Caring for *Pachamama*: Recommendations for Engaging with Agricultural Development

By

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Chapter One – Introduction

> *"The universal Andean deity of the land and its fertility, Pachamama, is considered to be the living earth. She is the matrix from which life arises"*
>
> - Paul Steele, *Handbook of Inca Mythology*

On Thursday, July 18th of 2013, I found myself sitting on a three legged stool in the small and dusty yard of a farmer. I was in the community of Chullpani, in the thin air of the Bolivian Andes, and the stool was one of the only pieces of furniture the family owned. As we sat sharing a bowl of small, boiled purple potatoes, surrounded by pecking chickens, he responded to my questions about his life as a farmer in an outpouring of Quechua, which my translator Maribel converted to Spanish. "We don't use chemicals," he told me. "Why?" I asked. "Because chemicals damage our bodies," he said.

Why would a resource-poor farmer in the Bolivian highlands, for whom the amount he is able to grow each year determines how much he and his wife are able to eat, decide to eschew chemical inputs which are designed specifically to increase crop yields? More importantly, if he was not using agrochemicals, what was he using instead? What was this farmer's strategy to ensure that he would produce a sufficient harvest year after year; what was his strategy to ensure his survival? I had arrived in Bolivia expecting to find a farming system that combined traditional agriculture with Green Revolution techniques like agrochemicals and genetically-modified seeds, yet this sort of Green Revolution agriculture was almost entirely absent, having been found unsatisfactory over a decade ago. Instead, an alternative style of agricultural development was flourishing under the guidance of municipal governments and non-governmental organizations, and I made it my goal to discover what this alternative agriculture entailed and how it had come to exist.

This research has led me to craft a guide for organizations that wish to engage with agricultural development in the developing world. Government agencies and NGOs in the international development sector that wish to support programs of agricultural development have a variety of options to choose from. These options range from efforts to increase yields through cash crop agriculture and chemicals to initiatives that prioritize environmental sustainability. This guide will explain the strengths and weaknesses of two seemingly opposing forms of agricultural development: the Green Revolution and indigenous agriculture. This information is located in chapters two and three, while chapter four will provide a case study of how an alternative, indigenous form of agricultural development was implemented in Northern Potosí, as an example of a successful program. Chapter five will explain the specific contexts in which one style of agriculture might be more effective than the other, and provide guidance to development organizations on the kind of agricultural program they should consider supporting based on the conditions of the area with which they are engaging.

An Introduction to Northern Potosí, Bolivia

As this thesis will demonstrate, the characteristics of the local environment greatly impact agricultural development, essentially determining which techniques will work well or poorly in an area. This introduction to the characteristics of Northern Potosí will provide context to my discussion of Green Revolution and indigenous agriculture in chapters two and three, as an example of the kind of area in the developing world in which a government agency or NGO might wish to engage. I will then return to Northern Potosí in chapter four to explain my findings.

I conducted my research in a section of Bolivia's highlands, called the *altiplano*. Badly-paved highways snake through a barren and rocky highland plateau, the desolate yet striking landscape dotted with clusters of tiny, dusty brown houses. It is a rural area dominated by farming but at about 13,000 feet in elevation, it is rarely lush or green. Instead, it is windy and bitingly cold, and aside from the

slightly more fertile valleys, little can survive on the *altiplano* aside from potatoes and hardy alpacas. Even the crops that do grow here grow poorly; due to factors such as geography and climate, crop yields in the Bolivian highlands only reach about half the world average (Mayer, 2002). The farmers and miners who live here are almost entirely Quechua and Aymara. It is in this section of Bolivia that an area called Northern Potosí is located. Comprising a northern offshoot of the *departamento*, or state, of Potosí, Northern Potosí covers about 8,000 square miles in area and contains roughly 250,000 people (El Programa de Desarrollo Integral Interdisciplinario, n.d.).

Northern Potosí is widely recognized as the poorest area in Bolivia (Aguirre et al., 1999). Eighty nine percent of the population live below the poverty line (El Programa de Desarrollo Integral Interdisciplinario, n.d.), a much higher rate than the fifty one percent that are impoverished in the nation as a whole (Institutio Nacional de Estadísticas, 2009). Aside from a few small towns, most homes do not have electricity or running water. Life expectancy in Northern Potosí is 56 years, compared to 65

years at the national average, and about seventy three percent of women and fifty percent of men in Northern Potosí do not speak Spanish. As formal politics, education and business in Bolivia are conducted almost entirely in Spanish, this language barrier only contributes to their marginality. With this depressing array of statistics, one might picture Northern Potosí as a dismal, hopeless place, characterized by stagnation. However, that picture would be misleading. Instead, much of Northern Potosí is dominated by a culture of optimism and pride, embodied in the many people and institutions who are working hard to build a better future for each other and for themselves.

