that Fidelia uses to raise guinea pigs. Hugo takes down two spray pumps and some pesticide bags that he keeps in a plastic bucket. A few minutes later, Lirio (Hugo's son) arrives. It is starting to rain and he comments that it is not a suitable day for spraying pesticide. Hugo says that it is only a light rain (*una garúa*) and that it will stop by the time we get to the field. After eating some breakfast that Fidelia has prepared, we walk for 45 minutes up the hill. Hugo and Lirio carry a plastic tank on their backs, both wearing blue raincoats. I ask them if they wear the raincoats during application and Hugo explains:

We bought the set of protective equipment for 40 dollars from the people from INIAP. They sold it to us on credit for three months. It included a raincoat, rubber pants, gloves, goggles and a mask. There is no place in El Angel to buy all the equipment, especially masks. Other farmers said it was too expensive and that they have been spraying pesticides their whole lives so that they don't need it. I bought equipment because I'm convinced that I need to protect myself from poison. I was impressed by the slides they [INIAP extension workers] showed about how people become exposed. That's why we are using the Andean weevil traps (*la tramperia*) instead of using carbofuran. I ask Hugo if they have personally experienced the adverse effects of pesticide:

> We don't know if we are affected or not because pesticides can act over the long term. Many people believe that if they can endure pesticide applications without getting dizzy then they aren't affected; in my family, however, Carol and I both had skin problems. Once we heard that fungicides could affect the skin and cause allergic reactions, we started worrying and now prefer to use the equipment.

The rain stops before we arrive at the field. Hugo decides to work with the cattle while the foliage dries. At 9:40 a.m., after having some coffee, Lirio takes a two hundred litre plastic tank out of a small storage building close to the field. He explains that they don't store pesticides in this building because they might be stolen. Hugo prepares the pesticide mixture (see table 6.2) in the bucket with water from an open irrigation channel that runs through the field.

Table 6.2. Pesticides applied to a potato crop by a *Seguro* farmer

Pesticide	Active ingredient	Pest targetted	Recommended doses	Doses applied	WHO toxicity class
Eltra Is*	Carbosulfan	Foliar pests	2-3 l/ha or 1 l/200 l water	0.50 l/ha	II Moderately hazardous
Curzate S*	Mancozeb & cymoxanil	Phytophtora infestans	2kg/ha or 500 gr/200 l water	0.5 kg/ha	III Slightly hazardous
TrizimanD C*	Mancozeb	Phytophtora infestans	2-4 kg/ha	1 kg/ha	IV Unlikely to present an acute health hazard

Is* systemic insecticide; S* systemic trans-laminar fungicide, C* contact fungicide

Hugo and Lirio put on the plastic pants, gloves and masks, fill the pumps with the mixture and begin the application. The day is cloudy and cold (we are at about 3,000 meters above sea level). I wonder if the cold weather explains why both men make use of all the protective equipment, unlike most other farmers who complain that it gets too hot. I ask them if they wear the same equipment when it is sunny and Hugo replies:

> There are sunny days here but it usually doesn't get too hot; when it does, we take off the mask and use a scarf, and we only wear a t-shirt inside the raincoat. Once it gets hot, we take off the gloves and cover our hands with the raincoat sleeves. We do that because my hands itch due to an allergy and I know they need protection. We are a bit concerned with our health, as it is getting worse now.

I also ask Hugo about the products they use. I notice that two of them are fungicides that contain Mancozeb - one of the active ingredients recommended for controlling late blight. He explains:

> We usually apply pesticide up to eight times for late blight here. We apply Curzate because it cures the plant that is already infected. TrizimanD is preventive, used to make sure that the crop will be protected. We also apply Eltra against leaf insects and it also kills the adults of the *gusano blanco*. But as you see, we only apply the lowest dosage when the potato plants are small, using a tank of 200 litres/hectare. (End of transcription)

Application in *Arriesgados'* fields: the task of labourers and sharecroppers

The following are verbatim transcriptions from notes taken while observing pesticide application in the fields of two *Arriesgado* farmers:

Lucas Espin – San Francisco

At five in the morning, Lucas and two of his cousins collect the pesticide equipment in preparation for an application. The equipment includes three backpack sprayers and a plastic container that holds an assortment of opened pesticide bags. Lucas' wife, Elena, has already been working for half an hour in the kitchen, boiling water for tea and making bread for our breakfast in the field. A few minutes later we travel in Lucas' pick-up to the village of Juan Montalvo, in the valley one hour away from San Francisco. This valley has an almost tropical climate. Lucas has planted about four hectares of green peas here, sharecropping with his brother-in-law, Jaime.

We arrive at the two fields. The first was sprayed with pesticide the day before, and today they will make another application. About five percent of the plants are affected by a stem-borer insect (*Diatraea* sp.).Lucas explains:

> This is the third application. Because this area is warmer, green peas can be harvested in two and a half months and a "*bulto*" [about 150-pound sack] of young green pea pods sells for 48 dollars in the market. That's a lot better than potatoes!

Lucas' cousins, Marco and Victor, fill a 200 litre plastic tank with muddy water from the irrigation canal. They mix a variety of pesticides into the water and stir the solution with a wooden stick. After the first application, they fill another tank with the same ingredients, rinse the empty bags in the irrigation canal and throw them into the field.

The mixture contains five different products: two insecticides, two fungicides and one foliar fertilizer (Table 6.3). Both insecticides are applied to control the same insect pest (*Diatraea* sp.). The fungicide targets two different fungal diseases. One of the bags of fungicide (Zekudazin) had exceeded its expiration date five months ago.

Both labourers wear rubber boots, pants and sweaters. When the mixture in the first tank is finished, they remove their sweaters and continue with the second tank. They wear only t-shirts. They chat during the application and sometimes spray one another with pesticide by accident. Two and a half hours later, Luca's brother-in-law and the sharecropper, Jaime, bring us coffee and bread. Marco and Victor look tired. They put the backpacks on the ground, rinse their hands in the irrigation canal and sit down to eat next to the pesticide tank in the middle of the field which has just been sprayed. Their backs, hips and hands are dripping with both sweat and pesticide. The sun is now high in the sky and the smell of pesticide is intensifying. I ask the labourers if they have ever been poisoned by pesticide. Marco, who is 18 years old, replies hesitantly:

> Yes, when we apply strong products–those with a strong smell–such as Eltra, Curacron or Furadan, but mostly Curacron. These [the mixture they are applying] do not smell much, while the others cause headaches just from the

smell. But we only work for my uncle on the days he has work. Usually, we work on our own crops, where we mostly grow potatoes.

Table 6.3. Pesticides applied to a green pea crop by a *Arriesgado* farmer

Pesticides	Active ingredient	Pest treated	Recommended doses	Applied doses	WHO toxicity class
Alphacor Py*	Alphacipermetrin	Diatraea sp.	0.175-0.25 l/ha	-	II Moderately hazardous
Karate Py*	Lambdaciahalotrin	Diatraea sp.	200 ml/ha	200ml/200 litres	II Moderately hazardous
Zekudazin Fs*	Carbendazim	Botrytis sp.	60 g/100 litres	100g/100 litres	IV Unlikely to present an acute health hazard
Cosan F*	Sulphur	Oidio sp.	Max 400g/100 lt	500g/100 litres	IV Unlikely to present an acute health hazard
Kristalon **	Composed mixture	-	-	1Kg/200 litres	NA

P* pyrethroid pesticide; Fs* systemic fungicide, F* contact fungicide, ** Soluble composed fertilizer

I also ask if they use protective clothing when applying the "stronger" pesticides and whether the women who wash their work clothes ever experience problems from the chemicals. Victor, who is 24, replies:

> No, here it is not like that. It is not customary for us to use any special clothing to apply pesticides. We are accustomed to applying without protection ("*asi nomás*"). I am married, so my wife washes my work clothes, but my mother washes his clothes [referring to Victor].

While the labourers are applying the pesticide, Jaime directs water from the canal into the rows of peas. Wearing old clothes and a hat, he is largely indistinguishable from the labourers. In contrast, Lucas wears new clothes and hiking shoes. Jaime seems apprehensive when we discuss the pests that affect green peas. He explains:

> I had a field of green peas, which I sharecropped with a relative; it was about harvest time and a middleman came to buy the crop. He explained that the field needed pesticide applications, but my partner convinced me not to apply or sell to the buyer. A week later, we lost the entire crop because of this insect.
>
> Three years ago, we did not need to apply pesticides, but people said that a man who lives close to this place started first [to apply]. It seems that the worms came from the products, because after that, the pests have increased,

> and it is no longer possible to produce without applications. Now, we need to sharecrop with someone who knows about it [the pest].

I also ask Jaime about his sharecropping arrangement with Lucas:

> I sharecrop to help reduce my expenses. But I also produce with someone who knows what to apply and how. Otherwise, I may lose the crop and the investment. Lucas is the one who knows about pesticides, and he also brings the labourers from San Francisco, because they are cheaper than here. But, if you sharecrop, you have to agree up front, since it is not possible to change [later on].
>
> This year I took a loan of 800 dollars from the cooperative Mira, 400 for me and 400 for Lucas, since he is in debt with a bank and cannot take credit himself.

When the workers have finished applying the pesticide, we drive for ten minutes to a nearby field. Jaime rides his horse. Jaime has loaned Lucas this hillside field, and Lucas has planted a quarter of a hectare of potatoes here. Lucas says:

> These potatoes only have three applications, and look, they are really nice. This is new land. We just started to produce last year, and potatoes produce faster here because of the warmth. These potatoes will be for us [home consumption]. At the top of the hill, you can see the green peas that Jaime just lost because his sharecropper did not want to apply pesticides [talking loudly enough, so Jaime could hear]. Now, he has started to independently plant another field next to the old one.

There is no water close to the field, so Lucas goes to a river to fetch water in his truck. When he returns, the labourers mix the water with Metamidophos, a red label organophosphate insecticide.[128] The field is on a hillside and the smell of insecticide is very strong, so the labourers try to complete the application as fast as possible. They use the slope to their advantage, by spraying downhill so that the pesticide will be spread more effectively. After the application, Lucas takes us to a house close to the field. The labourers wash their hands in a water tank, and we share the tea and bread that Elena sent with us for breakfast. (End of transcription)

Some days later, Manolo, another of Lucas' sharecroppers, gave his opinion regarding Lucas' knowledge and use of pesticides:

> Lucas always applies a lot of [pesticide] products; take the green peas in Juan Montalvo, for example. The 11th and 12th of July when he invited me, he applied 240 dollars worth of pesticides. Then, three days later, he made

[128] The toxicity level of a pesticide is indicated by the colour of the label. A red label indicates the highest level of toxicity for human health.

> another application, and seven days later he applied again. He has spent a lot of money on that crop! You know he has some old products [pesticides] from a project when he was the president of the community committee and we had a pesticide supply shop. Because the coordinators in Quito closed the project, he kept all the pesticides in his house, and now he is using them. He also gave me some [pesticides] for free, and my potatoes are doing very well.
>
> It is not true that Lucas knows more about pesticides [like Jaime told me before]; he simply trusts the pesticides sales people, and I even have to help him. Sometimes he does not return those products that are already expired. Once, the shopkeeper wanted to sell us a product a year after the expiration date. He said that each year only one gram of the product gets lost, but the product was not cheaper, so I told Lucas to go to another shop. We learn by experience, and the "*Arriesgados*" tend to lose a lot of money before they win.

Andrés Olivo – Santa Martha

Carmen (23) frequently worked as a cook in Andrés' house. She told me:

> My family has worked for Don Andrés ever since we were children. The highest paid jobs are pesticide applications and carrying the potato quintals to the road. Here, a worker earns five dollars when normally [when not applying pesticides] it is four dollars a day. If the person brings his own spray pump he charges six dollars. To take the potato quintals out of the field—work that is very hard—a labourer earns seven or eight dollars a day. But the worst and most hazardous work is pesticide spraying (*fumigar*) because sometimes the poison gets on to the face. I used to apply pesticides and my shoulders swelled after carrying 30 litres the whole day. I complained to my husband that I did not do that job when I was single and then we decided that I shouldn't do it. Fortunately I never got poisoned. One of my neighbours works alongside her husband while spraying pesticides. I think their children are affected because they always get sick with infections and pneumonia.

The following is another verbatim transcription from my notes:

Today, we apply pesticide in two potato fields. Each field is about three hectares and is located within ten minute's walk of Andrés' house. One of the labourers is Miguel, Carmen's 17 year-old brother, and the other is Carlos, Andrés' 26 year old brother-in-law. They load two horses with large water tanks for the application. I ask Carlos if he is sharecropping with Andrés, and he replies:

> No, I do not have good luck producing with Andrés. We always lose money when sharecropping. I only work for him a few days each week.

On arrival at the first field, the labourers begin to prepare the mixture. Carlos mixes the pesticides in the plastic tank. His hands get wet, even though he uses a wooden stick to stir the mixture. Both labourers fill their backpacks with the pesticide mixture and start the application, spraying alternately with and against the wind as they move up and down the rows. The only protective clothing that they use are thin rubber boots. When the level of the pesticide mixture in the barrel gets low, they put their heads into it in order to reach down and scoop up the liquid with a two-litre container. They use this to fill their backpack sprayers. When the first barrel is empty, Miguel uses horses to fetch water from a stream close to the field. He uses the pesticide containers (about 250 ml each) for getting water. In the process, some of the residual remaining in the container inadvertently washes into the stream.

After the first field has been sprayed to their satisfaction, we go back to Andrés' house for breakfast. The labourers wash their hands in the *pila* (a cement water reservoir holding water that is used for laundry and other household needs, and also a source of drinking water for the domestic animals). After eating, we immediately proceed to the second field where there is a water reservoir. The mixture is prepared with water from this reservoir. The application is similar to that of the first field. The sun is now high so Miguel removes his jersey and performs the application wearing only a t-shirt.

During the process, Andrés' four-year old son and Carmen's five-year old son play in the same field. Around midday, Carmen brings lunch and the labourers sit on the ground next to their spray equipment. After lunch, Carmen washes the dishes in the same water reservoir from which the water for the pesticide mixture was taken. The application takes approximately eight hours for both fields. (End of verbatim notes).

It was my impression that labourers were willing to risk the dangers of spraying pesticide because the job paid more than other jobs. For Andrés, the main problem was not so much the health dangers as the powerful smell:

> For the [pesticide] applications the payment is better, but not everyone can endure the smell. Women and children are particularly weak. For instance, Carlos had to first grow accustomed, and now he can keep up with the other labourers

Andre had a total of about six hectares planted with potatoes of the Gabriela variety. The pesticide mixture he used contained one kg of Malathion (an organophosphate insecticide) and one kg of Curacron in 200 litres of water.

Marcial López' grandchildren

Farmers were often reluctant to talk freely about the issue of poisoning in their own families or communities. Children were less hesitant and were therefore an important source of information on the subject. The following narratives are children's accounts of pesticide poisoning.

Marcial López was an *Arriesgado* farmer. He had six grandsons, all under the age of seven. Five children gathered around the fire in the kitchen for this interview. Karina, Marcial's 15-year-old daughter, described pesticide poisonings in her community:

> When I was in sixth grade, one of my friends, a girl, went home and found an empty bag of pesticides. When she put water in the bag the water went white (*lechosa*), so she thought it was a powdered drink. Since she was thirsty, she drank it and later her parents found her dead. Then the teacher started to teach us about the danger of pesticides.
>
> Some months ago, a ten -year old boy in Tambo (an adjacent community) came back from school; his mother sent him to deliver lunch to his father, who was applying pesticides in the field. The boy returned home with an empty bag of pesticides. The remaining liquid in the bag was similar in colour to Coca-Cola and he was thirsty, so he drank it. When his mother found him, he was already dead."

When I asked if there had been poisonings in the family, she responded:

> Yes! When Federico (Marcial's grandson) was three years old, he was playing in the barn that was an old house. The day before my sister Nancy had left the backpack in the barn without washing it. Federico stayed in the barn for several hours, and when he came out he was pale, and then started to cry and salivate. I gave him milk and water, and we wanted him to vomit, so we gave him a piece of onion, but he did not respond. Then, my mother took him to the hospital, and he vomited on the way. The doctor said that he survived thanks to the milk, but Federico had to stay in the hospital for two days. When he came back, he did not talk much and appeared traumatized; he would cry if we touched him. He did not recognize anyone other than my mother [the child's grandmother].
>
> Because the doctor did not trust our judgment, he asked us to bring all the materials that were in the barn, so we brought him the pump, the empty bags and some pesticide bags that the hens used for laying eggs. The doctor figured out that Federico was playing with the pump and tasted the spray nozzle with his tongue. The other pesticide containers also had his fingerprints on them but were not opened, so he must have poisoned himself with the remaining liquid in the pump. Since then, we wash the backpack sprayers immediately after use and hang them in the back of the house. Also, we store the pesticide bags in the room of the guinea pigs and not in the barn.

Another girl interrupted to say:

> No, we still store the pesticides in the rafters of the house.

Marcial's nephew added:

> This is not true. You do not always wash the backpacks immediately. Just this week, Marco [a three –year old grandson] was in front of the backpack that still had some pressure and the pesticide was released. Since he did not understand [the danger], he stayed there and his face became completely saturated with the liquid. Then, my uncle Marcial came and washed him with water and asked him to rinse his mouth.
>
> Poisonings are very common. When I was 11 years old [two years earlier], we were applying Furadan with my brother on a field of Capiro [a potato variety]. I was applying at about the level of my head, since this variety grows very tall and I was shorter than the plants; a lot of product came in contact with my face and mouth. Then my brother became dizzy and I told him to continue, like a man. After applying on two more fields, he started to vomit, and my father sent him home to tell my mother to take him to the hospital. When we went to see him in the hospital, he had received two litres of serum. The doctor said not to let him sleep otherwise he would die. I was also dizzy, but it passed after some hours."

Karina continued:

> Once my sister Nancy [a potato farmer] became poisoned. She came home pale and said that she thought she was poisoned. I remembered what the engineers from the [agrochemical commercial] companies taught us, and then I put a lot of soap on her back and arms and told her to wash her face. She said she felt dizzy, and I helped her to vomit. After that, she got more accustomed to pesticides, and now she can produce a lot [of potatoes] like my father. The first time when I went with my father [Marcial] to help him to stir the mixture I got dizzy. Then, he sent me back home. I think I will never be tolerant to these chemicals because I still cannot endure the smell.

This family was the only one of those I studied that could directly relate stories about pesticide poisoning within the family. Most families said that they had not experienced serious poisoning, but the above narratives suggest that children from *Arriesgados*' families have more exposure to pesticides than those from families from other styles. Several factors contribute to this situation: 1) children who are not yet of school-age (younger than five) often go to the fields when labourers are making pesticide applications, or accompany the cook to the fields during meal times. This applies to both the *Arriesgados*' own children and to the children of the labourers who work for them. The children often play in the fields without adult supervision because the labourers are focused on the task at hand, and the owners of the fields are often absent. 2) Labourers are usually in charge of both handling and storing the application equipment and pesticides, but are not always conscientious or systematic when it came to rinsing equipment and storing it safely after use. They commonly leave empty pesticide bags in the field rather than burying or burning them. Open bags containing pesticides are sometimes stored in places that are easily accessible to children. Most labourers consider their work for the day to be over as soon as the application has been completed or do not have much time after the application to properly manage the packing away of equipment and chemicals.

Experimentadores apply high levels of carbofuran

I visited the Chávez family twice when they were applying pesticide. On the first occasion, Juan was spraying a very small potato field (590 m2) that he cultivated with his 17-year-old son, Javier. The following narratives are compiled from notes taken that day:

Juan was leaving for his field when I arrived at his home. He was not sure if I was interested in seeing the application, because his field was less than 1,000 square metres in size and the application would not take long. I assured him that I was indeed interested. While we walked to the field I asked him what he was going to apply that day. He showed me two small bottles that he had bought from a local pesticide outlet the day before. We walked to a river 100 meters from his field where he allowed me to measure the volume of the pesticides he was going to apply. One bottle contained 250ml of Furadan 4F and the other 80 ml of Mefisto (see Table 6.4).

Juan said that he had paid $4.60 for the Furadan and $1.80 for the Mefisto. He had paid an inflated price for both products. Furadan 4F normally cost $15 per litre and Mefisto six dollar per litre. Juan had paid the equivalent of $18.40 per litre for Furadan and $7.30 per litre for Mefisto. I asked him if he was aware of these price discrepancies:

> Yes we know that we pay more when buying in small quantities (*pites*) but we do not like to buy litres [touching his pocket, meaning he did not have money]. When we do not have cash we go to the shop and ask for some days of credit. The added expense is actually the interest we pay for taking things without paying at that moment. The pesticide shop works as a bank but that is what we have to do (*eso toca*) when we need to apply pesticides. Imagine if we would buy those expensive pesticides? They would be a fortune when bought on credit.

Table 6.4. Pesticides applied to a potato crop by a *Experimentador* farmer

Pesticide	Active ingredient	Pest treated	Recommended dosage	Dosage applied	WHO toxicity class
Furadan 4F	Carbofuran	Premnotrypes vorax	2 l/ha	4.24 l/ha	Ib highly hazardous
Mefisto	Metamidophos	Epitrix spp.	0.75-1 l/ha	1.36 l/ha	Ib highly hazardous

Juan mixed all the pesticide that he had purchased in a two hundred-litre tank. He topped up the mixture with water to a quarter of the tank's capacity. This was enough to fill three spray pumps. He used a wooden stick to stir the mixture. He finished the application in one hour, and we walked back to his house. Juan didn't rinse the pump because he said that by so doing he would "disinfect" the flowers around the house with small quantities of pesticide.

On my second visit to the Chávez family, Juan's wife Camila sent me to a field where Juan and Javier were applying pesticide with two other labourers. It was a sharecropped field and they were applying a mixture of pesticides provided by their sharecropping partner. They could not recall which products were in the mixture.

The Chávez family did not wear much protective clothing while applying pesticides, but they did take some precautions. In both applications that I witnessed, Juan and Javier wore rubber pants and used plastic bags to cover their backs. Juan explained:

> We do not have clothes other than these, because the equipment that the engineers recommend is too expensive. Also, one day I went to San Gabriel and did not find masks. Actually, I don't like to wear much clothing because during applications it gets very hot. I prefer this [make-shift] poncho [a plastic fertilizer bag]. I don't use gloves because they melt in the hands after a while!