Bolivia's New Political Culture

The physical environment is not the only factor that impacts agricultural development. Culture also plays a significant role in determining what style of agricultural development will be a good fit for a certain region. In Bolivia, the country has historically been characterized by a gaping chasm separating its poor, indigenous majority from its white and mixed race elite. Proof of this can be seen in Bolivia's ranking as the 14th most unequal country in the world, based on the GINI coefficient of inequality (CIA World Factbook, 2009). Historically, whites and mestizos have discriminated against Bolivia's indigenous peoples, and this racism is still rampant today (Freedom House, 2012). Over time and through political activism, however, Bolivia's indigenous majority has converted itself into a powerful political force, and in 2005 the country elected its first indigenous president, a political reality that has significantly affected agricultural development in Northern Potosí in a way that will be traced throughout this thesis. Evo Morales and his supporters have transformed the tone of Bolivian politics, promoting a sense of pride in indigenous culture and aspiring to a version of Bolivia that is inclusive and equal. Evidence of this can be seen in the rhetoric used in Bolivia's new constitution, created under Morales' government in 2009. For example, in the President's forward to the new document, Morales states,

> *"We have a historic opportunity to close the doors on racism, discrimination and exclusion. This begins with the construction of a pluralistic, multinational state: intercultural, authentically democratic, and founded on the cultural plurality of our homeland…In order to construct a more just Bolivia…we must follow the path of the indigenous peoples. The New Constitution establishes a new kind of country in which the indigenous people will participate profoundly in civil, political and economic life" (Morales, 2009, p. 3-4)*[1].

This has created a fertile political environment for investing money and attention in the isolated, indigenous *altiplano,* and has fostered a tendency to celebrate all aspects of indigenous life.

In fact, there has long existed a culture of grassroots organizing and activism in indigenous Andean society, which has become increasingly powerful as indigenous culture grows in importance in Bolivian politics. This culture has its roots on the ayllus, the bodies that have governed indigenous life for centuries. The ayllus are comprised of leadership positions that rotate between community members each year and make decisions communally about issues such as which land should be used for farming versus grazing (De la Cadena 1989). Even where ayllus no longer exist, they have been replaced by community organizations, and participation in these organizations is so valued that practically all members of a community participate (Zibechi 2005). This existing grassroots organizational structure has combined with Bolivia's political focus on rural, indigenous life to create fertile ground for non-governmental organizations (NGOs) to spring up and flourish in Northern Potosí.

These NGOs work in partnership with the municipal governments to improve quality of life in Northern Potosí, but at the same time they believe strongly in the importance of preserving and valuing indigenous traditions and indigenous heritage. Local NGOs have worked with farmers in Northern Potosí to create new techniques for agricultural development that have supplanted Green Revolution strategies like agrochemical use. What they have created is a local indigenous agriculture that looks very different from anything the North American and European agribusiness industries would recognize

[1] See Appendix A for the original Spanish.

as modernization; an agriculture built on crop diversification, organic fertilizers, micro irrigation systems and more.

This thesis will explain why this brand of agriculture works better in Northern Potosí than chemical agriculture. Moreover, it will use this case study to outline the conditions under which development institutions should consider investing in alternative agricultural strategies rather than Green Revolution-style agriculture.

PRODII: an NGO in Northern Potosí

One of the institutions which make up the flourishing NGO culture in Northern Potosí is PRODII, *el Programa de Desarrollo Integral Interdisciplinario* (the Program for Integral, Interdisciplinary Development). PRODII works to improve quality of life within Northern Potosí by promoting organic farming, constructing irrigation systems and protecting seed biodiversity, among other strategies. I came into contact with PRODII through Nourish-UNC, a student-led social justice organization of which I am a member. Nourish runs business ventures during the academic year and uses the proceeds to fund two to three development projects each summer in collaboration with community-based nonprofits around the world. Nourish supports these community-based nonprofits with grants and teams of student interns who work with nonprofit staff to carry out the proposed project during a period of six to eight weeks in the summer.