I did not see children in the field during either application, but Juan mentioned that his nine-year-old daughter sometimes helped him to stir the mixture. He maintained that they had not experienced serious poisoning at any stage. Nevertheless, he had a rash on his hands and was allergic to certain plants, including grasses. Javier had a similar rash on his neck. They said that they did not know the cause of these symptoms[129].

[129] I explained to farmers that continuous contact with pesticides or fungicides can cause such allergies.

Experiementadores' application of carbofuran

I visited three other *Experimentadores* families, apart from the Chávez family, to find out more about their use of carbofuran. All the families cultivated small areas of land.

As explained in chapters Four and Five, farmers cultivating fields smaller than a hectare often miscalculate pesticide dosages. This is because the pesticide preparation instructions are given on a per hectare basis. Most farmers with large fields mix one litre of carbofuran in 200 litres of water, to be applied to one hectare. This is the rough equivalent of "ten spraying pumps." This practice ignores the specific recommendations for different formulations of the same active ingredient (carbofuran) (see Table 6.5).

Table 6.5. Data on the commercial products containing carbofuran in Carchi, 2004

Commercial product	Active ingredient	Concen-tration	Formu-lation	Unit	Qty sold	Price USD*	Rec. dosage	Packaging
Carbofuran	carbofuran	480g/l	Liquid	litre	1	14.60	1 lt/ha	1 kg, 25 kg
Curaterr	carbofuran	330g/l	SC**	litre	0.5	7.70	2.6-4 l/ha	1lt, 500ml
Furadan 3F	carbofuran	360g/l	SC	litre	0.25	3.75	2.5-3 l/ha y 8 l/ha	1lt, 250ml, 500ml
Furadan 4F	carbofuran	480g/l	SC	litre	1	15.00	2 l/ha y 5.8-6 l/ha	1lt, 250ml, 500ml

* Price according to a list supplied by outlets in main towns. The retail price varies according to payment arrangements and place of purchase. Prices increase dramatically (almost double in certain cases) when the products are purchased either on credit or from the community's local shops. ** Soluble concentrate.
Source: Vademecum 2004 and personal research in shops during 2003 and 2004.

Experimentadores have to make calculations for the preparation of specific pesticides on the basis of fractions of basic units of measure. This means that they have to take the confusing differences between commercial carbofuran formulations into account. The complexity of such calculations leads to deviations from the recommended concentrations and application rates. I observed some farmers calculating the dosage for fields of half a hectare and less. The concentration of the pesticides that they mixed was half of what it should have been according to the recommended preparation procedures. I also observed them using a full litre on fields only slightly larger than half a hectare. Such simple miscalculations can lead to the application of large dosages (average 3.46 kg a.i. /ha, or three times the recommended level) of dangerous carbamates. These farmers not only pay more for carbofuran in small containers than they would in standard, one-litre containers, but often apply more of the product per area than necessary. A 1 litre bottle costs around $15 from an outlet in the area, but the same amount purchased in smaller increments costs more than $17. The cumulative consequences of higher than necessary concentrations, application rates and costs all contribute to the general problem that pesticide use has created among *Experimentadores*.

<u>Reports of poisonings at a public hospital</u>

The public hospital in the municipality of El Angel serves three other municipalities and coordinates its activities with three rural community health centres (Ibarra 2005). I visited the hospital to collect data regarding pesticide poisoning in 2007. The head nurse said that there had been three hospitalizations in January 2008 alone. This was a much higher number than normal. She explained:

> Patients with pesticide poisoning come here but not very frequently. In 2007, this hospital and all the health centres of this jurisdiction received a total of nine visits due to pesticides. But you should be aware that this only represents people who were feeling very bad and went to the hospital or health centre as a last resort.

As the nurse indicates, data collected from hospitals and public health centres in El Angel under-represent the actual number of poisonings because they exclude the many cases in which people treat themselves at home and do not report a case of poisoning. This is confirmed by the International Potato Centre (CIP), which combines cross-sectional survey data with the active surveillance of a farm population. They have found that the hospitalization figures represent only 10% of the total number of poisoning cases (Mera-Orcés *et al.* in Yanggen *et al.* 2003a).

Table 6.6 shows hospital and health centre visits due to pesticide poisoning in 2007. Three of the nine cases were intentional (suicide attempts).[130] The remainder were work-related.

---

[130] Bertolote *et al.* (2006) found that access to acutely toxic pesticides in rural communities is associated with high suicide rates.

Table 6.6. Visits for pesticide poisoning to the public hospital and health centres in El Angel, 2007

Health centre	Age of the patient	Sex of the patient	State of poisoning	Pesticide	Way of poisoning
El Tambo	21	Male	Moderate (headache)	Lorsban	Applying to field of beans
Mira	24	Male	Moderate	Furadan	Working
Mira	Unknown	Male	Light	Furadan	Working
El Angel	36	Male	Moderate (vomiting, cramps, weakness, dizziness and headache)	Fungicides	Applying in flower plantation
El Angel	35	Female	Slight	Unknown	Applying in flower plantation
El Angel	60	Female	Slight	Ranger	Intentional
El Angel	33	Female	Severe	Malathion	Intentional
Concepción	26	Male	Severe (difficulty breathing)	Racumin	Accidental
Concepción	53	Male	Severe (disorientation, lack of coordination and difficulty breathing)	Rector	Intentional

Source: modified by the author from El Angel public hospital registries

Farmers' perceptions of pesticide use and poisoning

This section summarizes farmers' responses to five standard questions related to pesticide use and poisoning. I conducted an open-ended interview with four labourers and 16 farmers, including one farmer representing each farming style.

The interview process was flexible and I encouraged the farmers to speak freely. In doing so they sometimes inadvertently answered questions which had not yet been put to them. In some cases, farmers' wives and their friends joined in the conversation, and I documented their comments as well. Answers were selected to represent each farming style.

Question one. What are the most dangerous jobs in terms of human health in potato production?

This question was asked in order to determine the degree to which farmers considered pesticide spraying a potential risk for human health (Box 6.1). All the farmers and labourers whom I interviewed thought that pesticide spraying was the most dangerous job in potato production. All the farmers, regardless of farming style, referred to pesticides as “toxins” (*venenos*) and “remedies” (*remedios*) interchangeably during our conversations. Some referred generally to all types of pesticides as “fungicides” (*fungicidas*) or “chemicals” (*químicos*). One *Arriesgado* farmer said that “everything can be dangerous” and an *Experimentador* said that “there are no dangerous jobs.” Nonetheless, both mentioned that they were especially careful with pesticide applications. A *Seguro* farmer argued that spraying pesticide on potatoes was less dangerous than spraying it in a green house.

Box 6.1. Examples of farmers’ answers to question one

Question one. What are the most dangerous jobs in terms of human health in potato production?

***Tradicional* farmer**

> Pesticide applications, because those remedies [pesticides] are very strong. The healthiest person can get sick when he has to mix the poisons. If the person does not get dizzy, at the very least he sneezes when the toxic containers are opened.

***Arriesgado* farmer**

> Everything can be dangerous. Even the use of oxen can be dangerous if the person does not know how to handle them. My least favourite job is applying pesticides to potatoes, so I try to be careful or I pay other people. It’s true that other people have more contact with the pesticide than I do, but now in this crisis any job is welcome (*es una limosna*).

***Seguro* farmer**

> Pesticide applications are dangerous. But at least here we apply in open fields (*al aire libre*), unlike in the green houses where the environment is closed.

***Experimentador* farmer**

> Here there are no dangerous jobs, while in the city one of my granddaughters had a car accident going to work. Only people who apply the remedies [pesticides] are the ones who have problems because those products are toxic.

Labourer

> Only pesticide applications are dangerous.

<u>Question two. Who are most likely to get poisoned by pesticides?</u>

Studies carried out by the International Potato Centre in 2003 (Yanggen *et al.* 2003a) concluded that:

> Among farmers there was the generalized belief that repetitive exposure brought about resistance to pesticides. The capacity to endure nausea and other immediate effects of pesticide intoxications, in general, were associated with physical strength and manhood.(Translated by the author from Yanggen *et al.* 2003a)

Question two was used to gather spontaneous opinions from farmers and labourers regarding their perceptions of people's "resistance" or "weakness" to chronic exposure to pesticide toxins. When analyzing the responses, I took into account the gender, age, and socio-economic status of the interviewee. Most labourers and farmers, regardless of farming style, agreed that people who drank alcohol were more likely to be affected by pesticides. Nevertheless, there were some differences of opinion between and within groups. As documented in Box 6.2, many *Tradicionales* thought that people who did not know how to calculate pesticide dosages accurately, or people who did not apply safety measures after application, were more likely to be poisoned. A *Tradicional* farmer said that men were more likely to be affected because they were the ones who applied pesticide. One woman said that women who stood near the men when they were spraying were likely to get poisoned.

Box 6.2. Examples of *Tradicionales'* answers to question two

Question two. Who are most likely to get poisoned by pesticides?

1. The people who put too much pesticide [higher than recommended amount] in the tank and the ones who apply red label products are the most affected. When just passing close to a field that is being applied with such products, it stinks horribly. Whether a person is healthy or not, it is always possible to get poisoned with pesticides if the person does not know how to handle them.

2. We [men] are more likely to be affected because we come to eat lunch at home and don't change our clothes. Even if we only wash our hands, the pesticide stays on the spoon and the plate.

3. Pesticide poisonings do not depend as much on food as they do on the care of the worker, especially when handling red label pesticides. When we finish spraying it is necessary to get a shower immediately with lots of soap because here we do not use masks.

Woman from a *Tradicional* family

Women who aren't careful are more likely to be poisoned. They take lunch for the labourers and stand next to containers full of pesticides.

Seguros stress that people who do not use protective clothing during applications are most likely to get poisoned (see Box 6.3). One *Seguro* farmer referred to other farmers who felt that they were "resistant" because they did not get "dizzy" during applications. He said that their confidence was misplaced because the symptoms appeared some time after the exposure and were not restricted to dizziness. It appears that many people do not use protective clothing because they only associated pesticide poisoning with "dizziness," rather than with more delayed symptoms such as allergies, headaches, fatigue and the loss of tactile sensation.

Box 6.3. Examples of *Seguros*' answers to question two

Question two. Who are most likely to get poisoned by pesticides?

1. They say that there are stronger and weaker people but I don't know a family here in which someone has not been poisoned. Some may say they have not been poisoned, but they don't know what goes on inside their bodies. Only if we see a person dying do we know for sure whether a person has been poisoned, although we hear a lot of people complaining everyday about headaches or dizziness. When one is not feeling very bad it is difficult to know if they have been poisoned. For instance, pesticides damage our health more when applied on a very sunny day, but the pains come days later; therefore most people do not think these pains are due to pesticides and consequently do not use protective clothing. Once I applied two and a half tanks without protection on a sunny day. I got dizzy, experienced loss of vision (*se obscureció la vista)*, and my legs got weak. That is because the skin absorbs the pesticides (through the pores).

2. Sometimes poisoning happens to people who don't use protection because the pesticide comes in contact with the skin and parts [of the body] that are very weak, such as the eyes. People who have been drinking alcohol are more likely to become ill because their blood and brain are not healthy. Also, smokers are affected more easily because the smoke does not let them breath normally when applying pesticides.

3. Pesticides affect those who are weakened by previous exposure; so if we aren't poisoned our body gets stronger.

Woman from a *Seguro* family

Pesticides affect people who don't apply with [protective] equipment and even with protection. Some workers are more likely to get poisoned. In my family, my brothers are the weakest because they apply all the time. A neighbour of mine says that by just washing clothes [that have been used on pesticide applications] she gets dizzy in her head (*le chuma la cabeza*). We don't get dizzy because my brother washes those clothes in the river before coming home.

One *Seguro* told me that people who had been previously affected were more likely to be affected again, because their bodies had grown weak from long-term exposure. A woman agreed with this, saying that her brothers were weaker because "they are the ones who apply [pesticides] all the time." These opinions are contrary to the findings of the CIP studies, which conclude that it is commonly believed by peasant farmers that "repetitive exposure brought about resistance to pesticides" (Yanggen *et al.* 2003a). *Seguros* stress that other factors are likely to influence the frequency and degree of poisoning. These include spraying on hot days (when protective clothing is less likely to be worn), drinking alcohol, smoking, or washing clothes that have been worn during pesticide application.

Most *Arriesgados* feel that people who are already physically weak due to factors such as high cholesterol, obesity, poor nutrition or physically debilitating work are most likely to be affected. They say that children under the age of five are very susceptible to poisoning as are "ill-treated women" and those people who are psychologically ill and obsessed with the idea that they are going to be poisoned. Drunkenness is also seen as a condition likely to increase the chance of being poisoned. As suggested by the CIP study (Yanggen *et al.* 2003a), many *Arriesgados* maintain that continuous exposure to pesticides during applications can make a person tolerant to the chemicals. The truth of this was evident, my informants told me, in that those who "are not used to spraying pesticides," such as women, are more likely to get "dizzy." One woman stressed that nutrition was important to help resist the ill-effects of pesticide exposure. She mentioned various foods that could help build resistance (Box 6.4).

Box 6.4. Examples of *Arriesgados'* answers to question two

Question two. Who are most likely to get poisoned by pesticides?

1. Maybe those people [who get poisoned] are overweight or have high cholesterol. It doesn't matter if a person is young or old, since some are resistant and others are not. Only after a person applies, we can determine whether he is resistant to chemicals or not.

Here we call those resistant people "well fed" (*bien comidos*) because their degree of poisoning is dependent on their nutritional history. I experienced that because I had a tumour and needed chemotherapy. I didn't lose my sight and my bones weren't sore (*dolor de huesos*); on the contrary, I got very hungry. An engineer told me that people who resist chemotherapy also resist the chemicals [pesticides].

2. People who look healthy and become dizzy are those who are not accustomed to spraying pesticides. Or, they don't like the type of work they are doing and decide to go home when they feel bad.

3. The pesticides affect women and children below the age of five because they are not used to this job. When older, they are not as affected as much. If the women are treated well [when growing up] then the pesticides do not affect them. People who have been drinking [alcohol] are more vulnerable because the pesticides go to their blood faster, since the pores of their skin are open.

Women from *Arriesgado* families

1. The smell of pesticides affects those who are less healthy. People who do not eat well or do not eat at all get poisoned faster. Sometimes, they faint just because of the bad smell when the remedies are too strong. People are resistant when they eat better. For instance, fruit and vegetables are better than potatoes and pasta. The resistant people eat cheese and drink juice instead of colas.

2. I think that a person can get psychologically sick and after he becomes sick, he believes "I am going to get poisoned." Other people, however, don't think like that and are less affected. For instance, I may get dizzy when I travel by car but if I ignore it, nothing happens to me.

Experimentadores believe that anyone who handles pesticides is likely to be poisoned because the products contain "toxins" that produce symptoms such as allergies. They also believe, however, that there are certain habits and conditions that make poisoning more likely. These include using particularly toxic pesticides (like Furadan and Curacron), drunkenness and smoking. An *Experimentador* farmer and his wife told me that men were more resistant to pesticides than women because they were accustomed to the job, implying that continuous exposure made men more resistant (Box 6.5).

Box 6.5. Examples of *Experimentadores'* answers to question two

Question two. Who are most likely to get poisoned by pesticides?

1. When applying pesticides, fat, underweight and even healthy people can be poisoned because they all touch the chemicals. Here the work with potatoes is hard and even though we all have allergies on the skin, we have to keep working. Of course, we [men] are more resistant than women as we are the ones who come in contact with the chemicals and women don't have to apply them.

2. Many times, it [pesticide poisonings] depends on the insecticides. I got intoxicated with Furadan and Curacron but I had to apply them whether I wanted to or not (*si o si*) because my family was big and I had to help.

3. Pesticide poisonings happen when people spray pesticides while they are drunk; they could even die. The ones who have been drinking alcohol are affected more rapidly (*rapidito*) because of carelessness when handling products: they splash pesticides on their skin and rarely wear protective gear allowing products to enter through their eyes, nose, mouth, and even their ears. The same happens when people smoke during applications, but alcohol is worse.

Woman from an *Experimentador* family

> It doesn't matter if a person looks healthy; any person can get poisoned. Men are more tolerant than women because they [men] are more accustomed. It is rare to see women applying pesticides; people here are very surprised to see women working with potatoes and handling pesticides.

Box 6.6 presents examples of labourer's opinions. Labourers felt that people who were overweight or elderly were more likely to be strongly affected by pesticides, as were workers who smoked while spraying and those who drank alcohol before spraying. Many respondents also said that men in general, and male labourers in particular, were more likely to be effected than women because they were in closer contact with pesticides.

Box 6.6. Examples of labourers' answers to question two

Question two. Who are most likely to get poisoned by pesticides?

> 1. Pesticides affect overweight people more than thin ones. They also affect older people more than the young; when I was young I had more energy. The pesticides also affect more men than women because men are the ones who apply them and usually become fatigued.
>
> 2. People that have been drinking alcohol are poisoned more easily because their bodies are weaker. If I apply pesticide after drinking alcohol, I turn purple; in that case, I must apply with a mask. Alcohol is also a poison and the body cannot deal with both at once.
>
> 3. The labourers are more likely to be affected because they are in closer contact with pesticides. The only person who is not poisoned by pesticides is the owner of the land, the patron. He just stands there watching the labourers that could be dying. We are labourers and the patrons tell us what to do. We have to apply the poison whether it is good or bad. I was poisoned once: I vomited, had diarrhoea, a stomachache and my head ached. I felt like I was going to die. Since I didn't want people to know that I was sick, I walked straight, but if somebody asked me how I felt, I could not hide that I was sick.

Woman from a labouring family

> 1. People who smoke are more vulnerable to pesticides. My husband smokes two packs a week and he usually gets sick after applying pesticides. I think he takes more pesticides into his mouth when he smokes.

<u>Question three. If a labourer is poisoned, who is responsible and where do people go for medical treatment?</u>

The CIP studies (Yanggen *et al.* 2003a) conclude that the cost of a typical poisoning (medical attention, medicines, and work days missed for recuperation) is financially equivalent to that of 11 working days.

Question three investigates where medical treatment for poisoning is sourced, how patients obtain treatment and who pays for it.

All farmers agree that the owner of the potato field (either the landowner or the sharecropper) where the affected labourer has been exposed to pesticides is the responsible party. *Seguros* and *Experimentadores* say that they were usually responsible for themselves if poisoned because they mostly spray pesticides in their own fields. *Tradicionales* and *Arriesgados* say that they accept responsibility for their labourers' health if the poisoning occurs in their fields. Labourers, however, insist that they often have to treat themselves and pay for their own medical attention because the symptoms of poisoning often appear only after they have returned home.

Box 6.7. Examples of farmers' answers to question three

Question three. If a labourer is poisoned, who is responsible and where do people go for medical treatment?

Tradicional farmer

The owner of the potatoes has to provide care. If I contract a labourer and he is poisoned, I would take him in a car to San Gabriel or Tulcan and perhaps we would share the costs, but I wouldn't let that person go without treatment. In some cases, if the poisoning is not serious, we would go to the local health sub-centre. Some of us have Peasant Health Insurance (*Seguro Campesino*) so we go to the social security clinic here in Mariscal.

Seguro farmer

If a labourer shows signs of poisoning after work, it is the duty of the family to take care of him. We usually pay the expenses ourselves because we get sick working in our own fields. We go to the pharmacy (*botica*) and tell the sales person what is happening to us; they give us a remedy and the problem goes away. We go to the hospital only if it is serious.

***Arriesgado* farmer**

We say, Go and take milk with water. If it is more serious, then we take the labourer to the doctor, but this hasn't happened to me yet. Once my brother-in-law was poisoned, and his family took him to the hospital in San Gabriel. In Cuba there is a sub-centre, but the doctor only works there three days a week.

***Experimentador* farmer**

Here, the farmer normally sprays himself because the fields are ours. When we are sick we go to a pharmacy and the sales person give us some pills for the liver or something like that.

Labourer

The employers (*patrones*) are the ones who bring the remedies [pesticides] and send the labourers to apply them. The employer should pay for the treatment; the labourers can

> hardly do anything. When a labourer gets sick in the field, the owner of the crop has to pay, but usually, it is we [labourers] who get sick later when we are back home, so we pay for the treatment ourselves.
>
> In my family, we have Peasant Health Insurance. There is a medical centre in San Francisco, but not many people go there because the doctors are there only on Tuesdays and Thursdays. So we go to the hospital in El Angel.

All farmers agree that the first course of action is to go to a pharmacy for advice or use local medicines to treat themselves. They would only resort to going to hospital if the symptoms seemed serious. This explains why the figures for hospitalization are so much lower than those compiled by means of cross-sectional surveys (Yanggen *et al.* 2003).

Most farmers say that community medical clinics (sub-centres) are not good places to get treatment for serious poisoning. They are not well equipped and doctors are only there at certain hours on specific days. They go directly to the closest hospital in one of the large towns if the case appears to be life-threatening.

Question four. How do you know that a pesticide is toxic and how do pesticides enter the body?

The CIP studies (Yanggen *et al.* 2003a) found that:

> Despite a literacy index of approximately 90%, more than 70% of men and 80% of women did not understand the pesticide industry system of pesticide labelling with colours for the toxicity levels of the products (translated from Yanggen *et al.* 2003a).

Question four looks at the ways in which farmers identify toxic pesticides and examines their perceptions of how pesticides enter the human body.

Some examples of the interviewees' responses are presented in Box 6.8. It is clear that the opinions of farmers from all the farming styles are very similar with regard to this question. *Tradicionales*, however, commonly have greater understanding on toxicity and poisoning.

Box 6.8. Examples of farmers' answers to question four

Question four. How do you know that a pesticide is toxic and how do pesticides enter the body?

Tradicional farmer

> From the label. Furadan and Eltra are category I. Each label represents a level of toxicity. In order to be poisoned with green or blue label pesticides, which are not very toxic, a person needs to ingest more of the pesticide than those with a red label.

> The pesticide enters principally through the skin and mainly the hands, because there are more pores there. It also enters through the penis because that part is weaker and the pesticide is absorbed, so we get sick. When people cannot read they only smell. For instance, farmers apply more Furadan than Curacron because Furadan does not smell so bad, but Furadan is more toxic. We know that the smell is not a good sign of how toxic a pesticide is.

Other farmers' answers

> The red label pesticides are the strongest, but all pesticides are toxic and affect people's health. There are different types of pesticides and they have different properties. One way to know them is through the colours [of the label].
>
> The pesticide enters our body through the pores in the skin, something we learned in a television program about the people from Huaca. Before I saw that program, I used to mix Manzate with my hand because I thought that using a little bit was not dangerous.
>
> I buy the pesticides in Colombia, and when we go to the [pesticide] shop they [the pesticide sellers] tell me which pesticide is more toxic. When there is a skull and cross bones and a warning that says, it should be put out of the reach of children, it means that the chemical is very dangerous. Also the smell of poison is strong and travels far in the wind. Pesticides mainly enter through the nose and skin.
>
> It can be seen on the pesticide label. We learned that the red label means that the product is extremely toxic. We always thought that it was the smell that told us if the pesticide was strong such as Curacron, but we've learned that there are others that are not stinky and still are highly toxic. For instance Furadan and Monitor commonly cause poisoning. The pesticide enters through the nose, but the workers also absorb the chemicals through the mouth.
>
> If it stinks and it is liquid, it is toxic. One immediately recognizes a pesticide from its smell. People here say that a pesticide is toxic when the smell is strong. It enters the body through the nose and the mouth.

All farmers and labourers say that they identify the level of toxicity of a pesticide by means of the colour of the label. All know that red label pesticides are the most dangerous. Many use a product's smell as an additional indicator of toxicity. A product is thought to be highly toxic if it has a strong, unpleasant odour. This belief, however, was not commonly held by the *Tradicionales*, all of which argued that smell had nothing to do with toxicity.

All the farmers and labourers who took part in the interview believe that pesticides enter the body primarily through the nose, presumably because the intensity of the smell is of diagnostic significance to them. All mention other potential routes of entry, such as the mouth, eyes, ears and hands. Only two *Tradicionales* agree with the CIP researchers (Espinosa 2000; Yanggen *et al.* 2003a) that skin is the main pathway through which pesticides enter the body.

Question five. Have your animals ever suffered from pesticide poisoning?

It wasn't easy for farmers to talk about pesticide poisoning that had occurred within their own households, but they were less reluctant talk about cases affecting their animals. Box 6.9 shows that all the farmers and labourers interviewed had first-hand experience of their animals being poisoned. The farmers said that there was a wide range of products involved in accidental poisonings, but that Furadan was the product most commonly used for intentional poisoning, such as someone poisoning their neighbour's dog. It was "the most lethal pesticide in town."

Box 6.9. Examples of farmers' answers to question five

Question five. Have your animals ever suffered from pesticide poisoning?

> My dogs were poisoned. People here give pesticides to the dogs. That is why it is good to make dogs smell the pesticide, so that they can recognize it and don't eat it. The most common pesticides used [to kill dogs] are the liquids like Furadan; whereas others are not as toxic.
>
> Once, one of my bulls went down this hill and ate Cosan because it looks like salt, but he didn't die. On another occasion, a neighbour allowed his oxen to drink water from a tank with Furadan and one of them died. A neighbour's cow was poisoned, but he didn't know how. Then he cleaned the guts and gave it to a dog. Then, he tried cooking it and gave it to the dog again. Nothing happened to the dog, so he also ate the meat. It didn't bother him either, so he began to sell the meat. One of his neighbours, however, knew about the incident and told others, so he was only able to sell 50 pounds.
>
> Yes, some people here spray the [stored] grains with Furadan to protect them from the rats. Then the rats spread the poisoned grains that chickens find and eat, and then die, something that once happened to my mother's chicken.
>
> Once my chicken died when we applied in the *retape* [second application and fertilization at the same time]. It was because the chicken ate the dead bugs (*moscos*).
>
> One of my neighbours lost her cow, and she didn't know what happened but found a plastic pesticide bag after opening the guts.
>
> One of my brother's cows died because it went to the potato field that had just been sprayed. Also a young bull (*novillo*) belonging to my sister died that way.

Relating highly toxic pesticides to specific farming styles

Carbamates: The extensive use of a highly toxic pesticide

Table 6.7 shows that Carbamate is more popular than other highly toxic pesticides (246 out of 360 applications of category Ib pesticides in this study). Table 6.8 shows that carbofuran (a carbamate) is the most commonly applied pesticide and one of the most toxic pesticides used in Carchi, due to both its chemical composition and the high exposure potential associated with its liquid formulation.

Table 6.7. Number of applications in one crop cycle, according to toxicity (n=94 fields)

Different pesticide chemical compounds or types	WHO toxicity category of the active ingredients					Number of applications
	Ib	II	III	IV	ND	Total
Bipyridylium derivative		1				1
Carbamate	246	177		1		424
Cooper compound		15	27			42
Organochlorine compound		11				11
Organophosphorus compound	113	306	36			455
Organotin compound		22		31		53
Pyrethroid	1	189				190
Thiocarbamate				1243		1243
Dicarboximida				2		2
Cymoxanil			579			579
Other		23	57	449	1	530
Total	360	744	699	1726	1	3530

Ib = highly hazardous , II = Moderately hazardous, III = Slightly hazardous, IV = Unlikely to present an acute health hazard, ND = not determined in the WHO table.

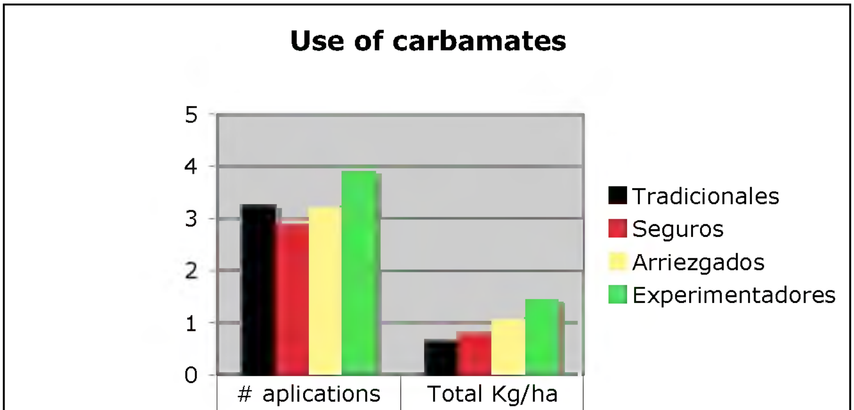
Table 6.8. Number of applications of carbamates in one crop cycle, according to toxicity (n=94 fields)

Active ingredients classified as carbamates	WHO toxicity category of the active ingredients					
	Ib	II	III	IV	ND	Total
Carbaril		1				
Carbofuran	226					
Carbosulfan		176				
Methomyl	20					
Propamocarb					1	
Totals	246	177		1		424

Ib = highly hazardous, II = Moderately hazardous, III = Slightly hazardous, IV = Unlikely to present an acute health hazard, ND = not determined in the WHO table.

Figure 6.1 shows the patterns of carbamate use, differentiated by farming style. The number of carbamate applications made by most farmers is similar, with *Seguros* making the lowest number and *Experimentadores* the highest. The quantities of this compound applied per hectare, however, are disaggregated across the four dominant farming styles in order to reflect nuances in local practice. It is shown, for example, that *Tradicionales* apply the lowest quantities of active ingredients and that *Experimentadores* apply the highest quantities.

Figure 6.1. Use of carbamate compounds according to farming styles



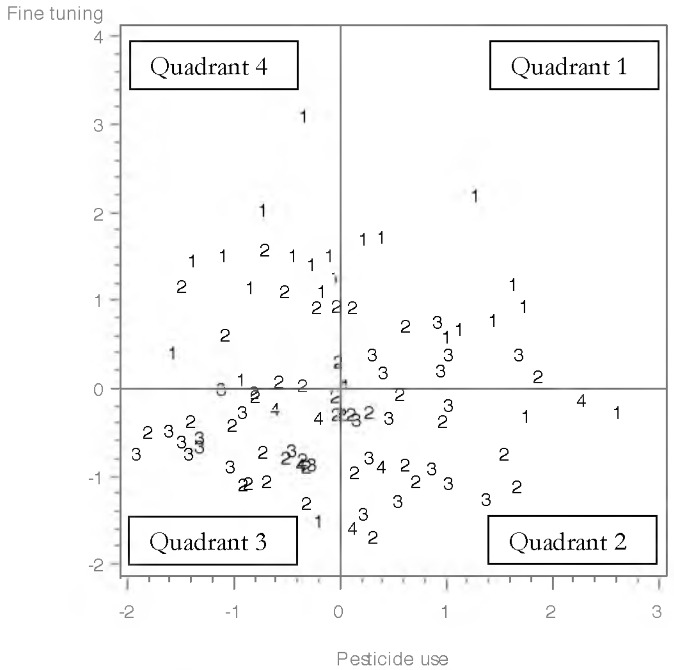
	# aplications	Total Kg/ha
Tradicionales	3.25	0.65
Seguros	2.87	0.80
Arriezgados	3.20	1.06
Experimentadores	3.90	1.45

The *Tradicionales* demonstrate the most efficient pattern of carbamate use among the four groups. Although the number of applications that they make is similar to farmers from the other styles, *Tradicionales* usually use the lowest recommended dosage and consequently apply lower quantities of carbamates per hectare. This pattern reduces the risk of exposure to high concentrations of carbamates during application. On the other hand, the *Experimentadores* make excessive use of carbamates. They apply higher quantities than recommended and make applications more often than farmers from other styles do. This not only increases their costs per hectare, but the workers' exposure to high concentrations of carbamates.

<u>*Fine-tuning* the use of pesticide</u>

Figure 6.2 shows a scatter plot of farmers' scores for *fine-tuning* and *pesticide use* differentiated by cluster. Clear differences between the styles are evident when the two factors are combined in this way. Dots in quadrant 4 represent the most efficient use of pesticides.

Figure 6.2. Scatter plot of farmers' factor scores on *pesticide use* versus *fine-tuning*



1= *Tradicionales*, **2** = *Seguros*, **3** = *Arriesgados*, **4** = *Experimentadores*

Dots representing *Tradicionales* (number 1) are concentrated in quadrants Four and One. This suggests that even those *Tradicionales* who receive a high score for *pesticide use*, use pesticides efficiently and with a high degree of *fine-tuning*. The distribution of dots representing *Seguros* (numbered 2) clearly reflects their tendency to reduce pesticide use. The sparse pattern in quadrant four, however, shows that only a small proportion of *Seguros* use pesticides efficiently. The distribution of *Arriesgados*' scores (dots numbered 3), predominantly in quadrants two and three, demonstrates a low efficiency of pesticide use (only a few scores in quadrant One) and a tendency to use large quantities of pesticide (high *pesticide use* scores). *Experimentadores*' high but inefficient use of pesticides is reflected by the distribution of dots (numbered 4) in quadrants two and three.

Heterogeneity of pesticide use. Looking for sustainability and food security

Table 6.9 presents the differences in yield, benefit and cost in relation to the populations represented in each of the quadrants in figure 6.2. The population in quadrant Four used relatively small amounts of pesticide, while practicing a high level of *fine-tuning*. The efficiency of this group makes it an interesting case to study in relation to sustainability and food security.

Table 6.9 shows that the population of farmers in quadrant Four had a high average yield (14272 kg/ha) and the highest benefit of the four quadrants (666 $/ha). Table 6.10 shows that the population in quadrant Four was made up exclusively of *Tradicionales* (57%) and *Seguros* (43%). This population (21 farmers) represented 22% of the total population included in the study. Table 6.11 shows that 57% of the farmers in quadrant Four practised *wachu rozado*.

These figures illustrate that certain styles of farming in Carchi are more sustainable than others in terms of pesticide use and natural resource management. They also contribute more significantly to the food security of peasant families. This contribution involves increased yields, better quality potatoes and improved benefits. The advantages of these styles only become apparent when looking at peasant heterogeneity. They are not evident when peasant farming is seen as a uniform whole.

Table 6.9. Yield, benefit and costs of populations in the quadrants in figure 6.2

Quadrant	N Obs	Variable	Mean	Std Dev	Minimum	Maximum
1	18	Yield (kg/ha)	15799	5811	7530	32296
		Benefit ($/ha)	102	828	-1717	1702
		Cost ($/ha) a	2004	515	1401	3213
2	25	Yield (kg/ha)	14792	5524	5600	25920
		Benefit ($/ha)	197	730	-473	3293
		Cost ($/ha)	1894	733	1107	4267
3	30	Yield (kg/ha)	13979	8177	2087	41005
		Benefit ($/ha)	267	994	-1236	4095
		Cost ($/ha) b	1567	804	497	4912
4	21	Yield (kg/ha)	14272	4332	7106	21954
		Benefit ($/ha)	666	1344	-2161	4000
		Cost ($/ha)	1762	353	1264	2558

Comparisons significant to the 0.05 level are indicated by letters a and b.

Table 6.10. Number and percentage of farmers from different clusters in the different quadrants of figure 6.2

		Quadrant				
Cluster		1	2	3	4	Total
Tradicionales	Frequency	9	2	1	12	24
	Percent	10	2	1	13	26
	Row Pct	38	8	4	50	
	Col Pct	50	8	3	57	
Seguros	Frequency	3	11	15	9	38
	Percent	3	12	16	10	40
	Row Pct	8	29	39	24	
	Col Pct	17	44	50	43	
Arriesgados	Frequency	6	9	11	0	26
	Percent	6	10	11	0	28
	Row Pct	23	35	42	0	
	Col Pct	33	36	37	0	
Experimentadores	Frequency	0	3	3	0	6
	Percent	0	3	3	0	6
	Row Pct	0	50	50	0	
	Col Pct	0	12	10	0	
	Total	18	25	30	21	94
	Percent	19	27	32	22	100

Table 6.11. Number and percentages of farmers practicing different crop systems in the different quadrants of figure 6.2

		Quadrant				
Crop System		1	2	3	4	Total
Full tillage	Frequency	11	23	29	9	72
	Percent	12	24	31	10	77
	Row Pct	15	32	40	13	
	Col Pct	61	92	97	43	
Wachu rozado	Frequency	7	2	1	12	22
	Percent	7	2	1	13	23
	Row Pct	32	9	5	55	
	Col Pct	39	8	3	57	
	Total	18	25	30	21	94
	Percent	19	27	32	22	100

Conclusions

This chapter has provided an explanation for the pesticide-use patterns identified in Chapter Five. In order to do this, I have focused on farmers' practices in the field and analyzed farmers' perceptions of pesticide use and poisoning. Although there are similarities between farmers' perceptions, there are also important differences.

Farmers' practices

The use of protective equipment

The pesticide industry prescribes personal protective equipment for spraying through its Safe Use of Pesticides programmes. These programmes disseminate information by means of product labels, brochures, courses and other media. Nevertheless, most farmers, regardless of farming style, do not generally use protective equipment. Instead, they apply pesticides wearing only their usual work clothes: rubber boots, pants, t-shirts, sweaters and hats. Only *Tradicionales* and *Seguros* cover their faces with scarves and wear gloves, plastic ponchos or jackets when mixing products. Some *Tradicionales* also provide their labourers with these sorts of protective garments.

Even when protective equipment is provided, many labourers choose not to use it because they find it uncomfortable to wear for extended periods of time. Gloves and masks are said to be particularly uncomfortable. The steep terrain in which some farmers spray adds to the difficulty of avoiding contamination. It is almost impossible to walk up and down hillsides while wearing a 20 litre backpack sprayer and not spill liquid on one's body. Even with protective clothing, there is a good chance of pesticide coming into contact with the skin. My research supports earlier studies that conclude that, in the context of the socio-environmental conditions of peasant farming in Carchi, it is not realistic to talk about the safe use of pesticides, especially when it comes to the use of the highly toxic ones (Crissman *et al.* 1998, García 2001; Yanggen *et al.* 2003a,b; Merino and Cole 2003; Orozco *et al.* 2007, 2009)

Patterns of application

Agronomists often criticize the practice of "blind calendar spraying." Nevertheless, farmers who spray according to the levels of pests and diseases have been shown to apply pesticides more often. This is particularly true of *Tradicionales*. But the overall amounts of active ingredient applied over a potato cropping season and the total expenditure on pesticide are not significantly higher for *Tradicionales* than they are for other farmers. This can be explained by the application of lower dosages by *Tradicionales*. They say that although the industry might recommend, for example, a 200-litre application of a particular product for a hectare of potatoes, this guideline is applicable only when the crop is fully grown. A lower dosage, they maintain, can be applied to newly emerged seedlings without compromising the impact of the pesticide. They argue that applying the appropriate dosage and reducing the use of highly toxic pesticides is an important way of avoiding pesticide poisoning. Since *Tradicionales* usually work in the fields with their labourers, they have a personal interest in trying to reduce the use of highly toxic products. Many of them prefer to set cardboard traps for the white potato borer (*gusano blanco* or *Premnotripex vorax*) rather than applying carbofuran. *Tradicionales* continuously change the type of pesticide they use so that the pests or diseases targeted will not have time to develop resistance to the active ingredients. This explains the figures that reveal that these farmers use a great diversity of active ingredients.

Tradicionales apply a lot of organophosphorus compounds. This can be attributed to the warm, humid environmental conditions under which *wachu rozado* is generally practised. Such conditions are conducive to frequent outbreaks of leaf pests. *Tradicionales* increase the rate of application of organophosphorus compounds in order to suppress these attacks.

Farmers practising particular styles provide different reasons for the number of pesticide applications they make. The *Seguros*' explain that they want to reduce monetary expenditure and avoid poisoning themselves and their families. Their pattern of practice clearly reflects these aims. They use relatively small amounts of pesticide in each application and purchase the cheapest products available. They also tend to wear more protective clothing than farmers from the other groups. The small size of fields means that they are able to spray an entire field relatively quickly and do not have to endure the discomfort of protective clothing for long periods of time.

Arriesgados characteristically apply pesticides on a calendar basis. This generally implies a fixed number of applications over a crop cycle. Their management practices are greatly influenced by the fact that they usually employ others to spray rather than doing the job themselves. Even when they sharecrop, the application of pesticides is generally the responsibility of their partners. Their belief that certain people develop a tolerance for the chemicals in pesticides is evident in their practices. I did not observe a single labourer in *Arriesgados*' fields wearing protective clothing while mixing chemicals or during application. Representatives of the other groups argue that poisoning is more common among *Arriesgados*' families than among their own. It is likely that this phenomenon is mainly due to the fact that

Arriesgados generally delegate pesticide application to farm workers. These workers are not likely to take full responsibility for the supervision of *Arriesgados'* children in the fields or for the careful cleaning and storage of equipment and pesticides.

Experimentadores cultivate the smallest fields among the four groups and have, therefore, the most difficulty in calculating the correct dosages required for their crops. The need to extrapolate quantities to represent fractions of a hectare often results in miscalculations. This results in farmers applying higher amounts of active ingredient than recommended. At the same time, *Experimentadores* try to economize by using the cheapest pesticides available. These are often older, highly toxic and non-specific products. The net result is a high concentration of dangerous chemicals in their fields. All the *Experimentadores* whom I interviewed said that they or their families had directly experienced pesticide poisoning. I observed also that *Experimentadores* did not use protective clothing, despite their awareness of the dangers of toxicity.

Farmers' perceptions

Of the sixteen farmers and four labourers questioned, all considered pesticide application to be the most dangerous task associated with potato production. Farmers, though, commonly associate pesticide toxicity with dizziness and faintness, but very rarely with long-term symptoms such as skin allergies, recurring headaches, loss of sight or sensitivity in their limbs. Most farmers agree that drinking alcohol before spraying increases the likelihood of being poisoned. Despite this degree of consensus, there are differences in perception among representatives of the different farming styles. *Tradicionales, Seguros* and *Experimentadores* all think that pesticides can affect anyone who comes into contact with them. They refer to pesticides as "poisons." In their minds, the likelihood of poisoning is related to the management of pesticide application and storage, rather than to the physical attributes of the people involved. *Tradicionales* blame bad management, in general, and the use of highly toxic products and stronger than recommended dosages, in particular. *Seguros* feel that the lack of protective equipment during pesticide application is the main problem. *Experimentadores* believe that highly toxic products are at the centre of the problem. *Arriesgados*, on the other hand, believe that "weaker" people are more likely to be adversely affected by pesticide. This "weakness" is related to a person's age (the very young are particularly "weak"), their eating habits and the amount of exposure they have experienced. They believe that prolonged exposure increases a person's resistance to pesticide.

Farmers from all the groups are generally in agreement with the literature in terms of the factors that increase the likelihood of pesticide poisoning (Crissman *et al.* 1998, Yanggen *et al.* 2003a and b, Orozco *et al.* 2009, Reigart and Roberts 1999). Nevertheless, the difference between *Arriesgados* and farmers practising other farming styles is important. The attitudes and beliefs of the *Arriesgados* is consistent with the finding of the CIP studies (Yanggen *et al.* 2003a) that revealed that "among farmers there was the generalized belief that repetitive exposure brought about resistance to pesticides." By contrast, *Tradicionales*, *Seguros, Experimentadores* and labourers in general contradict this. They maintain, rather, that men become less resistant when they are exposed to pesticide more often. These contrasting perceptions shed light on the ways farmers from different style groups relate to farm workers and pesticides. When farmers are involved in the application of pesticide themselves, they tend to explain poisoning in terms of the external conditions of application. On the other hand, farmers, such as *Arriesgados*, who employ others to make the applications, tend to explain poisoning in terms of the physical state of those affected. In this way, they reduce their own responsibility for not providing the workers with adequate safety measures and equipment.

All farmers agree that the owner of the potato field is responsible for the medical treatment of a labourer who is poisoned while working in his fields. Labourers report, though, that in practice they have to treat themselves because the symptoms of poisoning usually only appear long after the work is finished. *Tradicionales* and *Arriesgados* sometimes have to take responsibility for poisoned labourers. This is not the case with *Seguros* and *Experimentadores* because they apply pesticides themselves and don't employ labour.

Farmers will use local medicines to treat themselves or their labourers before they resort to professional medical attention. This is consistent with studies that have shown that many cases of poisoning are not reported to hospitals. Mera (2001) found (by means of active surveillance of Ministry of Health statistics) that only 10% of actual poisoning cases were registered in Carchi. Farmers are of the opinion that the medical sub-centres in their communities are not adequately equipped to deal with serious cases of poisoning and that there are not enough doctors available in them. In the event of an acute poisoning case, farmers take the victim to the emergency room of a local hospital. Viteri (2007) shows that there were important limitations in terms of infrastructure, equipment and budget for health services in Ecuador in 2003, and that there was a concentration of medical professionals in urban areas.