I discovered and reached out to PRODII in the fall of 2012 and they applied and were selected as a Nourish-UNC partner organization for the following summer. During that time I had become fascinated with PRODII's work, and because of my familiarity with the nonprofit, I was chosen lead the team of students. Along with my co-leader and four team members, I oversaw the execution of PRODII's proposed project, which was to discuss, promote and document ancestral agricultural

knowledge among high school students in rural areas. During that time and for two weeks after the completion of the Nourish-PRODII project, I conducted interviews with farmers and PRODII staff members about agricultural development in the region.

Research Design and Method

In order to discover what kind of agricultural strategies were in use in Northern Potosí and why, I targeted those who understood local agriculture best: the farmers themselves. I also interviewed PRODII's staff and a member of Pocoata's municipal council. I conducted 26 interviews in total, which ranged from 15-45 minutes in length and took place either in the PRODII office (in the case of staff members), or outside of farmers' homes (in the case of local residents). Most of the farmer interviews involved Quechua-speaking interviewees, therefore it was necessary for a PRODII staff member to translate between Quechua and Spanish. I interviewed both male and female subjects who varied widely in age and represented seven different communities within Northern Potosí in total. I also wrote down frequent observations about farming during my ten weeks in Northern Potosí and gleaned information from informal conversations I had with locals. Once I returned to the United States, I analyzed and interpreted this data. My research revealed a strategy for agricultural development that differed markedly from Green Revolution standbys like agrochemicals and high-yield variety seeds. Finally, I identified the conditions that made it possible for this grassroots style of agricultural development to flourish.

"Para Vivir Bien": What it Means to Live Well

Before beginning my discussion of Green Revolution and indigenous agriculture, and explaining my findings, it is important to define what makes an agricultural system successful. What is it that residents in Northern Potosí, in their vigorous push to improve quality of life, are driving toward?

Farmers spoke to me of increasing their crop yields in order to earn enough money from the sale of their surplus produce to buy warmer clothes. They wanted to revive communities that had been nearly extinguished by out-migration, because they worried that the local school would be shut down due to low attendance and the few children that remained would lose access to primary education. Farmers hoped for help to build irrigation systems because with a steady supply of water they could grow fruits and vegetables that were impossible to grow with unpredictable rainfall. These fruits and vegetables would add variety to their diets and help their children grow strong. They requested trainings on how to grow new crops that had recently become viable in their area because of climate change, and help from an agronomist to diagnose potato blights. In summation, farmers sought first to increase crop yields in the short term without damaging soil fertility so much as to lower crop yields in the future. Secondly, they sought to reduce the risk inherent in farming by diversifying their crops so that if one crop failed they would still have others to depend on. In the long term, farmers sought to turn farming from something that is "solo para sobrevivir, nomás" ("barely enough for survival")[2] to a livelihood that affords them a decent quality of life by Bolivian standards.

Their low-input, risk-reducing system of farming was built to take advantage of local biodiversity as well as local innovations and technical knowledge in areas like irrigation. This system demonstrably helping them to achieve these goals in a way that they found preferable to chemical agriculture. Understanding why this is the case in Northern Potosí can shed light on what kinds of agricultural modernization work well in different contexts.

[2] From an interview I conducted with a farmer on July 2, 2013 in the district of 31 de Enero in the municipality of Pocoata.

Chapter 2 – Green Revolution Agriculture

> *"Pachamama thought for a long time about how she could help these humans and improve their quality of life, and she created a fruit that she called the 'potato'...This fruit had a dark skin but the inside was delicious and as white as Pachamama's heart…[The women] understood the magnitude of Pachamama's gift and went searching for her, and promised that before every meal there would be a challa (a ceremony of thanks) in her honor"*[3]
>
> -Evelyn Ríos de Reyes*, Historia Oral de Bolivia*

Defining Green Revolution Agriculture

This thesis will contrast the Green Revolution with an indigenous, alternative style of agriculture; two broad categories that can nevertheless be used to classify a wide range of agricultural development. The Green Revolution was a series of scientific breakthroughs that occurred in Mexico in the 1940s and led to an agricultural development strategy that became widespread in the late 1960s, which reached its highest levels of success in Asia. In essence, the Green Revolution promoted the use of agrichemicals, irrigation and high-yield grain varieties (HYVs) as a way to increase agricultural production (Dixon, 1990).