Studies in Ecuador and Peru have found that only a small percentage of farmers understand pesticide toxicity colour codes (Orozco *et al.* 2009). Nevertheless, all the farmers and labourers in this study gauge pesticide toxicity levels by means of the colour of the labels. All of them knew that red label pesticides were the most dangerous. This level of awareness is probably attributable to the relatively high levels of literacy among farmers in Carchi, as well as the fact that Spanish is their first language (the instructions are usually in Spanish). Numerous public and private education programs designed to inform farmers about pesticide toxicity colour codes have been implemented in the last decade. These include Farmer Field Schools, television programs and campaigns in rural schools. Despite awareness of the significance of labels, most farmers and all the labourers regard the smell of a product as the main indicator of toxicity. They believed that the stronger and more unpleasant the smell, the greater the level of toxicity. This may explain why farmers and labourers agree that chemicals enter the body primarily through the nose. They also believe that it can enter through other parts of the body, such as the mouth, eyes, ears, and hands. Only two *Tradicionales* agreed with CIP researchers (Yanggen *et al.* 2003a) that pesticide entered the body mainly through the skin.

Farmers and labourers are reluctant to speak about incidents of pesticide poisoning in their families, but speak freely about the poisoning of animals. All the subjects in my study had first-hand experience of animals being poisoned with pesticides. Furadan is the pesticide most commonly used to deliberately poison an animal. Men and women from the same families appear to perceive the issues of pesticide use and poisoning in a similar way.

Use of highly toxic pesticides

The American Association of Poison Control Centres lists carbamates as one of the seven pesticides most commonly implicated in symptomatic illnesses in the United States (Reigart and Roberts 1999). The high use of carbamates documented in the present study is an indicator of farmers' heavy reliance on highly toxic pesticides (WHO toxicity category Ib) in Carchi. The high toxicity of carbamate is largely attributable to the active ingredient, carbofuran. This is sold in liquid form throughout the study area.

The *Tradicionales* demonstrate the most efficient pattern of carbamate use. They use relatively low quantities per hectare, even though their application rate is similar to that of farmers who practise other styles. *Experimentadores* use the largest quantities of carbamates, often in excess of industry recommendations. This increases the likelihood of poisoning and leads to increased costs per unit area, despite the fact that their rate of application is similar to that of other groups.

Comparison with CIP's findings

The studies of local practices and perceptions led by CIP (summarized in Yanggen *et al.* 2003b) are largely limited to farmers who practise the *Arriesgados* style of farming. These studies conclude that communities believe that continuous exposure to pesticides makes farmers tolerant to toxins and that men are more resistant than women or children. My study has found that this is applicable only to *Arriesgados*. Representatives of the other groups hold the opposite opinion, maintaining that continual exposure is likely to lead to health problems rather than "resistance."

My observations concur with the conclusion that farmers do not use protective equipment and find it difficult to observe preventative measures in the field and at home (Crissman *et al.* 1998, Yanggen *et al.* 2003a, Sherwood 2009, Orozco *et al.* 2009). Having said this, many S*eguros* and *Tradicionales* do utilize protective equipment and observe safety measures. Although the vast majority of farmers use highly toxic pesticides, *Experimentadores* are particularly vulnerable to poisoning. They are directly involved in the application process and use high dosages of the cheapest, most toxic products. My conclusions support the CIP-led research that found that the unsafe storage of products and contaminated equipment in households was largely responsible for the poisoning of children. This mostly applies to *Arriesgados,* who rely on external labour for applying pesticides and also for storing them and cleaning the equipment.

In the end, my results do not contradict the CIP studies. Instead, they point to the limitations of the earlier studies, which at times can be blinding in the conceptualisation of the local dynamics of agricultural practice. In their effort to explain certain realities around potato farming, they conceal others, in particular with regard to certain grounded experiences that are potentially rich in insights for informing and enabling much needed institutional transition in development practice.

Translations, sociotechnical regimes and black boxing

Chapter Two shows that modernization policies created the circumstances in which patterns of risk were institutionalized in the framework of trust in expert knowledge, while alternative ways of potato production were largely ruled out (Giddens 1990: 35,90).[131] The material presented here, however, shows that trust is relative to the context in which farmers work. In practice, farmers' trust in pesticides is a socially created condition. This is especially true with respect to the different levels of awareness of the risks involved in their use. The ways in which farmers structure the labour process (the objects of labour, the tools or instruments and the labour force) is an essential part of the process that has produced different levels of awareness of the risks of pesticides. It is also integral to the degree to which farmers can exercise agency in determining what constitutes "acceptable risks" (Ibid: 35). For instance, farmers who monitor their own crops and apply pesticides themselves have different ways of evaluating "acceptable risk" from those who hire labourers and apply pesticides on a calendar basis.

The study of farming styles reveals that farmers trust expert knowledge. This knowledge, embodied in the use of pesticides and other industrial-era technologies, is susceptible to continual transformation in the hands of users, however. This is one way in which the hegemony of the sociotechnical regime of modernization is continually eroded 'from below' in order to facilitate local needs.

Heterogeneity, sustainability and food security

Taken together, the quantitative and qualitative examination of the local heterogeneity of potato farming in Carchi reveals populations of farmers that strategically practice low *pesticide use* and high *fine-tuning*. I argue that this combination represents a more sustainable approach to farming than the aggregated forms of farming practice put forward by the scientists at INIAP and CIP (Yanggen *et al.* 2003b). This promising strategy of agricultural practice is characteristic of the *Tradicionales* and *Seguros* styles, which incorporate the resource conserving *wachu rozado* planting system. In many ways this strategy represents a response to public calls for healthy production practices and sustainability. These farmers generate high production levels and derive the highest benefits per hectare of the entire farming population. This strongly challenges the assumption that the price of increased sustainability is reduced economic benefits.

131 Giddens (1990) defines trust as "confidence in the reliability of a person or system, regarding a given set of outcomes or events, where that confidence expresses a faith in the probity or love of another, or in the correctness of abstract principles (technical knowledge)" (Giddens 1990: 34).

This research sheds light on the endogenous potential latent in the heterogeneity of local farming practice. This potential is not only ignored by public policy, but is actively suppressed by the promotion of the sociotechnical regime of modernization (Sherwood 2009). These findings have important implications for institutional agricultural science and development practice. From a research perspective, it is only possible to discern endogenous potential when the focus of the analysis shifts from uniformity of the whole population to the diversity and diversification of local practice. Such a change of focus raises concerns regarding the suitability of current institutional designs. My experience suggests that the movement towards sustainability in particular areas, such as Carchi, can be underpinned by the existing practices and experiences of certain peasant farmers within that population.

Chapter 7

Conclusions

This chapter addresses the main research questions of the thesis and discusses the conclusions reached with regard to the modernization of agriculture in Ecuador. It then goes on to identify key lessons from this research for rural development policy and practice.

The modernization scenario

Land reform as a creator of space

This study has shown that the ambiguous process of agrarian reform in Ecuador has not only created constraints, but also opportunities for *precaristas* in the generation of new production styles. Other studies have also demonstrated this (Long 2004, van der Ploeg 2008, Hebinck 2008). Even though agrarian reform was implemented with the aim of allocating land to *precaristas*, its main impact has been the opening of avenues for commoditized and non-commoditized access to land, resources and inputs.

Heterogeneity of pesticide use

Translation analysis is used in Chapter Two to analyze the policies and practices relating to the rise of the dominant potato production system in Carchi. Ecuador's policy of agricultural modernization is linked to the introduction of pesticides and proliferation of their use.

After fifty years, pesticides are the primary strategy for controlling pests in potato production in Carchi. This is not surprising. Pesticide products have been portrayed as the "modern" way of pest and disease management and are said to increase agricultural production and the ability of farmers to participate in markets. Traditional agriculture, on the other hand, is labelled as 'problematic' and "backward" because it does not produce the same short term results as when using advanced technologies. Modernization promotes networks of "experts" who endorse the application of modern technologies, such as agrichemicals, mechanized tillage and improved varieties of potatoes. These networks are linked through education, markets, research and other means. The case of the group of researchers that failed to elicit enough public support for a policy banning highly toxic pesticides make evident the strength of the networks that promote pesticides.

Although the modernization network is comprised of many elements (e.g., policies, technologies, organizations and individuals, with their characteristics and skills), pesticides have come to represent agricultural modernization itself since they have, in effect, "black boxed" the entire network – a phenomenon that pervades university classrooms, research centre laboratories, farmers' fields and market places. Pesticides have been central to claims of durability, stability and mobility achieved by the agricultural modernization network. The growing strength of this network has created a sociotechnical regime organized around protecting the idea that pesticides are the only viable option for controling pests and diseases.

The system of potato production that developed in Carchi has suppressed alternative strategies of pest and disease control very effectively. Even those farmers who have become aware of the impact of pesticides on their health have found it difficult to produce potatoes commercially without the use of pesticides. As a result, Carchi has developed one of the highest rates of pesticide poisoning in Ecuador. This situation was exacerbated by the dollarization of the economy, which has in fact generated a situation of dependence on purchased inputs and increasing costs of the products. One of the results is that many farmers opt for cheap, highly toxic pesticides rather than more expensive products.

Research conducted by the International Potato Centre (Crissman *et al.* 1998, Yanggen *et al.* 2003a) shows that virtually all peasant farmers in Carchi use pesticides to grow potatoes, but that a number of different patterns can be identified in the ways in which they are purchased and utilised. This thesis has studied these different patterns as a way of identifying endogenous alternatives to using "modern" technologies.

<u>Authoritativeness of the modernization policy</u>

Modernization policies favouring the import of externalized technology, sales and research within the agricultural education and extension system have been highly effective in portraying pesticide use as an "improvement" on traditional methods of pest control and, over time, a necessity in food production. Meanwhile, questions of "externalities" regarding the impact of pesticides and other industrial era technologies on human health and the environment largely have been neglected or ignored.

"Modern" technologies are an integral part of the expert-based technological "packages" (e.g., a combination of improved varieties, agrichemicals, and tillage regimes) designed to overcome problems in food production and rural poverty, largely through increased production and intensification. Nevertheless, diverse research in Carchi finds worrisome social and environmental "externalities" associated with this technology. These include studies on the impact of pesticides on production, human health and the environment (Yanggen *et al.* 2003a summarizing 15 years of research), the depletion of soils due to mechanization (Valverde *et al.* 2001, de Noni and Trujillo 1986), the loss of potato diversity associated with production intensification and market integration and a comprehensive institutional analysis of these tendencies (Sherwood 2009). Together, these studies make clear that through promoting production in Carchi, modernisation has generated a multiplicity of unwanted outcomes.

In summary, the undesirable consequences of agricultural modernization in Carchi have led researchers to question the assumption that the application of western science and technology to peasant agriculture has generated "progress." The idea that western science and technology are neutral, cumulative or evolutionary has also been challenged. Nevertheless, modernization continues to dominate the policy discourse in Ecuador. Chapter Two looks at how this situation has developed, in order to understand the tenacity of agricultural modernization and to more carefully reveal the problems associated with its development.

<u>Farming styles as different expressions of modernity: community versus farmers' constructions</u>

Although modernization policies have promoted a particular suite of practices, my research finds that the historical circumstances associated with land acquisition in Carchi are more influential over a community's natural resource management and agricultural development. This is shown by the particular style of farming that dominates in each community. The relationship between hacienda workers and hacienda owners influenced the peasants' moment of land acquisition (either before or after agrarian reform), the quality of available resources that came with the land (forest, *páramo*, water, etc.), and the local meaning of resources and agricultural production (e.g., whether or not a group decided to continue or break away from production traditions established on the hacienda). This explains why the farmers' initial access to a similar asset base gave origin to different farming styles and resource management, which in turn is expressed in certain generalizeable qualities of community-level patterns of production.

Nevertheless, I have found that some farmers have been able to establish styles of farming that are very different from the dominant styles of their community and even of the region. Van der Ploeg (2003: 7) shows that farmers are able to mobilize and develop available resources (both material and social) in a variety of ways, regardless of a common history. In other words they are capable of "re-constituting or transforming existing 'localized' situations, cultural boundaries and knowledge" (Arce and Long 2000: 6). This implies that notions of "community" and "locality" are not homogeneous, and therefore, that the terms cannot be used as valid units for planned development. Each location appears as a (social and material) composition of different expressions of modernity (dominant and alternative) that "generates specific forms, directions and rhythms of agricultural change" (Long and van der Ploeg 1988: 27).

Certain individual farmers and their families are able to develop lasting food production, even when the dominant production system in their locality is not sustainable. Long-term (centuries instead of decades) sustainability on a scale larger than that of the family farm, however, involves decision making at community and regional levels.

Addressing the research questions

Question one: What emerge as the main strategies of potato production when a broad sample of farms and production systems is considered?

The study which forms the basis of this thesis includes a wider population of farmers than my initial research did (Paredes 2001). By looking at communities with different production systems, I have been able to identify four main styles, each with a specific production rationality. Chapters Four and Five describe the main strategies of potato production that characterize the different farming styles.

Tradicionales fine-tune the use of inputs and focus on the intensive use of good quality labour. This results in high yields and benefits. This style is uniquely intensive. This group is less market-dependent than the others. Even when they do produce for the market, they create room for manoeuvrability in terms of both inputs and outputs. A remarkable difference between this style and the others in their sociotechnical network is their sustainable management of forest and *páramo* environments, as well as their reliance on time-tested practices. *Tradicionales* show that it is possible for peasant farmers to produce potatoes intensively and sustainably using "modern" technologies. For this to happen, though, the resource base needs to be preserved and "traditional" practices have to be incorporated into an overall strategy. The capacity of farmers to refashion elements of "traditional" and "modern" agriculture into their own amalgams has been found to be crucial for *in situ* conservation in other Andean settings (see Zimmerer and Basset 2003: 10).

Seguros use large quantities of seed and soil fertilizer to compensate for the poor quality of the soil they farm. Yet, they still obtain low yields and benefits. Their style of production is the most extensive of the groups. Their historical identity is based on opposition to the "modern" production system and its strong ties with markets (especially for labour). They value independence from input and output markets by relying heavily on non-commoditized relations. They commonly express aversion towards the recommendations of technicians associated with modernization.

Arriesgados prioritize much higher investments in mechanization than the other styles do. Decades of mechanized tillage have degraded their soils and have resulted in low yields and benefits. Their productivity continues to decline despite the input of high quantities of fertilizers and the practice of soil disinfection. In attempting to produce exclusively for the market, they practise an extensive style of farming that is heavily dependent on input and output markets that are part of the sociotechnical networks of modernization. Their style continues to be the dominant model of potato production in Carchi due to its economic success in the 1980s, when soils were still fertile, input costs lower and potato prices more stable. The *Arriesgados'* low levels of productivity in 2004, however, highlight a sustainability crisis in terms of resource management. These farmers habitually take risks, "playing the lottery" by spending as much money as possible on external inputs, in hopes that high potato prices will provide a promsing return on investment. Nevertheless, in recent time the odds of 'winning the lottery' have declined.

Experimentadores are characterized chiefly by their liberal use of foliar fertilizer and cheap pesticides, instead of costly soil-based fertilizer and species-specific pesticides. Their intensive style of farming achieves high yields and monetary benefits mainly because it is based on the practice of soil conservation techniques on small fields. *Experimentadores* produce for the markets but make very low investments in external inputs. They experiment continually in order to minimize the costs of production. They use the highest percentage of non-commoditized inputs of all the groups, demonstrating a high degree of self-sufficiency. Their involvement in the market proves that farmers with poor resources (resulting from the economic crisis and land fragmentation) are not necessarily subsistence farmers producing for their own consumption.

This study of peasant heterogeneity in Carchi makes it clear that potato cultivation does not follow a single model of modern production, even after decades of modernization policies. Instead, farmers have created their own realities (*modernities*). This phenomenon has been observed in other parts of the world (van der Ploeg 1989, 2003, Long 1989, Bebbington 1990, Arce and Long 2000, Zimmerer 1997). The farmers who base their style on modern recommendations appear to have reached a crisis point due to the degradation of their natural resources and their dependency on unstable input and output markets. However, the fact that farmers produce potatoes for the market does not in itself necessarily mean that they have lost the freedom to organize the processes of production in particular ways. Different farming styles exhibit different scales and intensities of production as well as relations to, and degrees of involvement with, markets and technology. These variables are based on farmers' particular priorities, networks and rationalities, which, in turn, are influenced by their community, culture and personal histories. This makes it possible to determine the extent to which various strategies of pesticide use represent endogenous solutions to the vulnerabilities and discontinuities that have been generated by modernization.

<u>Question two: Given the fact that pesticides have been promoted in standardized ways, with clear and detailed directions, is pesticide use across farming styles a homogenous or heterogeneous phenomenon?</u>

Chapter Five demonstrates that patterns of pesticide use correspond to various strategies of production, rather than to the standard directions recommended by the pesticide industry. Pesticide use differs from one farming style to another in terms of the number of applications, the choice of specific pesticides, the total number of active ingredients applied, the number of labour days committed to application and the kind of labour employed for application. It is important to look at differences between the groups in terms of their application patterns because the actual quantities (kilograms of active ingredient per hectare) of pesticide used do not differ significantly between farming styles. I have argued that a farmer's pattern of pesticide use is embedded in a particular form of farming rationality. This means that the farming process (the relations between farm labour, labour objects and instruments) and the social relations of production define the different ways in which farmers control or manage pests and diseases by the tactical use of agrochemicals.

Question three: How do farmers utilize pesticides and manage the risks associated with their use?

Chapter Six finds that most of the farmers who were interviewed think of pesticides as poisons and recognize pesticide toxicity by the colour of the labels on the containers. Nevertheless, most farmers in this study, regardless of farming style, do not use personal protective equipment for pesticide applications. The study shows clear differences between farming styles in terms of the level of risk to which farmers, their families and their farm workers are exposed. The likelihood of poisoning, therefore, varies from group to group.

The differences between farming styles regarding pesticide use and the associated risks have been examined according to three main criteria: 1) the relation between the pattern of production characteristic of a particular style and the pesticide application strategy employed by that style, 2) the tendency to use, or to avoid, highly toxic pesticides and 3) perceptions regarding the causes of pesticide poisoning.

Tradicionales' fine-tuning of the use of pesticides involves the use of family labour to facilitate a pattern of application based on continuous monitoring of the crop. Their use of the *wachu rozado* planting system reduces the conditions conducive to pest and disease attacks and makes possible a more integrated strategy of pest management. *Tradicionales* are aware that the risk of pesticide poisoning increases with the use of highly toxic pesticides, especially in higher than recommended dosages. As a result, they either apply pesticide products according to technical recommendations or completely avoid their use.

Seguros' strategy of minimizing labour means that they perform a low number of pesticide applications over a cropping cycle. Their utilization of mechanized tillage to reduce the labour input has led to soil degradation. High quantities of potato seed are used to compensate for losses caused by pests and diseases. Overall, though, their farming strategies have resulted in low production. *Seguros* mostly apply pesticides themselves. This probably explains why they are among the limited number of farmers who regularly use protective equipment. Many farmers in this group have experienced pesticide poisoning at one time or another. This has led them to recognize that one of the most important reasons for poisoning is the absence of protective gear.

Not unlike *Seguros* and *Experimentadores, Arriesgados* make relatively few applications, usually on a calendar basis. Many farmers in this group have degraded their soils by using tractors for soil preparation. They frequently disinfect the soil in order to combat pests and diseases and try to increase the efficiency of labour by contracting groups of labourers for the application of pesticides. They believe that people who are physically "weak" (e.g., men not accustomed to spraying pesticides, women, children and the malnourished) are most likely to be affected by pesticide poisoning. Most of the narratives regarding incidents of children being poisoned by pesticides that are documented in this thesis were recorded from *Arriesgados'* children. Workers who are delegated to apply pesticides on *Arriesgado's* farms are less likely to supervise the owners' children in the fields than the parents themselves would be. Farm workers do not always take full and clear responsibility for storing pesticides and equipment safely after application. Spray pumps are not always rinsed thoroughly, and open bags of pesticide are often left unattended in a field or stored in places that children can easily access. The lack of direct involvement by the *Arriesgados* farmers in the application process results, therefore, in conditions that increase the risk of their children being poisoned.

Experimentadores typically make a low number of high dosage pesticide applications. They have limited capital and so use the cheapest pesticides on the market. These products are often far more toxic than more costly alternatives would be. *Experimentadores'* fields are small, often fractions of a hectare. This makes the accurate calculation of dosages very difficult for them, and they frequently apply dosages that are higher than recommended. The combination of inappropriate dosages and very toxic products puts this group at high risk of poisoning, particularly because they and their extended families apply the pesticides themselves. Although *Experimentadores* view all pesticides as poisons, they are reluctant to use protective equipment during the process of application.

Farmers continuously explore the articulation of new elements with existing farming practices by the way they structure labour. The word "articulation," as suggested by Latour (1999b), refers not only to language and sophistication, but to material components as well:

> An articulate subject is someone that learns to be affected by the others – not by itself… A subject only becomes interesting, deep, profound, worthwhile when it resonates with others, is effected, moved, put into motion by new entities whose differences are registered in new and unexpected ways. Articulation means being affected by differences… [Instead] an inarticulate

> subject is someone who whatever the other says or acts always feels, acts and says the same thing." (Latour 1999b: 4)

The regular incorporation of a new foliar fertilizer into a farmer's production process, for example, involves not only a reorganization of labour for application of the product (time scheduling, skills for application), but the redistribution of the resources that relate to production on the farm and to the family budget, as well as new relations with agrochemical agents, knowledgeable farmers and technicians. The translation of a new element (foliar fertilizer, a new pesticide, a new pest) into the world of the peasant farmer implies its internal articulation in the labour process.

I propose, therefore, that farming styles (or the different ways to articulate the labour process) are also particular ways to perceive and bring about health or sickness. For some farmers, pesticide poisoning is a sign of weakness, but for others it is the sacrifice that farmers have to make in order to earn a living. Haraway (1989) uses the metaphor of "cyborg identity" to expose ways in which things considered natural, such as human bodies, are constructed by our ideas about them.[132] According to Latour, our body is defined by interfaces with other elements. It can be perceived as "the dynamic trajectory by which we learn to register and become sensitive to what the world is made of" (Latour 1999b: 1). Using sensory ethnography (Pink 2009), or what Latour calls "body talks," Chapter Six examines how farmers that practice different styles use pesticides, and how they perceive the associated health concerns. The material in this chapter supports an understanding of how farmers' practices and opinions regarding pesticides emerge from and are articulated in (or inarticulated from) the labour process.