Other hallmarks of the Green Revolution include a focus on cash crops over subsistence crops, increased mechanization and an emphasis on higher yields as its primary goal, as opposed to other measures of success such as crop diversification and risk reduction. Attributed with feeding millions of people that would otherwise have starved due to population growth, the Green Revolution was widely hailed as major victory over hunger. I entered Northern Potosí expecting to find that Green Revolution techniques had become an integral part of the local farming system, yet they were mostly absent. Therefore, this section will outline not only the benefits of Green Revolution agriculture but also its

[3] See Appendix A for the original Spanish.

drawbacks, which have led farmers to move away from this style of agriculture in Northern Potosí and in some other parts of the world.

The Promise of the Green Revolution

The pioneering project of the Green Revolution was the Comparative Wheat Research Program, which began in Mexico in 1943 and used an high yield variety to increased Mexico's annual wheat harvest six times by 1965 (Johnson, 2011). In another case, in Mexico's 1967-1968 Puebla Project, 133 small hold farmers who experimented with new high yield variety seeds and fertilizers were able to double their yields and increase their net income from an average of $27.35 to as high as $126 (Thiesenhusen, 1972). According to Robert Evenson and Douglas Gollin's thorough assessment of the Green Revolution, which they based on a study called the Standing Project on Impact Assessment conducted by the Consultative Group of International Agricultural Research (CGIAR), the implementation of high yield varieties accounted for 21% of growth in yields in the developing world from 1961-1980 and 50% of yield growth from 1981-2000 (2003). Additionally, the researchers analyzed what the result would have been had the Green Revolution not taken place, and determined that per capita caloric intake would have been 13.3% to 14.4% lower and childhood malnutrition would have been 6.1% to 7.9% higher in the developing world (Evenson & Gollin, 2003).

The Green Revolution transformed agriculture, and its importance in increasing the global food supply is difficult to overstate. The following case study demonstrates well the benefits and promise inherent in these statistics, and shows that Green Revolution agriculture can be successful even in the Andean region, where my contrasting research in Northern Potosí is also situated. Why the Green Revolution could work well in the following case study yet be found largely ineffective in Northern Potosí is one of the central questions that will be answered in this thesis, as this is vital information for

organizations within the international development world that are interested in investing in agricultural modernization.

Potato Farming in Southern Colombia: An Agro-Chemical Success Story

Anthropologist Jason Antrosio documented a typical agro-chemical success story in Túquerres, a community in Southern Colombia between 1994 and 1998. Farming in Túquerres appears very traditional at first glance. Most farms are relatively small in scale, either consisting of household plots kept for subsistence purposes or small commercial farms run on wage labor.[4] In addition, farming is mainly done by hand – tractors and other hallmarks of mechanized agriculture are not only expensive but impractical on the steep and scattered fields of the region.

However, agriculture there is not entirely traditional: the Green Revolution has arrived in Túquerres. "Most of the potatoes grown in Túquerres are high-yield hybrids, chemically fertilized and sprayed with pesticides made by DuPont and Bayer. They are then loaded onto trucks and taken to the major cities of Colombia" (Antrosio, 2000, p. 8). According to his research farmers in the Southern Colombia community are enthusiastic when it comes to fumigating their crops in order to ward off pests, and, despite the lack of safety equipment, they see the increased yields that come from chemical use to far outweigh any potential health consequences (Antrosio, 2000). In addition, the fact that an HYV potato strain called "Parda Pastusa" can be grown year-round as opposed to traditional varieties, which could only be planted and harvested twice a year, has made Parda the potato of choice in Túquerres notwithstanding the fact that it requires heavy use of chemicals and cannot be replanted as seed the following year (Antrosio, 2000). Evidently, farmers in this Colombian community see many

[4] The scale of farming in Túquerres is a key difference between this case and that of Northern Potosí. While farms in Túquerres are small, those in Northern Potosí are smaller – the latter are not prosperous enough to hire wage laborers.

commercial agricultural techniques as superior to traditional practices and have been able to increase their yields by implementing this style of agriculture.

However, it is worth noting that even this Andean community which has embraced the most significant techniques of the Green Revolution has still found it necessary to adapt the model to suit their own local environment and needs. Antrosio makes a point of this, explicitly categorizing Túquerres as a community that is consciously creating a kind of development that is appropriate for them. While Túquerres has embraced the use of chemicals, agriculture there largely remains an activity that is done by hand because mechanization is seen as completely impractical on its scattered, sloping fields. In addition, Túquerres is an exception to the vision of industrialized agriculture as being made up of large-scale farms, in which small-scale farmers have been pushed out due to their inefficiencies. In Túquerres small farmers have been able to survive not in spite of the commercial farming model but *because* of this model: it is precisely by adopting new inputs like chemicals and modified seeds that these small farmers have been able to maintain their lifestyles as viable (Antrosio, 2000).

Therefore, Túquerres is an example of a community that has had success in incorporating some Green Revolution techniques, but it is important to keep in mind that even Túquerres rejects other parts of the commercial farming model in an effort to personalize agricultural development to their unique context. It is crucial to make adjustments to any program of agricultural modernization so that it fits the local context, something development organizations should take into account when engaging with agricultural projects.

The Drawbacks of Green Revolution Agriculture

As in Túquerres, the Green Revolution has been embraced in farming communities worldwide because of its success in increasing yields, allowing these communities to feed many more people than ever before. However, there are also drawbacks to the Green Revolution that make this style of

agriculture unattractive to small farmers in other communities, such as Northern Potosí. Every style of agriculture has pros and cons that must be weighed, and it is important to recognize these benefits and drawbacks when designing an agricultural program or choosing an existing program to invest in.

The first drawback of Green Revolution agriculture is the toll agrochemicals can take on human health and on long-term soil fertility. Handling agrichemicals frequently without proper precautions can be dangerous to one's health. Pesticide poisoning accounts for as many as 300,000 deaths annually worldwide, not to mention the non-lethal health effects these agrochemicals cause as well (Aggarwal & Goel, 2007). A variety of studies have found evidence linking pesticides to everything from mild symptoms like abdominal pain, nausea, vomiting, dizziness and skin and eye problems (Echobichon, 1996), to more serious health complications, like non-Hodgkin lymphoma, leukemia (Bassil et al., 2007), and birth defects (Sanborn et al., 2007).

These health effects can be easily mitigated by reading and following the safety instructions printed on the packaging of agrochemicals. Yet for many poor, rural farmers around the world, this is a more difficult proposition that one might expect. Rural farmers often have decreased access to education, and they may not have access to the resources they need to follow these instructions. For example, the farmers I encountered in Northern Potosí rarely spoke Spanish and were primarily illiterate, making it all but impossible for them to read the safety instructions and health warnings on the packaging of agrochemicals. Even if the Northern Potosí farmers were able to read these instructions, most lacked money to buy safety equipment like plastic gloves and had limited access to running water to wash with after using chemicals.

Additionally, there is some evidence that although agrochemicals increase soil fertility in the short term, they can damage the fertility of soil over the long term; especially when too much chemical fertilizer is used (Evenson & Gollin, 2003; Grace Communications Foundation, 2014). This is particularly

worrisome in the case of marginal land, where soil fertility is already low. Marginal land is more susceptible to degradation than good-quality land (Kendall & Pimentel, 1994), and if the use of agrochemicals were to decrease the soil fertility of already-marginal land this could create a serious problem for farmers.

Another drawback of the Green Revolution is that it is input-heavy and requires significant upfront investment due to the fact that a farmer must purchase agrochemicals and HYV seeds at the start of every growing season. This is a significant change for a traditional farmer, accustomed to fertilizing his or her fields using manure from livestock and planting using the remains of last year's harvest. HYV seeds, in contrast, lose their effectiveness when replanted and therefore must be bought each year. The reality is that in some cases these inputs are simply too expensive for a poor subsistence farmer to afford, a reason that Green Revolution agriculture tends to function better on medium and large-scale farms. Although in some cases, like Antrosio's study of Túquerres, small to medium hold farmers do find a way to afford agrochemicals, it is well-documented that the techniques of the Green Revolution were adopted mostly by medium to large-scale farms producing for the market, leaving many subsistence farmers out of the process (Altieri, 2002). Indeed, many small farmers are actually pushed out of the market as a result of the high investment needed to adopt Green Revolution techniques. As Charles H. Southwick stated, in many cases "the paraphernalia of modern crop production become prohibitively expensive for many farmers…Better able to meet these rising costs, as well as the costs of capital, agribusiness moved in and took over from small landowners" (1996, p. 188).