Farmers' perceptions of pesticide toxicity are generally related to the degree to which they rely on their own labour and that of their families for pesticide application. When farmers apply pesticides themselves, they tend to attribute incidents of pesticide poisoning to the conditions in which the chemicals were used. This is the case of *Tradicionales*, *Seguros* and *Experimentadores*. On the other hand, farmers, such as *Arriesgados*, who employ other people to apply the pesticides, tend to associate poisoning with the physical state of the individual who performed the application.

---

[132] The notion of the cyborg deconstructs binaries of control and lack of control over the body, object and subject, nature and culture (Haraway 1991: 180).

<u>Question four: What insights are provided by a study of heterogeneity that could inform new policies that aim to promote healthier and more sustainable agricultural production?</u>

Cole *et al.* (2007) find it is possible to limit pesticide-related health problems in Carchi by reducing exposure to pesticides. The study of farming styles, however, shows that patterns of pesticide use are part of a rationality of production and not just isolated modes of practice. This explains why industry and government supported programs promoting the safe use of pesticides (SUP) are not very effective (Atkin and Leisinger 2000; Murray and Taylor 2000).

This research has not sought to promote previously suggested alternatives to pesticide use in Carchi (see for instance, Crissman *et al.* 1998, Sherwood *et al.* 2002, 2003, 2005, 2007; Yanggen *et al.* 2003a, Pumisacho and Sherwood 2005) so much as to contribute to the debate on the subject by describing farmers' strategies for reducing pesticide use and poisoning and to demonstrate that the heterogeneity of peasant agriculture itself contains sustainable alternatives and solutions to the problems created by modern technology. It is not suggested that these options and strategies be used as a blueprint for policy. In response to the demands for re-direction, this study argues for a diversified view of production (i.e., in addition to the modernization model), which would involve the introduction of new networks of actors (beyond those connected to the modernization regime).

Tradicionales have achieved a degree of sustainability through the application of "traditional" practices while decreasing exposure risk to pesticides as well as vulnerabilities to inputs, labour, and commodity markets. Despite this potential promise, their practices have received more antagonism than support from the community of "experts" (specialists from research centres, universities, and commercial companies) – the protagonists of modernization policy and the promoters of "new" and "improved" practices (see Sherwood 2009 for a discussion of how profound institutional differences prevent these experts from supporting traditional practices). The development of the *Traditionales'* style was facilitated by particular social and environmental conditions. The relatively peaceful land acquisition on some of the more progressive haciendas in the decades before land reform granted certain farmers the time and social support to subsequently re-invent styles. In addition, certain historical processes of land acquisition protected particular natural areas from exploitation, thus conserving environmental conditions that allowed "traditional-modern" practices to evolve through a process of *fine-tuning*. This has resulted in a relatively intensive and sustainable system of production. All peasant farming styles in Carchi have "sustainability" issues, such as mono-cropping, falling production and pest and disease proliferation. While not immune to such difficulties, the sustainability and health benefits of the *Tradicionales* style merit further attention from researchers, interventionists and policy makers.

The style practised by the *Seguros* has been shaped by attitudes forged during a history of antagonistic relations between hacienda owners and their labourers. The *Seguros* did not want to replicate hacienda-style patron-labourer relations on their own farms, so they developed strategies for minimizing dependence on paid labour. Many *Seguros* acquired land decades before land reform, similar to the *Tradicionales*, which provided a degree of freedom to develop and establish their own style before the arrival of industrial era technology and aggressive market integration. Their main source of income during this formative period was the exploitation of finite forest resources. After initially struggling to access the newly opened input and commodity markets brought about by modernization, over time their low external input intensive strategies have afforded them a safeguard against the variability of labour, capital and input costs.

The style of the *Arriesgados* raises serious sustainability concerns. This style was developed mainly in communities that acquired land after land reform. Many *Arriesgados* needed capital to finance their newly acquired land and saw no option other than using "modern" technology to generate income by means of the newly available markets. Their commitment to the markets meant that the *Arriesgados* had less freedom to shape their farming style than other groups did. The opportunities available after land reform allowed them to create wealth and model their lifestyles on those of the hacienda owners. Their production system has proved unsustainable, however, in that the use of modern technology has degraded their natural resources. Their success was short-lived.

The *Arriesgados* commonly worked with extension services that promoted modern packages after land reform, and this is how the style came to be generally representative of peasant farmers in Carchi, at least in the eyes of policy makers. But the style has arrived at a crisis point and has created severe problems related to pesticide poisoning and unsustainable practices. Policy makers and interventionists should take note of the effects of uncompromising policies, such as land reform, that are linked to new technologies. Agriculture can be rapidly "reshaped" among certain groups of farmers, but the vulnerabilities and undesirable outcomes for environmental and human health only become apparent decades after policies have been implemented. It would be more beneficial for "experts" to invest in learning about sustainability from farmers themselves, rather than installing inappropriate new models based on foreign expertise. Both governmental and non-governmental institutions could develop a more nuanced response to the diverse realities of farming, instead of a blanket approach based on an idealized model. It can only be wise to utilize decades, in some cases millennia, of farmers' experience to better preserve agricultural diversity and sustainability (Zimmerer and Basset 2003: 10).

The *Experimentadores'* style illustrates how some farmers in Carchi cope with market vulnerabilities and with the use of technologies. Although these farmers have less access to land and capital than others, they manage to maintain high production per unit area by only cultivating very small fields of land. They are directly involved in the production process because they mainly use family labour. Family members tend to perform their tasks with more care than hired labourers. Nearly all peasant farmers in Carchi rely on family labour to a degree, particularly since the advent of dollarization, but the *Experimentadores* are clearly the most dependent on this source of labour for survival and the continuation of their style. Since most of their produce is marketed, these farmers constantly try new ways to spend less and produce more, often at the expense of their health. Indeed, *Experimentadores* are usually well represented among those who suffer pesticide poisoning each year in Carchi. For policy makers and interventionists, this style clearly illustrates the creativity that farmers are capable of exercising in relation to technology and its mechanisms. It also shows that small landholders are not necessarily subsistence farmers. In addition, they produce for the market and sell their labour.

Chapter six places into question the assumptions that agricultural based on the modernization model is more productive, and thus more developmental, than strategies that maintain "traditional" practices and relations of production. A significant number of *Tradicionales* and *Seguros'* show low levels of pesticide use and a high degree of *fine-tuning*, while their yields and benefits are usually higher than those of farmers who have developed more "modern" styles.

The *Arriesgados* have increasingly struggled with their levels of production over the last decades, but even when they produce high yields and benefits, their sustainability is questionable in that they demonstrate low levels of *fine-tuning* and high levels of *pesticide use*.

The above conclusions illustrate that:

1. Contrary to the assumptions made by protagonists of modernization, farming styles based on traditional practices and non-commoditized relations of production appear to be more sustainable in the long term than more "modern" styles based on commoditization of the production process.
2. Farmers who had decades to develop their own production strategies have maintained more sustainable practices with higher yields and benefits than those who have been pressurized to make abrupt changes to their production styles.
3. Peasant potato farming in Carchi can be sustainable while maintaining high production levels and limiting the risks of pesticide poisoning.
4. Modernization policy has played an important role in creating a desired model that continues to be promoted by a network of experts (the system of education, extension and research) as the "authoritative" reality. In cases like that of Carchi, this "created-reality" can only be contested after a long period of time.

In order to promote more sustainable practices, policy formulation should not be carried out by central government alone. Local governments and non-governmental organizations can make valuable contributions with their knowledge of particular farming styles.

Elimination of highly toxic pesticides (category Ia and Ib), as decreed by law in 2010, is an important step towards protecting the health of farming families and more sustainable agriculture. Trust in expert systems promoting pesticides has been eroded. The attitudes of peasants who have suffered the effects of these products have changed and so have the perspectives of policy-makers and laypersons. 'Updates' of knowledge, made available via the communication media and other sources, have made the modernization sociotechnical regime vulnerable (Giddens 1990: 91).

The problem of pesticide poisoning cannot be tackled in isolation. It must be seen as part of a production rationality that has somehow been promoted by interlocking policies and projects. Although certain farmers may have chosen a particular farming style, policy continues to play an important role in making specific styles more possible to follow than others.

Once pathways for support transition towards more sustainable practices have been identified, it becomes necessary to identify and understand lessons from the past. The translation analysis of land reform in Chapter

Two shows how different events allowed a group of actors to secure the implementation of the agrarian reform law promoting modern technologies and the expert knowledge associated with them. The findings of this study show that once again policy makers "are not looking for the best way or most efficient alternative for solving a problem. They are instead searching for support for action already taken, and for support that serves the interests of various components of the policy shaping community" (Palumbo and Nachmias 1983: 9-11, cited in Long 2004: 27). This may explain why more attention is paid to signing laws and labelling policies than to the processes of policy transformations 'from below'. Following the documentation and publication of the health-related problems associated with pesticides, the policy response at national, local and private levels has taken the form of the promotion of the "safe use of pesticides." This thesis shows, however, that pesticide policies have favoured the promotion of the use of pesticides, in general, rather than their 'safe use', in particular.

From one perspective, the role of pesticides in farmers' fields appears 'stable' and 'durable'. They have become a black box representing the modernization networks of scientists, researchers, agents, skills, resources and relationships. When one considers farming styles, however, it becomes apparent that farmers break open black boxes of technologies in their own ways, by means of their own experiences and encounters with pesticides.

Concepts such as that of 'regimes of governance' (Nuijten 2002: 4) facilitate the understanding of how governance takes place in heterogeneous ways through the interaction of different sets of actors. As Nuijten argues, the concept of governance is separated from the idea of the state as the principal actor that designs and implements policies and programs. It also contests the idea that there is an artificial dichotomy between the public and private sectors. Farmers interface in different ways with policy and transform it by their practices.

Pesticides were introduced to markets in Carchi during the 1950s as part of a technological package for modernizing peasant agriculture through the intensification of production. The term "package" refers to the different technologies that are required for the implementation of the policy. The use of each component of a package reinforces the need for the other components. This thesis shows, however, that farmers do not use technology packages as a whole; different elements are applied when they seem a useful means of enabling certain styles to progress. Van der Ploeg (2003) has described this process in other parts of the world.

Potato farmers in Carchi invest about USD five million in pesticides. This can be viewed as indicative of the "success" of agricultural modernization. Nevertheless, this study of farming styles has demonstrated that this policy has not been homogeneously successful in terms of pest management or the impact on the health of peasant families.

This thesis has focused mainly on the use of pesticides and their effect on human health, but the issue of price policies is also worth mentioning. This was one of the foremost concerns for all farmers I encountered during my fieldwork. To varying degrees, different farming styles supply food for the cities, labour for their own family and community, and sustainable resource management. By selling potatoes at prices determined by the production costs that are established by 'free supply and demand' and not taking into account the household resources that are used in commercial production, farmers do not benefit the consumers in the big cities as much as the middlemen and food corporations in these cities. It has been demonstrated that the relative price of potatoes has increased for consumers lately but that the real price received by producers has dropped (Sherwood 2009: 105). This situation calls for a price policy that protects peasant production and its important role in sustainable rural development.

Implications for Rural Development

In this study, rural development is understood in relation to farmers' patterns of practice. The following lessons can be learned from this:

1) Development, or the move towards different concepts of "progress" or "improvement," is intrinsic to farming practice because it requires the continuous moulding of complex sociotechnical realities. Instead of being characteristic of "backwardness." Therefore, heterogeneity is the expression of a dynamic farming sector within which farmers exercise agency by articulating and activating their different perceptions of development and "good farming," even under the most restrictive conditions.
2) Policy unfolds as an ambiguous and fragmented process that creates or restricts new spaces for the interface of knowledge, rather than as a purely constructive force for rural development. As a result, different assemblages and bricolages of farming practice arise that go beyond the dualism of the "modern" and the "traditional." It is possible to find different approximations to markets and technology, as well as important countertendencies to modernization that offer solutions to sustainability.

3) It is not the authoritative intervention of western scientific knowledge that changes the agrarian landscape, but the reconfiguration of knowledge that occurs at the interface with farming practice.
4) The study of heterogeneity is central to strengthening democracy through legitimizing views that do not correspond to official policy. It involves the study of diverse configurations of knowledge and history that change the image of the past, present and future.
5) The study of farming styles as representative of heterogeneity allows farmers to be seen as citizens, continuously engaged in the transformation of policy and geography in the course of their everyday practice.

This thesis has identified a number of promising impact points for rural development policy. Present public courses of action appear to be counter-productive, especially when it comes to improving human health, productivity and sustainability. Sherwood (2009) finds that the enduring legacy of modernization in Carchi appears to be broad scale degradation of soil and water resources, a reduction in crop diversity, rising costs, relative declines in commodity prices and associated losses in the marketplace. Despite initial success in increasing productivity in potato farming, the 'model of modernization' has led to large-scale abandonment of farming, fuelling violence and migration. This socio-environmental decline is clearly counter-productive for the long-term interests of Ecuador, in general, and peasant farming communities, in particular.

Recently, two exhaustive, multi-disciplinary assessments on the global state of agricultural science and development – the International Assessment of Agricultural Science and Technology for Development (IAASTD) (McIntyre *et al.* 2009) and the U.S. National Resource Council's Report on Sustainable Agriculture in the 21rst Century (NRC 2010) – have raised concerns over the complicity of present-day institutions in the on-going food and environmental crisis, in particular as a result of a simple preoccupation with prescriptive solutions, technology, and market integration at any cost. Alternatively, this thesis shows how the political force of modernization is continually shaped by the on-going construction and re-construction of socio-technical networks embedded in the counter movements of peasant agriculture. As a result, despite five decades of aggressive agricultural modernization and ensuing socio-environmental decline, a rich patchwork of diversifying agriculture holds on tenaciously to the hillsides of the northern Andes.

In Carchi, certain styles of farming practice have proven more favourable than others in terms of employment, productivity, economic growth, resource conservation and sustainability. This spontaneously generated diversification of practices provides indisputable evidence of the possibility of more productive, healthy and sustainable agriculture. It represents a powerful example and inspiration for change. The central lesson, however, does not lie in the resulting technology but in the fabric of the socio-technical process. The way forward is not the simple promotion of a particularly attractive farming style but the preservation and promotion of continued diversification in farming practice, which demands a multi-functional policy organized around the continual embedding and re-embedding of agriculture in the context of locality.

Bibliography

Alcázar J., and F. Cisneros. 1997-1998. Taxonomy and Bionomix of the Andean Potato Weevil Complex: Premnotrypes spp. And related Genera. CIP report 1997-1998. Lima. 11 p.

Antle, J.M., D.C. Cole and C.C. Crissman. 1997. Further evidence on pesticides, productivity and farmer health: Potato production in Ecuador. *Agricultural Economics* 2 (18): 199-207.

Antle, J.M., D.C. Cole and C.C. Crissman. 1998. The Role of Pesticides in Farm Productivity and Farmer Health. In: C.C. Crissman, J.M. Antle and S.M. Capallbo (eds). 1998. *Economic, Environmental, and Health Tradeoffs in Agriculture: Pesticides and the Sustainability of Andean Potato Production*. Boston: Kluwer Academic Press, pp. 231-242.

Acosta, A., 1998. *Breve Historia Económica del Ecuador.* Quito, Corporación Editora Nacional, pp. 262

Arce, A. and N. Long. 2000. Reconfiguring modernity and development from an anthropological perspective. In: A. Arce and N. Long (eds.). *Anthropology, Development and Modernities: exploring discourses, counter-tendencies, and violence.* London and New York, Routledge, pp 1-31.

Atkin, J. and K.M. Leisinger (eds). 2000. *Safe and Effective Use of Crop Protection Products Developing Countries*, CABI Publishing, Oxon, UK.

Barrera, V., Norton, G. and O. Ortiz. 1998. *Manejo de las principales plagas y enfermedades de la papa por los agricultores en la provincia del Carchi, Ecuador.* 2nd ed. INIAP, IPM-CRSP, CIP.

Barrera, V. 2000. *Sistematización y análisis de la información relacionada con la cuenca del rio El Ángel, Provincia del Carchi-Ecuador.* Fundación para el desarrollo agropecuario. Proyecto MANRECUR II.

Barsky, O. 1984. *Acumulación Campesina en el Ecuador: Los Productores de Papa en Carchi*. Facultad Latinoamericana de Ciencias Sociales (FLACSO), Quito, Ecuador.

BBC (British Broadcasting System). 2004. Dying to make a living. A two-part world Service series on globalization and pesticides. Aired worldwide in May; available at: wwww.bbc.co.uk/worldservice/specials/1646_dying/.

Boff, L., and C. Boff. 2010. A concise history of liberation theology. In: *Introducing Liberation Theology.* Orbis Books. Reprinted by permission. http://www.landreform.org/boff2.htm

Beckerman, P., and H. Cortés-Douglas. 2002. Ecuador under dollarization: Opportunities and risks. In: P. Beckerman and A. Solimano (eds). *Crisis and Dollarization in Ecuador*. World Bank, Washington , DC, pp. 81-126.

Bebbington, A. 1990. Indigenous Agriculture in the Central Ecuadorian Andes: *The Cultural Ecology and Institutional Conditions of its Construction and Its Change*. Ph.D. dissertation, Clark University, Worchester, MA.

Bernard, R.H. 1988. *Research Methods in Cultural Anthropology. The Foundations of Social Research* (Chapter 2). Newbury Park: Sage, pp. 27-61.

Bernard, R.H. 1994. *Research Methods in Anthropology. Qualitative and Quantitative Approaches*. Participant Observation (Chapter 7), 2nd ed. AltaMira, London, New Delhi.

Bertolote, J.M., A. Fleischmann, A. Butchart, and N. Bebelli. 2006. Suicide, suicide attempts and pesticides: a hidden public health problem. *Bulletin of the World Health Organization*, (84):4.

Cáceres P., M. Pumisacho, G. Forbes and J. Andrade. 2007. Guía para facilitar el aprendizaje sobre control de tizón tardío de la papa. CIP/INIAP/CENACYT. Quito. 142 p.

Callon, M. 1980. Struggles and *Negotiation to Define what is problematic and what is not*. The Socio-logics of Translation. In K.D. Knorr, R. Kronh and R.D. Whitley.

Callon, M. 1986. Some elements of a sociology of translation: domestication of the scallops and the fishermen of St. Brieuc Bay. In: J. Law (ed.). *Power, Action, and Belief*. Routledge and Kegan Paul, London, UK.

Callon, M. 1995. Four Models for the Dynamics of Science. In: S. Jasanoff. *Handbook for Science and Technology Studies*. London: Sage, pp. 30-63.

Callon, M. 1999. Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay. In: J. Law (ed) *Power, Action and Belief: A new sociology of knowledge?* Sociological Review Monograph, 32, London: Routledge and Kegan Paul, pp. 196-233.

Callon, M. and J. Law. 1997. *After the individual in society: lessons on collectivity from science, technology and society*. Canadian Journal of Sociology. Spring 1997 v22 i2 p.165-82. University of Alberta. Canada.

Carpio, F. 1990. La salud ocupacional en el Ecuador. *Cuadernos de Políticas Sociales* No. 6. Políticas de Salud. Quito, Ecuador: ILDIS/ILPES; 1990.

Centro Internacional de la Papa (CIP) and Federación Departamental de Comunidades Campesinas (FEDECH). 2006. Catálogo de variedades de papa nativa de Huancavelica-Perú. CIP and FEDECH. Lima. 205 p.

CIP, 2000. *Salud Humana, Produccion y Medioambiente: Los costos verdaderos de Plaguicidas y Esfuerzos de Cambio en Carchi.* Un programa colaborativo de investigación-acción. CIP document.

Cole, D., F. Carpio, J. Julian, N. Leon, R. Carbotte, and H. de Almeida. 1997a. Neurobehavioural outcomes among farm and non-farm rural Ecuadorians. *Neurotoxicology and Teratology*, 19(4): 277-286.

Cole, D.C., F. Carpio, J. Julian, and N. León. 1997b. Dermatitis in Ecuadorean farm workers. *Environmental and Occupational Dermatitis*, 37: 1-8.

Cole, D.C., F. Carpio, N. Leon, R. Merino, J. Julian. 1998a. Health Impacts of Pesticide Use in Carchi Farm populations. In: C.C. Crissman, J.M. Antle and S.M. Capalbo (eds.). *Economic, Environmental, and Health Tradeoffs in Agriculture: Pesticides and the Sustainability of Andean Potato Production*. Boston: Kluwer Academic Press, pp. 209-230.

Cole, D.C., F. Carpio, J. Julian, and N. León. 1998b. Assessment of peripheral nerve function in an Ecuadorian rural population exposed to pesticides. *Journal of Toxicology and Environmental Health*, 55(2): 77-91.

Cole, D.C., F. Carpio, N. Leon. 2000. Economic burden of illness from pesticide poisonings in highland Ecuador. *Pan-American Review of Public Health*, 8(3): 196-201.

Cole, D.C., S. Sherwood, M. Paredes, L.H. Sanin, C. Crissman, P. Espinosa, and F. Muñoz. 2007. Reducing pesticide exposure and associated neurotoxic burden in an Ecuadorian small farm population. *Internatioal Journal for Occupational and Environmental Helath*, 13:281-289.

Costales, P. and A. Costales. 1971. *Reforma Agraria*. Editorial Casa de la Cultura Ecuatoriana, Quito, Ecuador.

Crissman, C.C., D.C. Cole, and F. Carpio. 1994. Pesticide use and farm worker health in Ecuadorian potato production. *American Journal of Agricultural Economics*, 76: 953-597.

Crissman, C.C., J.M. Antle, and S.M. Capalbo (eds.). 1998. *Economic, Environmental, and Health Tradeoffs in Agriculture: Pesticides and the Sustainability of Andean Potato Production*. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Cristovao, A. *et al.* 1994. Practices of endogenous development in Barroso, Northern Portugal. In: J.D. van der Ploeg, and A. Long (eds), *Born from within. Practice and perspectives of endogenous rural development*, Assen, Van Gorcum, pp. 38-59.

De Noni, G., and G. Trujillo. 1986. La erosión actual y potencial en Ecuador, localización, manifestaciones y causas. In: *La erosión en el Ecuador*. Documentos de investigación, CEDIG, Quito, Ecuador.

Den Ouden, Jan H.B. 1995, *Who's for work?* The Management of Labour in the process of accumulation in three Adja Villages, Benin. Africa 65.

Día a Día. 2001. *Amarga Cosecha* (Bitter Harvest), 20-minute documentary produced by Rodolfo Asar. (aired in Ecuador in September and October).

Encarta dictionary: English (UK) 2007.