To give an example of the financial burden that purchasing these inputs represents to a poor Andean farmer, in the 1980s in the Bolivian highlands the cost of fertilizer was increasing so rapidly that it was necessary for potato farmers to produce double the amount of potatoes as in the previous year in order to afford the same quantity of imported fertilizer. Meanwhile potato yields were actually

decreasing each year even as fertilizer use went up (Altieri, 1999). Because of this, promoting the use of agrochemicals, expensive irrigation systems and mechanization can sometimes be unrealistic as a development strategy for subsistence farmers of humble means (DeWalt, 1994). Furthermore, in many areas of the Global South access to agricultural inputs is limited by poor transportation infrastructure. Many isolated rural communities simply cannot obtain a secure supply of agrochemicals and HYV seeds each planting season, meaning that from a practical standpoint, these farmers cannot employ a form of agriculture that is input-heavy as long as they remain relatively isolated. Thus, they must turn to alternative forms of agriculture instead.

It is also worth examining what goals Green Revolution agriculture is meant to achieve. For example, the Green Revolution is specifically formulated to increase yields. However, many poor farmers in the Global South are not entirely yield-oriented – for many it is more important to decrease risk than it is to increase yields. To give an example, unmodified rice varieties produce lower yields than HYV rice but these yields are more consistent, so while the modified strain of rice will produce more over a long period of time, it is more likely than the traditional variety to experience occasional years of poor production. If a farmer is poor enough that a single bad harvest could mean starvation, they may prefer the stable traditional variety to the productive yet inconsistent modified variety (Dixon, 1990).

A final downside of the Green Revolution is that agricultural research has concentrated mainly on staple grain crops like rice and wheat, while scientists have created relatively few high yield varieties of tubers, which are the staple crop of the Andes (Evenson & Gollin 2003). While some modified varieties of tubers exist, there are fewer of them than exist for grain crops – another explanation for why Green Revolution agriculture could be a good option for some communities while having less to offer to other communities.

Conclusion

It is important to recognize both the benefits and the drawbacks of the Green Revolution, neither of which should be overlooked. It is undeniable that Green Revolution-style agricultural modernization has been remarkably successful at boosting harvests in many parts of the world, yet it is also undeniable that these techniques do not work as well for some farming communities as they do for others. For this reason, development specialists must consider Green Revolution agriculture and its alternatives equally, and be mindful that the wide variation among farming communities across the Global South makes it necessary for each community to construct its own particular brand of agricultural modernization based on all the options available. The following chapter will explore these alternatives to the Green Revolution in more detail, and outline in what contexts these alternatives might be preferable to chemical agriculture.

Chapter Three – Indigenous Tradition and Innovation

> *"[the Quechua] regard Pachamama as an extension of themselves - a being that needs taking care of - a force that must be nourished and protected lest it die."*
>
> -Carol Cumes, Rómulo Lizárraga Valencia*, Pachamama's Children: Mother Earth & Her Children of the Andes in Peru*

Defining Indigenous Agriculture

In this thesis, I will use the term indigenous agriculture to refer to an alternative to the Green Revolution that combines traditional agricultural techniques with locally-formulated innovations. This includes traditional strategies created specifically for the local topology and climate, along with any new development or idea that has originated in or been carefully adapted to the local community. Examples include polycultures, which involve planting different crops side by side in the same field; terracing, a labor-intensive technique to prevent soil erosion; and the use of green manures and organic fertilizers rather than agrochemicals. In contrast to Green Revolution agriculture, which is high-input, profit-maximizing, labor-reducing and based on scientific research taking place in labs in the Global North, indigenous farming is low-input, risk-reducing, labor-intensive and based on local knowledge and resources (Altieri, 2002).

Locally-adapted indigenous agriculture is an important alternative in communities for which Green Revolution-style agriculture is not well-suited. This style of agriculture – based on grassroots experimentation and traditional knowledge – deserves the same consideration from the international development community as do Green Revolution techniques. This is because by emphasizing community participation and grassroots innovation, these indigenous programs can create agricultural

strategies that are more cost-effective for small farmers than chemical agriculture and are a better fit for their unique needs.