Espinosa, P. and C.C. Crissman. 1997. *Raíces y Tubérculos Andinos. Consumo, aceptabilidad y procesamiento.* Centro Internacional de la Papa. Quito, pp. 63.

Espinosa, P. 2000. *Estudio de línea de base sobre el conocimiento y manejo de los pesticidas en el Carchi.* Encuestas del proyecto Ecosalud del fondo CIID. CIP document.

Food and Agriculture Organization of the United Nations. 2003. International code of conduct on the distribution and use of pesticides. Rev. ver. Rome, Italy: Food and Agriculture Organization of the United Nations.

Gallagher, K. 1999. *Farmer Field Schools (FFS): A Group Extension Process Based on Adult Non-formal Education Methods*. Global IPM Facility, Rome, Italy, pp. 7.

Gallegos, P., G. Avalos, and C. Castillo. 1997. *El Gusano Blanco de la Papa* (Premnotrypes vorax) *en el Ecuador: Comportamiento y Control*. INIAP, Quito, Ecuador.

Garcia, J. 2001. *El mito del manejo 'seguro' de los plaguicidas en los países en desarrollo: De la A a la Z*, pp. 8.

Giddens, A. 1976. *New rules of Sociological Method: A positive Critique of Interpretive Sociology*. London: Hutchinson.

Giddens, A. 1990. *The Consequences of Modernity*. Polity Press, Cambridge, UK.

Giddens, A. 1997. *Política, sociología y teoría social. Reflexiones sobre el pensamiento social clásico y contemporáneo.* C. Salazar (Trad.). 300 p.

Green, J., and Thorogood N. 2009. *Qualitative Methods for Health Research.* Second Edition. London: SAGE Pub. Ltd., pp. 304.

Guerrero, A. 1983. Haciendas, Capitales y lucha de clases andina. Quito: Editorial El Conejo.

Hamilton M. (To appear). Unruly Practices: What a Sociology of Translations can offer to educational policy analysis. In: T. Fenwick T. and R. Edwards. *Educational Philosophy and Theory Special Issue on "Actor Network Theory"*.

Haraway, D. 1989. *Primate Vision: Gender, Race, and Nature in the World of Modern Science*. Routledge, New York, NY.

Harden, C. 1991. Andean soil erosion: *a comparison of soil erosion conditions in two Andean watersheds*. National Geographic Research and Exploration, 7(2): 216-231.

Herrera, M., H. Carpio and G. Chávez. 1999. *Estudio sobre el Subsector de la Papa en el Ecuador*. Programa Nacional de Raíces y Tubérculos, Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP), Quito, Ecuador.

Hebinck, P. 1995, Intervention and the black box: a case study of maize farming in Nandi District Kenya, in: Frerks, G & J. den Ouden (eds.), *In Search of the Middleground. Essays on the sociology of planet development*, Wageningen Agricultural University.

Hebinck, P. and J.D. van der Ploeg. 1997. Dynamics of agricultural production. An analysis of micro-macro linkages In: H. de Haan and N. Long (eds.). *Images and Realities of Rural Life*. Wageningen Perspectives on Rural Transformations, Assen, Van Gorcum, 1997, pp. 202-226.

Hebinck, P. 2008. Land reform, scripts and social space: emergent properties in rural South África. In: P. Hebinck, S. Slootweg and L. Smith (eds.). *Tales of Development. People, Power and Space*. Van Gorcum, Assen, pp. 33-50.

Howard-Malverde, R. 1997. *Creating Context in Andrean Cultures*. Oxford Studies in Anthropological Linguistics

Ibarra L.A. 2005. Cantón Espejo, Carchi: *Pueblo, Historia y Cultura*. Quito. 342 p.

IFAD and CropLife. 2001. *Una iniciativa publica-privada en el pro del desarrollo*. Information bulletin. Rome, Italy, pp. 16.

INEC. 2002. *Tercer Censo Nacional Agropecuaria*. Instituto Nacional de Estadisticas y Censos (INEC), Quito, Ecuador.

CIP-INIAP. 2003. *Huacho Rozado: Evaluación y Fortalecimiento de un Sistema de Labranza Reducida en Papa*. MAG-PROMSA proyecto IQCV-067, Quito, Ecuador.

INIAP-CIP. 2004. *Eco-suelos: Investigación para un Manejo más Productivo y*

Sostenible de Suelos Andinos en la Ecoregión Centro-norte del Ecuador. MAG-PROMSA proyecto IQCV-42, Quito, Ecuador.

Knapp, G. 1991. *Andeanecology: adaptive dynamics in Ecuador.* Boulder, Col.: Westview Press. 220p.

Knorr-Cetina, K. 1999. *Epistemic Cultures: How the Sciences Make Knowledge.* Harvard University Press, Cambridge, MA.

Latour, B. 1987. *Science in Action: How to Follow Scientists and Engineers Through Society.* Harvard University Press, Cambridge, MA.

Latour, B. 1999a. Morale et technique: la fin des moyens. In: *Réseaux, numéro special anniversaire*, numéro 100, pp. 39-58. (Morality and technology: the end of the means. English translation. Theory and Society 1999, pp. 11.)

Latour, B. 1999b. Bodies on Trial. Paper for Akrich &Berg. Duke University Press.

Law, J. 1992. *Notes on the Theory of the Actor Network.* Social Science Studies Centre, Lancaster University, Lancaster, UK.

Law, J. 2004. *Enacting Naturecultures: A Note from STS.* Centre for Science Studies, Lancaster University, Lancaster, UK.

Lehman D. 1986 "Sharecropping and the Capitalist Transition in Agriculture. Some Evidence from the Highlands of Ecuador", Journal of Development Economics, 23: 333-354.

LEISA. 2003a. Learning with farmer field Schools. *LEISA Magazine for Low External Input and Sustainable Agriculture,* March, 19(1).

LEISA. 2003b. *Aprendiendo con las ECAs. LEISA* Revista de Agroecología (Latin America edition), June, 19(1).

Long, N. 2001. *Commoditization and issues of social value: A theoretical excursion. Development sociology: Actor Perspectives.* London and New York, Routledge. 22 P.

Long, N. and J.D. van der Ploeg. 1988. *New challenges in the sociology of rural development.* Sociology Ruralis, XXVII.

Long, N. and A. Long, (eds.). 1992. *Battlefields of Knowledge: The Interlocking of Theory and Practice in Social Research and Development.* Routledge, London, UK and New York, NY.

Long, N. and M. Villarreal. 1993. 'Exploring Development Interfaces: From the Transfer of Knowledge to the Transformation of Meaning'. In: F.J. Schuurman (ed.). *Beyond the Impasse: New Directions in Development Theory.* London and New Jersey: Zed Press, 140-168.]

Long, N. 1996. 'Globalization and Localization: New challenges to Rural Research'. In: H. Moore (ed). *The Future of Anthropological Knowledge.* London and New York: Routledge, pp. 37-59.

Long, N. 1997. *An Introduction to the Sociology of Rural Development.* Tavistock Publications. London and New York.

Long, N. 2001. *Commoditization and issues of social value: A theoretical excursion.* Development sociology: Actor Perspective. London and New York, Routledge, pp. 22:49.

Long N. 2004. Actors, interfaces and development intervention: meanings, purposes and powers. In: T. Kontinen (ed.). *Development Intervention Actor and Activity Perspectives*. Helsinky – Helsingfors, pp. 15-36.

Llovet, I., O. Barsky and M. Murmis. 1986. Caracterización de estructuras de clase en el agro ecuatoriano. In: M. Murmis (ed.). *Clase y Región en el Agro Ecuatoriano*, Biblioteca de Ciencias Sociales Vol. 7. Proyecto FLACSO – CERLAC II. Corporación Editorial Nacional, Quito.

Marchán. C. 1986. Estudio Introductorio. In: *Biblioteca Básica del Pensamiento Ecuatoriano.* Vol. 23. Banco Central del Ecuador, pp., 13-67.

Martínez L. 1983. Capitalismo Agrario: Crisis e Impacto. In: *Ecuador: presente y futuro.* Editorial El Conejo. Quito, 37-84 p.

Martínez L. 1992. *El empleo rural en el Ecuador.* Documentos de Investigación N2. Instituto. INEM ILDIS. Quito, 58 p.

Martínez L. 2000. *La Investigación rural a finales de siglo.* In: Martínez L. (ed.). Estudios Rurales. Flacso-Ecuador. 306 p.

Mayer E. 2002. Alguito Para Ganar ("A Little Something To Earn"): Profits and Losses in Peasant Economies (With Manuel Glave). In: *The articulated peasant: Household Economies in the Andes.* E. Mayer. Westview press Colorado and Oxford., pp. 205-237.

Mayer, E. 2009. *Ugly Stories of the Peruvian Agrarian Reform.* Durham: Duke University Press.

McIntyre B.D., H.R. Herren, J. Wakhungu, and R.T. Watson RT, (editors). 2009. *International Assessment of Agricultural Knowledge, Science and Technology for Development* (IAASTD): Global Report. Available at: http://www.agassessment.org (referened: 7 November 2010).

Mera, V. 2001. Paying for survival with health: potato production practices, pesticide use and gender concerns in the Ecuadorian highlands. *Journal of Agricultural Education and Extension*, December 8(1): 31-40.

Mera-Orcés, V. 2000. *Agroecosystems Management, Social Practices and Health: A Case Study on Pesticide Use and Gender in the Ecuadorian Highlands.* Canadian-CGIAR Ecosystem Approaches to Human Health Training Awards, IDRC, Ottawa, CA.

Merino, R. and D. Cole. 2003. Presencia de plaguicidas en el trabajo agrícola, en los productos de consumo y en el hogar. In: D. Yanggen, C. Crissman, and P. Espinosa (eds.). *Los Plaguicidas: Impactos en Producción, Salud, y Medioambiente en Carchi, Ecuador.* Ediciones Abya-Yala, Quito, Ecuador, pp. 71-94.

Morales, C., S. Parada, and M. Torres. 2005. *Los Impactos diferenciados del Tratado de Libre Comercio Ecuador – Estados Unidos de Norte América sobre la agricultura del Ecuador.* Unidad de Desarrollo Rural de la CEPAL. Proyecto "Apoyo al Sector rural para facilitar la información y participación en el proceso del Tratado de Libre Comercio" No. 00038896.

Murray, D. and P.L. Taylor. 2000. Claim no easy victories: evaluating the pesticide industry's global safe use campaign. *World Development*, 28: 1735-1749.

NPAG. 2006. NPAG Data: Tecia solanivora. Central American Potato Tubermoth. A Potential Threat to American Potato Growers. 8 p.

NRC. 2010. *Towards Sustainable Agriculture Systems in the 21rst Century. Committee on Twenty-First Century Systems Agriculture.* US National Research Council, National Academy Press, Washington, DC. Available at: www.nap.edu/catalog/12832.html. 598 pp.

Nuijten, M. 2002. *Corruption as Part of Governance.* Paper presented to the panel on Ethnographies of Governance, EASA conference, Copenhagen, Denmark.

Ochoa, C.M. 1999. Las papas de Sudamérica: Perú (Parte 1). Allen Press, Kansas, Estados Unidos.

Ochoa, C.M. 2001. Las papas de Sudamérica: Bolivia. Centro Internacional de la Papa (CIP), Instituto Francés de Estudios Andinos (IFEA), Lima, Perú, 2001.

Orozco F, Cole D.C, Muñoz V, Altamirano A, Wanigaratne S, Espinosa P, Muños F. 2007. R*elationship among production systems, pre-school nutritional status and pesticide – related toxicity in seven Ecuadorian communities – a multi-case study approach.* Food Nutr Bull; 28, (2 , suppl.): S247-257.

Orozco F, Cole D.C, Forbes G, Kroschel J, Wanigaratne S, Arica D. 2009. *Monitoring adherence to the International FAO Code of Conduct on the Distribution and Use of Pesticides* – highly hazardous pesticides in central Andean agriculture and farmers' rights to health. International Journal of Occupational and Environmental Health 15(3); 255-268.

Otañez, G. 2005. Ecuador: *Breve Análisis de los Resultados de las Variables del Censo Nacional Agropecuario 2000*. SCNA/SEAN/INEC. 28 P

Paredes, M. 2001. *We are Like the Fingers of the Same Hand: Peasants' Heterogeneity at the Interface with Technology and Project Intervention in Carchi, Ecuador*. MSc thesis, Wageningen University, Wageningen, The Netherlands.

Pink, S. 2009. 'About Doing Sensory Ethnography', pp 1-4. In: S. Pink (ed.). *Doing Sensory Ethnography*. London: Sage.

Preston, W. 1996. *Development Theory: An Introduction*. Oxford, Cambridge, Blackwell.

Pumisacho, M. and S. Sherwood, (eds.). 2000. *Herramientas de Aprendizaje: Manejo Integrado del Cultivo de la Papa*. Abya-Yala, Quito, Ecuador.

Pumisacho, M. and S. Sherwood, (eds.). 2002. *El Cultivo de la Papa en Ecuador*. INIAP and CIP, Quito.

Pumisacho, M. and S. Sherwood, (eds.). 2005. *Escuelas de Campo de Agricultores en América Latina: Guía para Facilitadores*. INIAP, CIP and World Neighbors, Quito, Ecuador.

Richards, P. 1995. Cultivation: *knowledge or performance?* In: Hobart, M. (ed), An anthropological critique of development: the growth of ignorance. EIDOS, Routledge. London. Pp: 61-78.

Reigart, J. R. and J.R. Roberts. 1999. *Recognition and Management of Pesticide Poisonings*. 5th ed. Washington. Published in: http://www.epa.gov/pesticides/safety/healthcare.

Remmers, G.G.A. 1998. *Con cojones y maestría: un estudio sociológico-agronómico acerca del desarrollo rural endógeno y procesos de localización en la Sierra de la Contraviesa (España)*, Wageningen Studeies of Heterogeneity and Relocalization, 2, CERES. LUW, Wageningen. The Netherlands.

Schultz, A. 1962 Collected papers. (Vol. 1) The Hague: *Netherlands: Martinus Nijhoff.*

Sherwood, S. 1998. *Wachu Rozado: Vestigio del Pasado, Oportunidad para el Futuro*. Report on highland covercrop and green manure systems, Centro International de Informacion sobre Cultivos de Cobertura (CIDICCO) and the Rockefeller Foundation. Tegucigalpa, Honduras.

Sherwood, S., R. Nelson, G. Thiele, and O. Ortiz. 2000. Farmer Field Schools in potato: a new platform for participatory training and research in the Andes. *LEISA Magazine on Low External Input and Sustainable Agriculture*, 16(4): 24-25.

Sherwood, S., C. Crissman, and D. Cole. 2002. Pesticide exposure is poisoning in Ecuador: a call for action. *Pesticide News.*

Sherwood, S., D. Cole, and M. Paredes. 2003. Estrategias para prevenir la exposición a plaguicidas. In: D. Yanngen, C. Crissman, and P. Espinosa (eds.). *Los Plaguicidas: Impactos en Salud, Productividad y Ambiente en Carchi, Ecuador.* CIP, INIAP, and Abya Yala, Quito, Ecuador, pp. 180-194.

Sherwood, S., D. Cole, C. Crissman, and M. Paredes. 2005. From Pesticides to People: Improving Ecosystem Health in the Northern Andes. Chapter 10. In: J. Pretty (ed.). *The Pesticide Detox: Towards a More Sustainable Agriculture.* Earthscan, Publications, London, UK, pp. 147-165.

Sherwood, S., D. Cole, and D. Murray. 2007. It's time to ban highly hazardous pesticides. *LEISA Magazine on Low External Input and Sustainable Agriculture*, 23(3): 32-33.

Sherwood, S. 2009. Learning From Carchi. Agricultural Modernization and the Production of Decline. Ph.D. thesis, Wageningen University. Wageningen, 286 p.

Solo de Zaldivar V.B. 2008. From agrarian reform to ethnodevelopment in the highlands of Ecuador. *Journal of agrarian change* (8)4: 583-617.

Vademécum Agrícola Ecuador. 2004. Edifarm & Cía. Quito, Ecuador, pp. 920.

Valverde, F., J. Cordoba, and R. Parra. 2001. Erosion de suelo causada por labranza con maquinaria agrícola (arado y rastra) en Carchi, Ecuador. *Report for the USAID Soil Management* CRSP, INIAP, Quito, Ecuador.

van der Fliert, E. 2006. The role of the Farmer Field School in the transition of sustainable agriculture. In: A.W. van den Ban, and R.K. Samanta (eds.). *Changing Roles of Agricultural Extension in Asian Nations.* B.R. Publishing Corporation, Delhi, India, pp. 325-342.

van der Ploeg, J.D. 1989. Knowledge Systems, Metaphor and Interface: The Case of Potatoes in the Peruvian highlands. In: N. Long et al, (eds). *Encounters at the Interface: A perspective on social discontinuities in rural development.* Wageningen, pp. 145-163.

van der Ploeg, J.D. 1990. *Labour, Markets, and Agricultural Production.* Westview Press, Oxford.

van der Ploeg, J. 1993a. Potatoes and knowledge. In: M. Hobart (ed.). *An Anthropological Critique of Development.* Routledge, London, UK, pp. 209-27.

van der Ploeg, J.D. 1993b. The reconstitution of locality: technology and labour in modern agriculture. In: Marsden, T. et al. (eds), *Labour and Locality. Uneven development and the rural labour process*, London, David Fulton Publ, pp. 19-44.

van der Ploeg, J.D. 1994. Styles of Farming: an introductory note on concepts and methodology. In: Ploeg, J.D. van der & A. Long (eds), *Born from within. Practice and perspectives of endogenous rural development,* Assen, Van Gorcum, pp. 7-31.

van der Ploeg, J.D. 1995. Agricultural production and employment: differential practices and perspectives, in: Verhaar C. and de Klaver (eds), *The functioning of economy and labour market in a peripheral region - the case of Friesland, Leeuwarden*, Fryske Akademy, 1995, pp. 68-93

van der Ploeg, J.D. 1997. Potatoes and knowledge. In: *An anthropological critique of development*, pp. 209-227.

van der Ploeg, J.D. 2003. *The Virtual Farmer: Past, Present, and Future of the Dutch Peasantry.* Royal van Gorcum Assen, The Netherlands.

van der Ploeg, J.D. 2008. The New Peasantries. Struggles for autonomy and sustainability in an era of empire and globalization. Earthscan, London, 356 p.

Veen, M. 1999. *The Development of Land Use and Land Management and their Effects Upon Soils in Processes of Mechanical Erosion and Compaction: A Case Study for a Potato-production Area in the Northern Andes of Ecuador,* MSc thesis, Department of Soil Science and Geology, Wageningen University, Wageningen, The Netherlands.

Viteri Díaz, G. 2007. *Situación de la salud en el Ecuador* In: Observatorio de la Economía Latinoamericana, N. 77. Available at: http://www.eumed.net/cursecon/ecolat/index.htm

Waterna D. 2006. Styles of making a living and ecological change on the Fon and Adja plateaux in South Bénin, c.a. 1600-1900. Ph.D. thesis Wageningen University. Wageningen, 700 p.

Yanggen, D., C. Crissman, and P. Espinosa, (eds.). 2003a. *Los Plaguicidas: Impactos en Producción, Salud y Medio Ambiente en Carchi, Ecuador.* CIP, INIAP, and Abya-Yala, Quito, Ecuador.

Yanggen, D., C. Crissman, S. Sherwood, and D. Cole. 2003b. Lecciones y sugerencias para el futuro. In: D. Yanggen, C. Crismann, P. Espinosa (eds.). *Los Plaguicidas: Impactos en Produccion, Salud y Medio Ambiente en Carchi, Ecuador.* INIAP, CIP, and Abya-Yala, Quito, Ecuador, pp. 176-196.

Zimmerer, K.S. 1997. Changing Fortunes: Biodiversity and Peasant Livelihood in the Peruvian Andes. California Studies in Critical Human Geography. 309 p
Zimmerer, K.S. and T.J. Basset. 2003. *Political ecology: an integrative approach to geography and environment-development studies*. The Gilford Press, New York.

Web pages

http://www.croplifela.org, 2010
http://www.utexas.edu/cc/docs/stat53.html#fn, 2007
http://www.eclac.org, 2007

Appendixes

Appendix 4.1. Sample selection and timing of the study between 1999 and 2001 (summarized from Paredes 2001)

Sample Selection

For the selection of the families to visit, I made a preliminary typification in collaboration with the field co-ordinator of the Farmer Field Schools and the co-ordinator of the socio-economic survey that was being carried out by the Ecosalud project. We used the list of participants in the first cycle of the Farmer Field Schools (one FFS cycle took six months), 31 in San Francisco, 25 in Santa Martha and 25 in San Pedro de Piartal. Because the project was already in its second cycle, the sample included farmers who had decided not to participate in that cycle. Farmers in the lists had between 1 to 30 hectares of land and the lists also included some labourers. We divided the list of each community according to the following criteria:

Farm size: small, medium, and big.
Collaboration in FFS: active, medium, and passive.
Level of pesticide application: average and exaggerated.
Family characteristics: number of members and age.
Wealth: rich, medium, and poor.

Criteria such as 'rich', 'medium', and 'poor' were relative to the information and the experience that the co-ordinators had with the families. Moreover, the criteria vary according to the community; for instance, farmers from San Francisco tend to produce in smaller areas than in Santa Martha. Thus the selection was based on comparisons within the communities.

Since we did not know whether it would be possible to work with all the families selected in a community, we selected six families that, according to the criteria, represented different characteristics. From those families three were selected once I was in the community, depending on the willingness of the family to collaborate in the study. In San Pedro and Santa Martha the families selected corresponded to three different farming styles, but in San Francisco farmers classified the selected families into only two styles. Thus the farmers I worked with advised me to visit a family that was not selected by the co-ordinators, but that according to them practised a different style, or as the farmers called them, a family of *Intermedios*.

Most of the farmers selected were attending the Farmer Field Schools, but two farmers, who corresponded to the style of the *Intermedios,* had already left the project after the first cycle. I worked with 9 families in 3 communities: 3 in San Francisco de la Libertad, 4 in San Pedro de Piartal and 2 in Santa Martha de Cuba.

The Unit of Analysis

When selecting the sample, the co-ordinator of the Farmer Field Schools, who was a man, referred to each case as "the farmer," meaning the person who attended the FFS meetings. On the other hand, the co-ordinator of the survey was a woman, and referred to each case as "the family." In both cases, the selection meant that I would interact with the people living in a particular house. In three cases the "farmers" selected were young men who were living in the house of their parents, and in some cases more than one family lived in the same house.

Therefore, although it is clear that I selected the family or families living in a house as if it were a 'unit', it was not possible that families living in the same house could be methodologically separated or mixed. I also did not distinguish clear-cut boundaries of a 'household' when families were sharing the production resources but lived in different houses. The analysis then draws upon empirical evidence and focuses mainly, but not only, on the relations within the family or families involved in the process of farm production.

With these considerations, in this study I use the term 'family' for persons living in the same house, and "farmers" for the persons who participated (although not exclusively) in agricultural production. This involves men and women and sometimes teenagers.

For the differentiation of farming styles, I identified the families living together in a house as the "unit" of negotiation that gives way to the structuring of a farming style. To avoid committing ecological fallacy[133] with the label 'family', per Bernard (1988: 47), the "farmers" within a family are the lowest level unit of analysis with whom I collected my data. Children, however, sometimes appear as 'informants'.

For the analysis of the intervention, my unit of analysis was the FFS in Santa Martha de Cuba. When necessary, I quoted farmers participating in FFS in other communities. In the analysis I refer to the CIP/INIAP project, because it was the framework for implementing the FFS.

---

[133] Drawing conclusions from the wrong units of analysis, usually making generalisations about people from data about groups is known as "ecological fallacy" (Bernard, 1988: 47).

Living with the Families

Different factors made me decide to adopt the role of an 'observing participant' (Bernard 1994: 138), involving myself in farm activities. In the first place, to understand farming in its locality it was important for me to understand the process of potato production in practice. In the second place, research based on long surveys was going on in the communities at that moment. Being a 'participant observer', it was not easy to understand complexity to the extent I attempted.

Therefore, CIP/INIAP staff introduced me to each family as a "student doing her thesis." Therefore I was rarely identified as a member of the project. I explained to each family that I wanted to learn about the different ways in which families produce potatoes, in order to write a thesis about that. I also asked the families for work as an 'inexperienced labourer' without payment for 2 or 4 days. In general all the families were eager to accept that, and when people did not answer my request I did not ask again.

I lived with each family for a period of 2 to 4 days depending on their activities and weather conditions. In Carchi it rains the whole year through. When the rain is strong, it is possible to milk the cows but not to work in the potato fields. I usually worked with family members in potato activities for 2 or 3 days and in cattle and home activities for one day.

I elaborated a checklist with all the aspects I wanted to know. To assess this information, I relied on daily talks with family members during their fieldwork. When they noticed my inexperience about the different practices, farmers themselves explained to me "how to do" things in detail. Children were very helpful in talking about pesticide intoxications. When I had questions remaining, I asked family members about my doubts. I took notes during coffee breaks and after meals, and I included my own observations during the day. A complimentary interest during the fieldwork was the documentation of local practices of potato production, such as the *wachu rozado* system.

The Situational Analysis

To analyse the activities of the Farmer Field Schools, I attended five meetings and two workdays in the FFS in Santa Martha. I chose this community because the co-ordinator explained to me that this was the school with the most difficulties in group's collaboration. I explained to the farmers that I wanted to know how the FFS worked in order to include that in my thesis. I took notes on the activities and discussions within the group.

The observations and discussions of the FFS are presented in this study as situational analysis. This means that instead of presenting my judgements about the accomplishment of FFS objectives, I relate what was said and what I observed in actual situations to the particular behaviour of the participants as part of the analysis (van Velsen 1967: 139-140). I also made use of situational analysis in the case of pesticide applications, since one of my interests was to contrast what people were saying and what they were doing.

Narratives and Documents

A narrative is a form of storytelling that presents events in linear fashion, and can impose and sustain one preferred version of events over and above all others (Howard-Malverde 1997: 13). However, in my study I translated actors' narratives into contrasting views, to support my observations or to describe or explain the history of a family in the process of agricultural production. Furthermore, I also documented actors' accounts and interpretations of project activities. Those are called operational narratives (van der Does and Arce 1998) since they represent actors' perceptions of their possibilities for manoeuvre and discourse within the social field of a project and in its different 'phases' of implementation (p. 86). Project documents were important sources for me to understand the "plan" of the CIP/INIAP project and the discursive claims for intervention.

Appendix 4.2. Description of the *wachu rozado* system and its comparision with full tillage

In 1998, based on a field visit, Sherwood (1998) noticed the practice of *wachu rozado* in some communities in Carchi and decided to extract information about this practice from a database of farmers who collaborated with a study for the International Potato Center (CIP). This preliminary data on *wachu rosado* is presented in table A2 and gave origin to further studies on this potato planting system in Carchi (by that time, numerous studies had been done already in Colombia). Here I present information on the first and subsequent studies done about the practice and results of *wachu rosado* in Carchi combined with farmers' accounts of this system.

The Kichwa and Spanish of *wachu rozado*

In Kichwa (an Andean language), "*wachu*" means furrow and "*rozar,*" in Spanish, means to cut, so this practice consists of land preparation through cut furrows of grassland. According to farmers' accounts, it is necessary that *wachu rozado* follow a pasture period, or that it be made on *páramos* (where native grass grows).

Farmers use *wachu rozado* to turn pastures into potato fields, but some farmers also plant melloco (*Ullucus tuberosus*) and oca *(Oxalis tuberosa*) under this system. After *wachu rozado*, farmers continue with 1 or 2 cycles of potato and 2 or 3 years of fallow in pasture. Occasionally farmers rotate wheat, maize, beans, vicia, and green peas before such fallow cycles (Sherwood 1998).

A particularity of this system is that the furrows for *wachu rozado* go top-to-bottom down the slopes. As a farmer explains, this way facilitates the work: "To start planting, the direction of the furrows has to be top-downward in the field; otherwise it is almost impossible to cut the grass equally on both sides of the furrow."

To prepare a furrow it is necessary to cut the pasture in two fringes of about 0.5 meter. Once farmers cut the pasture on both sides of the fringe, blocks of grass ("chambas") from both sides are folded towards the centre. Thus the inside of the furrow becomes green manure. The furrows are formed in the direction of the pendent and the soil on the pathways is removed and serves to cover the seed and for the subsequent tasks of hilling and weeding. The literature mentions that sowing occurs 15 days after soil preparation (CIP-INIAP 2003: 13) but in my study, farmers explained that it is possible to sow potatoes the day after land preparation.

The rest of the cultivation practices do not vary from the conventional way of cultivating potato, except that *wachu rozado* avoids the first weeding. When comparing *wachu rozado* with the conventional system, labour, technology, and markets deserve detailed explanations as presented in the next section.

Farmers and technicians' perspectives on wachu rozado

During my first study (in 2000), three of the *Seguros* had one field in *wachu rozado*, and none of the other farmers did. During my second study (2003-4), 22 farmers included in the sample practiced this system and they were mostly living in Mariscal. Table A1 presents a summary of the farmers' perceptions on the advantages and disadvantages of *wachu rozado* as well as the different conclusions found in some studies and research done in this system by technicians.

Different perceptions on labour use

Explanations of the non-use of *wachu rozado* mention practical reasons, but most narratives show that in the context of Carchi and for most farmers who planted in full tillage this system is considered a non-modern technology, "only used in *páramos*." Thus from the perspective of farmers who planted in full tillage, "modern" soil preparation is always done not only with as little labour as possible but also with "modern" means such as tractor. Consistently, one of the narratives that talk about "laziness" shows a common tendency to avoid manual labour.

> "Wachu rozado is mostly good for the *páramos*. There the land is poor and you should not plough, because all the nutrients get lost. I do not have *páramo* land so I do not sow in *wachu rozado*." An Arriesgado in Santa Martha

> "We do not sow in *wachu rozado* anymore because we are lazy (*perezosos*); we go for the easiest way with a tractor even when we know that *wachu rozado* is better." An Arriesgado in San Pedro

> "A lot of people work in *wachu rozado* because the potatoes get a nice red colour, which is good because it increases the price. It also produces the same as the 'normal' way, but you have to work hard manually ('a fuerza de brazo'). The problem is that during summer the furrows get dry very fast, so you need to irrigate but we do not have irrigation channels here." An Arriesgado in San Francisco

Table A2 shows that in the data of 1998, *wachu rozado* required more labour days (207) than the conventional system using tractor or oxen (162). This was confirmed by my data from 2003 (see table 5.5 in chapter 5). However, *wachu rozado* requires fewer labour days (50 to 75%) than the conventional system on hillsides where only manual labour can be used for land preparation. This is because *wachu rozado* avoids ploughing, lining, ridging, and one weeding. That is why farmers who practiced *wachu rozado* in my study mentioned that comparing *wachu rozado* with mechanised tillage was 'unfair'; labour should be compared when only manual labour was used.

In my second study I found that farmers who practiced *wachu rozado* made cheaper labour arrangements with organized teams (*cuadrillas*) who charged less than daily hired labourers. This is different where individual labourers are predominantly contracted and farmers tend to reduce labour by means of mechanisation. Given the advantages that some farmers found in practicing *wachu rozado* (see table A1), it seems that farmers who planted with this system seek to reduce costs more than manual labour. Additionally some farmers mentioned that the intensification of potato production through mechanization implies less fallow time and less rotation with grassland, thus more incidences of soil pests.

Results on soil erosion

In 2000, through a simulation model, Kantebeen found that the effect of *wachu rozado* on the organic matter contents was 0.25% to 0.50 % more than full tillage. The researcher explained that this effect was mostly due to soil erosion, which is controlled more under *wachu rozado* than under full tillage (Kantebeen 2000:70). In 2003, researchers concluded that during land preparation and harvest, *wachu rozado* reduced soil erosion to 15 t/ha while in full tillage the erosion was 40.7 t/ha (CIP-INIAP 2003:13).

Soil pests and disease management

In 2000 farmers mentioned that the incidence of the Andean weevil (*Premnotrypes vorax*) and late blight (*Phytophtora infestans*) was lower in *wachu rozado*. The CIP-INIAP research in 2003 (involving comparative fields between *wachu rozado* and full tillage) confirmed this asseveration. The researchers concluded that there was less severity of infection due to late blight and a lower percentage of potato tubers with damage of Andean weevil as well as multiple diseases, such as sarna (*Streptomyces scabies*) and rhizoctonia (*Rhizoctonia solani*) under *wachu rozado* than in full tillage, both in dry and rainy seasons (CIP-INIAP 2003: 79, 118).

The literature suggests that the environment inside the furrows in *wachu rozado* is antagonistic to the Andean weevil for physical, chemical, and/or biological reasons. Moreover, excess of water is a common problem in Carchi during the rainy season and all through the year in *páramo* lands. The direction of the furrows in *wachu rozado* allows excess water to drain downhill, and decreases the humidity of the microclimate, which could interfere with the development of the fungus-like causal organism of late blight. Furthermore, decomposition of the pasture inside the furrows increases temperature, which probably is non-favourable for the development of the pathogen (Sherwood 1998).

Consequently, some farmers said that in *wachu rozado* it was possible to reduce pesticide applications by one third. Yet table A2 shows that the use of pesticides and fungicides in *wachu rozado* in 1998 was not significantly different. Even more, table 5.5 in chapter 5 shows that farmers who plant in *wachu rozado* applied significantly more thiocarbamates and other pesticides than farmers planting in full tillage. Farmers explained that the wet environment in which they practice *wachu rozado* is more conducive to late blight attacks than other places. That is why in both studies (1998 and 2003) the comparison could be called "unfair" according to farmers because the situation of the fields was not comparative. Additionally, although farmers applied less carbamates (highly toxics) in *wachu rozado* than in full tillage this difference was not significantly different.

Table A1. Farmers' and technicians' qualifications of *wachu rozado* when comparing it with the conventional system (full tillage)

Disadvantages of *wachu rozado*
FARMERS' PERSPECTIVE
Needs manual labour Dries fast during summer requiring irrigation Always requires grassland Only suitable for páramos and wet environments
TECHNICIANS' PERSPECTIVE
High demands of manual labour limits that more farmers use this system This system is more common in steep hillsides but it is more possible to use tractors on steep lands and farmers prefer to plant in full tillage with mechanized preparation.
Advantages of *wachu rozado*
FARMERS' PERSPECTIVE
It is possible to sow immediately after land preparation Potatoes germinate faster Keeps pests away

During rainy season potatoes do not get rotten Harvested potatoes acquire a nice red colour The covering grass and its roots reduce soil erosion more than full tillage
TECHNICIANS' PERSPECTIVE
Pest and disease management and potential benefits for human health Creates an antagonistic environment for the proliferation of diseases and soil pests Increases the rotation of potatoes with grass which also reduces soil pest population Reduction of diseases and soil pests reduces the application of highly toxic pesticides in quantity and number of applications Soil conservation Avoids soil compaction Reduces mechanical movement (mainly in hillsides) Grass decomposition provides nutrients to the crop and increases macro and micro organisms Productivity Is more productive than full tillage Requires 50 to 75% less labour than full tillage when soil is prepared only manually Requires less energy than mechanical soil preparation with tractor Requires less seed per hectare than full tillage Soil pests reduction allow including an extra potato cycle in rotation with pastures Soil pests reduction allows reducing the quantity and number of pesticide applications Due to its reduction effect on soil compaction and erosion, is a more sustainable production system than full tillage in the long term **Other** Requires 25 more labour days than soil preparation with tractor thus, it generates employment. It allows planting potatoes between 8 to 15 days after soil preparation (earlier than full tillage). The farmer obtains production in less time and can plan the crop for seasons with best selling prices. Allows planting potatoes in highly humid areas and during strong rainy seasons. The potatoes have better quality (best colour and less pest damage) which gets a better price

Table A2. Comparison between the conventional system (with tractor and oxen) and *wachu rozado* (fields after pasture)

Characteristic	Complete tillage (tractor) (n=145)	Wachu Rozado (n=33)	Significance (T-test; p=.10)
Rotation	Pasture-potato-potato-pasture	Pasture-potato-potato-potato-pasture	N/A
Frequency	81.2% (145)	18.8% (33)	N/A
Distance of field from house	2.022 m	1.717 m	No
Altitude of field	3.015 masl	3.129 masl	Yes
Slope of field	17,21%	18,94%	No
Area planted/field	7.059 m²	5.029 m²	Yes
Labour	162 man days	207 man days	Yes
Traction (mechanised and oxen)	$47.10	$31.16	Yes
Use of seed	1,758 kg $163.84	1,665 kg $152.25	Yes
Pesticides			
Fungicides	$131.39	$153.13	No
Insecticides	$74.51	$57.85	Yes
Total use of pesticides	$205.90	$210.96	No
Fertilisation:			
Nitrogen	141 kg	150 kg	No
Phosphorus	319 kg	387 kg	No
Potassium	160 kg	162 kg	No
Foliar applications	$21.85	$26.93	No
Total fertilisation	$328.09	$359.11	No
Production	21.1 t./ha $2,262.36	22.3 t/ha $2,399.12	No
Profit	$591.89	$592.61	No

Note: Due to the lack of studies on the system, data was extracted from a general database. The fields were not comparative, so results should be viewed as preliminary. Source: Sherwood (1998)

Appendix 4.3. Qualitative and quantitative comparision of farming styles (2000 vs. 2003-2004)

		Qualitative analyses*	Quantitative analysis
Farming style	Community	Number of cases	Number of cases
Tradicionales	Mariscal	3	18
	San Pedro	1	3
	Santa Martha	1	2
	San Francisco	0	1
Subtotal		5	24
Seguros	Mariscal	1	4
	San Pedro	2	24
	Santa Martha	1	7
	San Francisco	1	3
Subtotal		5	38
Arriesgados	Mariscal	1	2
	San Pedro	1	6
	Santa Martha	2	9
	San Francisco	1	9
Subtotal		5	26
Experimentadores	Mariscal	0	1
	San Pedro	1	1
	Santa Martha	1	1
	San Francisco	3	3
Subtotal	Experimentadores	5	6
TOTAL	4 communities	20	94
Cases per community	Mariscal	5	25
	San Pedro	5	34
	Santa Martha	5	19
	San Francisco	5	16

* The 20 cases of this sample include the 9 families with whom I initiated my qualitative studies in year 2000 for my M.Sc. research.

Appendix 5.1. Variables included in the analysis and their descriptive characteristics

Variables of 94 observations	# (%age)	Median,	Mean	(SD)
Field description				
Farmer's code	NA			
Community code:	1=16			
1= San Francisco	(17%)			
2= Santa Martha de Cuba	2=19 (20%)			
3= San Pedro de Piartal	3=34 (36%)			
4= Mariscal Sucre	4=25 (27%)			
Farmer Field Schools' (FFS) participation				
0= Did not participate in	0=72 (77%)			
FFS	1=14 (15%)			
1= Assisted to 1 FFS	2=5 (5%)			
2= Assisted to 2 FFS	3=1			
3= Assisted to 3 FFS	(1%)			
4= ECA group's field	4=2 (2%)			
Field tenure				
1= self owned				
2= rented to other				
3= rented from other	1=35 (37%)			
4= loaned	2=0 (0%)			
5= received through	3=5 (5%)			
sharecropping	4=8 (9%)			
6= given through	5=46 (49%)			
sharecropping	6=0 (0%)			
7= other	7=0 (0%)			
Owned or shared production				
1= Self owned	1=25 (27%)			
2= In share	2=69 (73%)			
Field topography				
1= Flat land				
	1=22 (23%)			
2= Hilly land	2=43 (46%)			
3= Steep land	3=27 (29%)			
4= Otro	4=2 (2%)			
Field area (hectares)		0.57	0.87	0.71

Variables of 94 observations	# (%age)	Median,	Mean	(SD)
Planting system				
Crop rotations (metric) The highest number represents a maximum of 3 different crops before potato and zero represents no rotations before potatoes		2.00	2.00	0.90
Number of planted varieties (metric)		1.00	1.30	0.58
Seed (kg/ha) (metric)		1548.39	1670.22	465.47
Crop system (nominal transformed)		1.00	1.23	0.43
1=Full tillage	1= 72 (77%)			
2=Wacho Rosado	2= 22 (23%)			
Resistance of planted seeds (nominal transformed) 1= susceptible 2= resistant	Frequency depends on # of planted varieties	1.00	1.23	0.43
Soil preparation (nominal transformed) 1= Tractor 2= Oxen 3=Horses 4=Manual labour	Frequency depends on combinations of different means of soil preparation	1.95	2.89	1.20
IPM (applied at least one IPM practice) (nominal transformed) 1= Yes 2= No		2.00	1.62	0.49
Production and its use (metric variables)				
Yield (kg/ha)		13910.17	14609.05	6274.32
Sold production (%)		0.85	0.80	0.20
Production for consumption (%)		0.05	0.10	0.15
Production for seed (%)		0.00	0.08	0.12
Pesticide Use (metric variables)[134]				
Carbamate (Kg of a.i./ha)		1.16	1.56	1.55

[134] See Appendix 2 for information about the classification of the pesticides applied during this study.

Variables of 94 observations	# (%age)	Median,	Mean	(SD)
Organochlorine compound (Kg of a.i./ha)		0.00	0.02	0.10
Organophosphorus compound (Kg of a.i./ha)		1.16	1.42	1.25
Pyrethroid (Kg of a.i./ha)		0.02	0.09	0.16
Thiocarbamate (Kg of a.i./ha)		14.31	14.49	7.34
Cymoxanil (Kg of a.i./ha)		0.47	0.48	0.33
Other type (Kg of a.i./ha)		4.70	5.95	5.23
Active ingredient applications number		36.50	37.55	18.48
Soil disinfections number		2.00	1.68	1.18
Pesticide applications number		7.00	7.33	2.84
Fertilizer use (metric variables)				
Fertilizations number		2.00	2.04	0.62
Nitrogen (kg/ha)		143.78	149.87	59.58
Phosphorus (kg/ha)		337.95	344.20	132.22
Potassium (kg/ha)		169.50	159.39	78.92
Foliar fertilizations number		4.00	4.16	2.90
Costs and benefit (metric variables)				
Total cost per hectare (USA dollars)		1618.63	1708.06	448.11
Benefit per hectare (USA dollars)		201.96	199.82	950.39
Equipment cost (ratio)		0.10	0.10	0.06
Fertilizer cost (ratio)		0.21	0.21	0.06
Foliar fertilizer cost (ratio)		0.02	0.03	0.04
Labour cost (ratio)		0.33	0.33	0.07
Pesticides cost (ratio)		0.15	0.15	0.05
Seed cost (ratio)		0.14	0.15	0.05
Labour Use (metric variables)				
Total labour days per hectare		112.17	114.08	30.80
Paid labour days per hectare		76.00	73.26	40.53
Total wages for pesticide applications/ha		23.32	27.00	15.83
Paid wages for pesticide applications (% of total wages for pesticide applications/ha)		35.36	37.77	33.51

Summary

Peasants, Potatoes and Pesticides: Heterogeneity in context of Agricultural Modernization in the Highland Andes of Ecuador

Myriam Paredes

After a half-century of agricultural modernisation, an intensive potato-pasture system has become well established in the highlands of Carchi in northernmost Ecuador. While described as highly productive in the short-run, studies have found that the system's potato component generates worrisome health and environmental concerns, placing into question its long-term viability. Pesticide use leads to serious health problems among a large portion of population. The introduction of mechanised tillage and the disk plough has led to wide-scale soil degradation. Growing price fluctuations have worked against farmers, turning potato farming into a risky enterprise. Further studies have shown that beyond representing a solution, public policy in Carchi has become locked into a self-referential and destructive institutional cycle of risk generation. New thinking is needed in agricultural policy.

Based on community-level research carried out between 2002 and 2009, this thesis examines agricultural modernization in Ecuador as a combination of agrarian reform accompanied by a fundamental policy shift towards intensification through the large-scale promotion of agro-industrial technologies tied with commercial production and market integration. In light of this global tendency, the study explores how different actors struggle to modify, counteract or maintain modernization policies in order to advance particular interests, thereby leading to distinct modes of production. I specifically concentrated on pesticide use and risks associated with particular peasant farming patterns. Drawing on van der Ploeg's (1993, 1994, 2003) pioneering approach to "farming styles," through qualitative and quantitative methods I describe and explain local heterogeneity. The analysis identified four prominent styles: *Tradicionales*, *Seguros*, *Arriesgados* and *Experimentadores*.

Different farming styles and agrochemical use

The *Tradicionales* have developed an intensive mode of production characterized by relatively high use of labour and high yields and benefits. This is achieved largely through their use of a pre-Colombian reduced tillage

cropping system, *wachu rozado*, which is uniquely suitable for the moist highlands. The *Seguros* use a more extensive style and plant large quantities of seed in order to compensate for their relatively low soil fertility resulting in lower yields as well as lower overall financial returns. *Seguros* do not like to take monetary risks. While most production factors were largely covered through non-commoditized arrangements, they favour practices permitting low financial investments in fertilizers and pesticides.

The extensive production style of the *Arriesgados* finds expression in substantial mechanised tillage and the application of a lot of fertilizer. *Arriesgados* like to take financial risks. Due to low soil quality after decades of ploughing steep hillsides, they reap low yields and little financial benefits. The style of the *Experimentadores* is characterised by their use of large quantities of foliar fertilizers and cheap, highly toxic pesticides as substitutes for more expensive but effective and safer alternatives. These farmers usually produce in a sharecropping arrangement with smaller landholders that are commonly members of the extended family. Through such means, the *Experimentadores* achieve relatively high yields and financial benefits.

Irrespective of style, farmers do not commonly use personal protective equipment as recommended in private and public "Save Use of Pesticides" programmes. The *Tradicionales*, *Seguros* and *Experimentadores* tend to explain health problems as a result of the conditions in which pesticides are used. Meanwhile, the *Arriesgados*, who rely on hired help for applications, commonly point to the physical weakness of labourers as the chief reason for intoxications and resulting health problems.

Commoditization levels

The thesis examines commoditization in farming styles by analyzing degrees of self-sufficiency (the ratio of factors and inputs produced on-farm to those produced off-farm) and market-dependency (the ratio between purchased resources and sold produce). *Seguros* have the highest level of self-sufficiency and *Tradicionales* have the lowest market-dependency. These styles were most common where families obtained land ownership prior to agrarian reform. In contrast, *Arriesgados* show a much lower degree of self-sufficiency while *Experimentadores* are positioned in between. The varying degrees of self-sufficiency and market-dependency are linked with unique priorities, history and culture within which each style is embedded.

Contrary to the assumptions of agricultural modernization policies and claims of many experts in Ecuador, high commoditization does not translate to "prosperity" or "development". In fact, the opposite is true for the highly commoditized *Arriesgados*, who performed poorly in recent time, in particular during Ecuador's historic financial crisis of 1999 that brought nearly 300% inflation. The other farming styles, which were less dependent on commoditized relationships of production, managed to survive price fluctuations. In terms of its ability to survive the pressures of the modern commercial market, a production system relying on non-commoditized production proved anything but "obsolete" and "backward."

Heterogeneity, sustainability and food security

The thesis presents cluster analysis to field factor scores of *fine-tuning* and *pesticide use*, showing contrasts in patterns and practices across the different styles. The *Tradicionales* and *Seguros* uniquely combine low *pesticide use* with high *fine-tuning*. These groups also tend to favourably employ the *wachu rozado* planting system. Economic production analysis shows that these families produce relatively higher yields at the same costs, while also using lower rates of pesticides per hectare. In sharp contrast with expert-led agricultural development in Carchi, in terms of productivity, human health and the environment, the production patterns of the *Tradicionales* and *Seguros* represent a promising positive-sum scenario for agricultural policy. Over time, these styles outperform the other production modes based largely on externally based expert knowledge and technology.

Way forward

The degradation of the natural resource base and poisoning and death by pesticides associated with modern technology has become the expected product of public policy rooted in ideals of modernisation. While a peasant family decides about the style around which to organize its livelihood, government programs and the expert regime make certain styles more viable than others -- both through their explicit purposes and generated "goods" as well as implicit contradictions and societal "bads." Meanwhile, an undercurrent of farming styles effectively hidden to all but those in rural communities reveals that peasant farmers must continually translate present public policy for their own purposes. *En route* certain families manage to construct viable pathways for the future, enabling them to stand up to agricultural modernisation.

Resumen

Peasants, Potatoes and Pesticides: Heterogeneity in context of Agricultural Modernization in the Highland Andes of Ecuador

Myriam Paredes

Luego de medio siglo de modernización agrícola, un sistema intensivo papa-pastos se ha consolidado en la sierra norte de Carchi en Ecuador. Aunque descrito como altamente productivo en el corto plazo, varios estudios han encontrado que el sistema de la papa genera problemas a nivel de la salud y el ambientales, poniendo en tela de juicio su viabilidad a largo plazo. El uso de plaguicidas provoca graves problemas de salud para una gran parte de la población. La introducción de la labranza mecanizada y el arado de disco han llevado a la degradación del suelo a gran escala. El aumento en las fluctuaciones del precio de papa ha perjudicado a los agricultores, convirtiendo el cultivo de la papa en una empresa arriesgada. Otros estudios han demostrado que más allá de representar una solución, la política pública en Carchi ha entrado en un ciclo institucional autorreferenciado y destructivo de generación de riesgos. Nuevas formas de pensar son necesarias en la política agrícola.

Basada en la investigación a nivel comunitario llevada a cabo entre 2002 y 2009, esta tesis examina la modernización agrícola en el Ecuador como una combinación de la reforma agraria y un cambio político fundamental hacia la intensificación a través de la promoción a gran escala de tecnologías agroindustriales vinculadas con la producción comercial y la integración al mercado.

A la luz de esta tendencia global, el estudio explora cómo diversos actores luchan para modificar, contrarrestar o mantener políticas de la modernización y así promover intereses particulares que llevan a modos de producción distintos. Específicamente el estudio se concentra en el uso de plaguicidas y los riesgos asociados con determinados patrones de agricultura campesina. Basándose en el enfoque de "estilos agrícolas" de van der Ploeg (1993, 1994, 2003), a través de métodos cuantitativos y cualitativos, el estudio describe y explica la heterogeneidad local. El análisis identificó cuatro estilos prominentes: *Tradicionales, Seguros, Arriesgados* y *Experimentadores*.

Diferentes estilos agrícolas y el uso de agroquímicos

Los *Tradicionales* han desarrollado un modo intensivo de producción caracterizado por el relativamente alto uso de mano de obra y altos rendimientos y beneficios. Esto se logra en gran medida a través del uso de un sistema de cultivo precolombino de labranza reducida denominado *wachu rozado,* adecuado especialmente a las tierras húmedas y altas de la sierra. Los *Seguros* utilizan un estilo más extensivo y siembran grandes cantidades de semilla para compensar su relativamente baja fertilidad del suelo el cual produce bajos rendimientos, así como también reduce los rendimientos financieros en general. Los agricultores *Seguros* evitan correr riesgos monetarios. Mientras la mayoría de los factores de producción son cubiertos a través de acuerdos no-mercantiles, ellos favorecen las prácticas que permitan bajar la inversión en fertilizantes y plaguicidas sintéticos.

El estilo de producción extensiva de los *Arriesgados* encuentra su expresión en una sustancial labranza mecanizada y la aplicación de gran cantidad de fertilizantes. Los *Arriesgados* tienden a tomar riesgos financieros. Debido a la baja calidad del suelo después de décadas de labranza sobre laderas, cosechan bajos rendimientos y pocos beneficios financieros. El estilo de los *Experimentadores* se caracteriza por el uso de grandes cantidades de fertilizantes foliares y plaguicidas de bajo costo pero altamente tóxicos que sustituyen a fertilizantes del suelo y pesticidas más caros pero que son alternativas más efectivas y seguras. Estos agricultores suelen producir "al partir" con productores más pequeños y que por lo general son miembros de su familia ampliada. De esta manera, los *Experimentadores* logran rendimientos y beneficios financieros relativamente altos.

Independientemente del estilo que practiquen, los agricultores no suelen utilizar equipo de protección personal tal como lo recomiendan los programas públicos y privados de "Uso seguro de plaguicidas."

Los *Tradicionales, Seguros* y *Experimentadores* tienden a explicar los problemas de salud como consecuencia de las condiciones en que se utilizan los plaguicidas. Mientras tanto, los *Arriesgados,* quienes por la mayor parte contratan mano de obra para las aplicaciones, generalmente apuntan a la debilidad física de los trabajadores como la razón principal de las intoxicaciones y los consiguientes problemas de salud.

Los niveles de mercantilización

La tesis examina la mercantilización de los estilos agrícolas a través del análisis de los grados de autosuficiencia (la relación de los factores e insumos producidos en la finca con los producidos fuera de la finca) y la dependencia del mercado (la relación entre los recursos adquiridos y productos vendidos). Los *Seguros* tienen el más alto nivel de autosuficiencia y los *Tradicionales* tienen el más bajo de dependencia del mercado. Estos estilos fueron los más comunes entre las familias que obtuvieron la propiedad de su tierra antes de la reforma agraria. Por el contrario, los *Arriesgados* muestran mucho menor grado de autosuficiencia, mientras que los *Experimentadores* se colocan en el medio. Los diversos grados de autosuficiencia y dependencia del mercado están relacionados con prioridades únicas, historia y cultura en la que se encaja cada estilo.

Contrariamente a las suposiciones de las políticas de modernización agrícola y a las afirmaciones de muchos expertos en el Ecuador, alta mercantilización no se traduce como "prosperidad" o "desarrollo." De hecho, lo opuesto es cierto para los agricultores *Arriesgados* altamente mercantilizados, quienes han mostrado un bajo desempeño en los últimos tiempos, en particular durante la histórica crisis financiera del Ecuador en 1999 que trajo consigo casi 300% de inflación. Los otros estilos agrícolas, que tenían una menor dependencia en relaciones mercantilizadas de producción, lograron sobrevivir a las fluctuaciones de precios. En cuanto a su capacidad para sobrevivir a las presiones del mercado comercial moderno, un sistema de producción que depende en factores de producción no-mercantilizados demostró no ser ni "obsoleta" ni "retrógrada."

La heterogeneidad, la sostenibilidad y la seguridad alimentaria

La tesis presenta las puntuaciones de los diferentes estilos (identificados a través del análisis de conglomerados) en los factores denominados *balance fino* [en la producción] y *uso de plaguicidas,* para identificar los contrastes en los patrones de prácticas de los diferentes estilos. Agricultores en los grupos de *Tradicionales* y *Seguros* combinan de manera única un bajo puntaje en *uso de plaguicidas* con alto puntaje en *balance fino.* Estos grupos también tienden a emplear favorablemente el sistema de siembra en *wachu rozado.* El análisis económico de la producción muestra que estas familias producen rendimientos relativamente mayores con los mismos costos que otros agricultores usando al mismo tiempo una taza reducida de plaguicidas por hectárea. En agudo contraste con el desarrollo agrícola en Carchi liderado por expertos, en términos de productividad, salud humana y el medio ambiente, los patrones de producción de muchos *Tradicionales* y *Seguros* representan un escenario prometedor para las políticas agrícolas. A través del tiempo, estos estilos superan a los demás modos de producción basados en gran parte en conocimientos y tecnologías externas.

El camino a seguir

La degradación de los recursos naturales y el envenenamiento y muerte por plaguicidas asociados con la tecnología moderna se han convertido en el producto esperado de la política pública basada en los ideales de la modernización. Mientras que la familia campesina decide sobre el estilo en torno al cual organizar sus medios de subsistencia, los programas de gobierno y el régimen de expertos hacen que ciertos estilos sean más viables que otros - tanto por sus propósitos explícitos y "bienes" generados cuanto por sus contradicciones implícitas y "males" sociales. Mientras tanto, una contracorriente de estilos agrícolas efectivamente oculta para todos menos para las comunidades rurales, revela que los agricultores campesinos continuamente transforman las políticas públicas para sus propios fines. *En route* determinadas familias logran construir caminos viables para el futuro, permitiéndoles sobrevivir a la modernización agrícola.

Samenvatting

Peasants, Potatoes, and Pesticides: Heterogeneity in context of Agricultural Modernization in the Highland Andes of Ecuador

Myriam Paredes

Na een halve eeuw modernisering van de landbouw, is een intensief aardappel-grasland systeem in de hooglanden van Carchi in het noorden van Ecuador tot wasdom gekomen. Terwijl deze ontwikkelingen zijn beschreven als zijnde zeer productief op de korte termijn, heeft een reeks andere studies heeft echter aangetoond dat het aardappelproductiesysteem op lange termijn zorgwekkende gezondheids- en milieu problemen voortbrengt waardoor de duurzaamheid in het geding komt. Het gebruik van bestrijdingsmiddelen leidt tot ernstige gezondheidsproblemen bij een groot deel van de bevolking. De sterk toegenomen gemechaniseerde grondbewerking en de introductie van de schijfploeg hebben geleid tot grootschalige aantasting van de bodem. Frequente prijsschommelingen werken in economisch opzicht averechts voor de boeren en maken de productie van aardappelen tot een riskante onderneming. In een aantal studies wordt beargumenteerd dat het vigerende beleid geen oplossingen kan en zal bieden omdat het opgesloten is in een in zichzelf gekeerde en destructieve cyclus die slechts risico's met zich meebrengt. Een nieuwe manier van denken is nodig om een nieuw landbouwbeleid te genereren.

Dit proefschrift onderzoekt aan de hand van veldwerk onder boerengemeenschappen van 2002 tot 2009 de dynamiek van de modernisering van de landbouw in Ecuador. Deze heeft vooral vorm gekregen door agrarische (land)hervormingen in combinatie met een intensivering van de landbouwbeoefening met behulp van agro-industriële technologieën en commercialisering van de productie en daarmee gepaard gaande marktintegratie. In het licht van deze wereldwijde tendens, onderzoekt de studie hoe de verschillende betrokken actoren de strijd aan gaan met het modernisatie beleid door dit te herontwerpen, aan te passen of te handhaven teneinde zekere belangen veilig te stellen hetgeen op zijn beurt leidt tot verschillende vormen van productie. Ik heb me in deze studie specifiek toegespitst op het gebruik van pesticiden en de inherente risico's die opgesloten liggen in de patronen van landbouwontwikkeling die kenmerkend zijn voor de regio Carchi. Ik heb me hierbij laten inspireren door het pionierswerk van Van der Ploeg (1993, 1994, 2003) op het gebied van van de "bedrijfsstijlen" in de landbouw. Door middel van kwalitatieve en kwantitatieve methoden van onderzoek heb ik deze stijlen van landbouwbeoefening beschreven in een poging de lokale heterogeniteit te verklaren. Mijn analyse onderkent en herkent vier prominente stijlen in Carchi: *Tradicionales, Seguros, Arriesgados* en *Experimentadores.*

Verschillende stijlen van landbouwbeoefening en het gebruik van agrochemische middelen

De *Tradicionales* hebben een intensieve wijze van productie welke wordt gekenmerkt door een relatief hoge inzet van arbeid welke gepaard gaat met hoge opbrengsten en grote economische voordelen. Dit is grotendeels bereikt door het gebruik van een pre-Columbiaans teeltsysteem, *Wachu rozado,* dat bij uitstek geschikt is voor de vochtige hooglanden. De *Seguros* hebben een meer extensieve stijl en planten grote hoeveelheden pootgoed om zo te compenseren voor de relatief lage vruchtbaarheid van de bodem welke resulteert in lagere opbrengsten en lagere totale financiële rendementen. *Seguros* nemen niet graag financiële risico's. Daar de meeste productiefactoren grotendeels verkregen worden door niet-gecommoditiseerde arrangementen, geven zij de voorkeur aan landbouwpraktijken die scharnieren om geringe financiële investeringen in kunstmest en pesticiden.

De extensieve stijl van de *Arriesgados* komt tot uitdrukking in sterk gemechaniseerde grondbewerking en de toepassing van veel kunstmest. *Arriesgados* nemen graag risico's van financiële aard. Door de lage kwaliteit van de bodem na tientallen jaren van ploegen op steile heuvels, realiseren ze geringe opbrengsten en genieten zo weinig financiële voordelen. De stijl van de *Experimentadores* wordt gekenmerkt door het gebruik van grote hoeveelheden vloeibare kunstmest en goedkope, zeer giftige pesticiden als vervangers voor de duurdere, maar effectievere en veiligere alternatieven. Deze boeren produceren veelal in een deelpachtregeling met kleinere grondbezitters die onderdeel uitmaken van de familie. Op deze wijze kunnen de *Experimentadores* relatief hoge opbrengsten voortbrengen met gunstige financieel rendement.

Boeren maken vaak geen gebruik van persoonlijke beschermingsmiddelen zoals aanbevolen in private en publieke "Veilig gebruik van pesticiden" programma's. Dit blijkt niet stijl specifiek te zijn. De *Tradicionales, Seguros* en *Experimentadores* hebben de neiging om gezondheidsproblemen in verband te brengen met de de omstandigheden waaronder pesticiden worden toegepast. Ondertussen heeft de *Arriesgados,* die veelal gebruik maken van loonarbeid wijzen veelal op de lichamelijke zwakte van de arbeiders als de voornaamste reden voor vergiftigingen en de daaruit voortvloeiende gezondheidsproblemen.

Incorporatie in de markt

Het proefschrift onderzoekt de relaties met markten (ook wel commoditisatie genoemd) die kenmerkend zijn voor de verschillende stijlen van landbouwbeoefening. Ik doe dit door de mate van zelfredzaamheid (de verhouding van de factoren en inputs geproduceerd op het bedrijf en elders verkregen) te analyseren in combinatie met marktafhankelijkheid (de verhouding tussen aangekochte middelen en verkochte producten). *Seguros* vertonen de hoogste graad van zelfvoorziening en de *Tradicionales* de laagste van de marktafhankelijkheid. Deze stijlen komen het meest voor in die situaties waarin boerengezinnen reeds grond bezaten voordat er sprake was van een landbouwhervorming. De *Arriesgados* daarentegen vertonen een veel lagere graad van zelfvoorziening, terwijl de *Experimentadores* daar tussenin zijn gepositioneerd. De verschillende manieren waarop zelfvoorziening en de markt-afhankelijkheid actief zijn en worden gecreëerd, komen voort uit de unieke prioriteiten, geschiedenis en cultuur waarbinnen elke stijl is ingebed.

Mijn studie laat zien dat, in tegenstelling tot de aannames van de modernisering van de landbouwbeoefening en het daarop gebaseerde beleid alsmede de claims van vele deskundigen in Ecuador, een hoge commoditisatiegraad niet lineair te vertalen is naar "welvaart" of "ontwikkeling". In feite geldt het omgekeerde: de *Arriesgados* hebben het de afgelopen tijd in economisch opzicht niet best gedaan, met name gedurende de financiële crisis van Ecuador in 1999 die resulteerde in een inflatie van bijna 300%. De andere stijlen die scharnieren om beduidend lagere graden van commoditisatie zijn er in geslaagd om de prijsschommelingen te overleven. Een productie systeem dat vooral een beroep doet op niet-gecommoditiseerde hulpbronnen en dito sociale verhoudingen is wel degelijk in staat om met de markt om te gaan en de druk van het moderne commerciële landbouwsysteem te weer staan. Een dergelijk systeem is dus alles behalve "achterhaald" en "achterlijk".

Heterogeniteit, duurzaamheid en voedselzekerheid

Het proefschrift presenteert een cluster analyse van factor-scores die staan voor praktijken als *fijn-regulering* en *het gebruik van pesticiden*. De analyse duidt op contrasterende patronen en werkwijzen en onderbouwt op deze wijze dat er verschillende stijlen van landbouwbeoefening zijn. De *Tradicionales* en *Seguros* staan voor een unieke combinatie van een lage *gebruik van bestrijdingsmiddelen* met een hoge *fijn-regulering*. Zij hebben ook de neiging om het *Wachu rozado* landgebruikssysteem toe te passen. Een economische analyse van de op dit systeem gebasseerde productie laat zien dat deze boerengezinnen relatief hoge opbrengsten voortbrengen tegen dezelfde kosten en daarbij ook nog minder bestrijdingsmiddelen per hectare gebruiken. In scherp contrast met de door experts gedreven ontwikkeling van de landbouw in Carchi, vertegenwoordigen de landbouwpraktijken van de *Tradicionales* en *Seguros* gemeten in termen van productiviteit, de menselijke gezondheid en het milieu, een veelbelovend scenario voor de toekomstige ontwikkeling van de landbouw. De *Tradicionales* en *Seguros* zijn in staat om beter te presteren dan de andere stijlen wiens productieproces grotendeels voortbouwt op deskundigheid van elders.

Hoe nu verder

De achteruitgang van de natuurlijke hulpbronnen en de vergiftiging en sterfgevallen door gebruik van bestrijdingsmiddelen die in het verlengde liggen van de verbreiding van moderne kennis en technologie behoort tot de verwachte uitkomst van een beleid dat geworteld is in de idealen van modernisering. Terwijl een boerenfamilie beslist over de stijl waar mee het invulling geeft aan zijn eigen levensonderhoud, voert de overheid gesteund door deskundigen een beleid dat bepaalde stijlen meer levensvatbaar maakt dan anderen. Dit komt tot uiting in zowel de expliciete doelstellingen en middelen als in de impliciete tegenstrijdigheden en maatschappelijke problemen die het veroorzaakt. Ondertussen blijkt zich een onderstroom van bedrijfsstijlen te manifesteren die daadwerkelijk verborgen blijft voor buitenstaanders. Diegenen die wonen en werken in de boerengemeenschappen hebben als taak deze praktijken te vertalen naar het huidige landbouwbeleid. Al doende slagen tal van boerengezinnen er in om een levensvatbare toekomst op te bouwen die hen in staat stelt om de strijd aan te gaan met modernisering van de landbouw.

Curriculum vitae

Born and reared on a farm in Riobamba, in the highlands of Ecuador, Myriam Paredes Chauca has lived and worked in Central and South America for over 15 years. Prior to initiating PhD research with the Rural Development Studies Group at Wageningen University in The Netherlands, she completed there an MSc in Management of Agricultural Knowledge Systems as well as a BSc in Agronomy at the Pan-American School of Agriculture (El Zamorano) in Honduras.

Myriam began her career in 1995 at the International Clearinghouse for Cover Crops (CIDICCO), where she helped to create the Honduran network of farmer-led Teaching and Learning Centers (CEAs). After that, she supported a number of community-led development projects in the Amazon and Highland regions of Ecuador. Her work as an International Consultant has included multi-faceted support to programme evaluation and learning as well as studies on farming heterogeneity as a way to understand the interfaces between peasant households and communities and intervention projects in Central and South America. She has supported university-level education on rural development throughtout the Americas as well as in Europe. Currently, Myriam works for Trent University's International Development Programme, as Academic Coordinator of its intensive, year-long study abroad program in Ecuador.

Myriam's husband, Stephen Sherwood, and she own and run an organic farm near Quito, Ecuador, where they are involved in a number of rural people's movements and conservation efforts.

Cover design: José Jimenez