Quinoa Production in Southern Bolivia: Organic Farming as a Point of Local Pride

Anthropologist Andrew Ofstehage's 2010 study of a farming community called Los Lipez, a region in the south of the Potosí department of Bolivia, is a good example of what indigenous agriculture can look like on the ground. In Los Lipez, the primary crop is commercial quinoa, grown by individual farming families on small plots of land and destined for local, regional and international markets. As one would expect, farmers in Los Lipez began experimenting with Green Revolution techniques in an effort to increase their yields. Specifically, in the 1970s a pair of Belgian bishops began promoting the use of agrochemicals and mechanization and many farmers adopted these new farming techniques just in time for the popularization of quinoa on the world market, which began in the mid-1980s (Ofstehage, 2010). But many of the chemicals the farmers were using were dangerous, including the now-banned DDT, and locals started to develop illnesses as a result. In addition, farmers noticed that they had to use larger and larger quantities of these chemicals each year, which was becoming increasingly costly. This can be attributed to the fact that pesticides killed not only the pests but also other insects that were natural predators of these pests (Ofstehage, 2010). By the time of the study, in 2010, the majority of Lipeño farmers had reverted to what they termed "traditional, ecological" practices, employing natural instead of chemical pesticides such as hot pepper ash or plant extract (Ofstehage, 2010, p. 92). Many quinoa farmers in Los Lipez took pride in their organic system, and would repeatedly mention the superiority of their quinoa to quinoa produced in other areas like Salinas, where "they all use tractors and chemicals" (Ofstehage, 2010, p. 92).

So why would Los Lipez farmers decide that the negatives of agrochemicals and mechanization outweighed the positives, while in nearby Salinas farmers were coming to the opposite conclusion? One

reason is altitude: Los Lipez is more than 4,000 meters above sea level, a staggering height at which only a few plants can survive and many natural plant diseases and pests are nonexistent (Ofstehage, 2010). This lack of pests makes the use of pesticides less necessary than in other parts of the world. Furthermore, nearby quinoa-producing areas had shifted quinoa production from steeply sloped land to the flatlands, where mechanization is possible and pesticides are more useful due to the presence of insects at this lower altitude. In Los Lipez, however, there was not enough precipitation for farmers to make this shift to the flatlands, which are dry. Instead, production has remained in the moisture-retaining hillsides, where the use of tractors is impossible (Ofstehage, 2010). In addition, even if a tractor were invented that could navigate this steep land its use would be undesirable to Lipeños; the light soil of Los Lipez easily blows away once disturbed and mechanization would create too much erosion to be sustainable (Ofstehage, 2010).

So, while Green Revolution techniques may be productive in other areas, they are largely ineffective in Los Lipez, Bolivia. This shows, as Andrew Ofstehage argues, that "it is too simplistic to make assumptions of the local based on a global situation (if the concept of a global situation indeed exists); let this be a call for a more complex and realistic analysis of the local context of situations and not a field of blanket assumptions" (2010, pg. 7). Each community has its own unique strengths and challenges, which call for a locally-adapted style of agricultural development.

Nayakrishi Andolon in Bangladesh: Agriculture of the People, by the People, for the People,

The Nayakrishi Andolon movement is another example of a successful indigenous agricultural program. In central Bangladesh, farmers began to use agrochemicals, HYV seeds and other hallmarks of “modern” agriculture such as tube well irrigation in the mid-1960s. However, their rapidly diminishing crop yields meant they had to use more and more inputs every year and the local livestock, fish and poultry populations soon began to die off (UNDP, n.d.). As one villager put it, “the fish started catching

diseases. We are not scientists, but we made the connection between pesticides and fish death" (McKibben, 2001). Not only were animals affected by the chemicals; many farmers started to notice health effects too. "Our skin would absorb the poisons," another woman stated, "We would get itchiness, get gastric trouble" (McKibben, 2001).

These farmers responded by creating what they called Nayakrishi Andolon, the "New Agriculture Movement" (McKibben, 2001). The main principles of Nayakrishi are to use no pesticides, which kill beneficial organisms as well as harmful ones; to gradually decrease the use of fertilizers to zero; to employ other strategies such as intercropping and agroforestry to improve soil fertility; and to conserve Bangladesh's genetic diversity by storing seed varieties at the household and community level (UNDP, n.d.). Over 25,000 farmers are now involved in the Nayakrishi movement across four districts: Tangail, Pabna, Cox's Bazar and Noakhali, and they have seen significant benefits (UNDP, n.d.). Farmers saw their livestock populations increase by 100% to 200%" after stopped using agrochemicals and they experienced a 50% to 200% increase in their cash incomes after switching from monocultures to more productive yet more labor-intensive mixed cropping (UNDP, n.d.). The farmers and their families have also seen their health improve (UNDP, n.d.). Furthermore, locals eat a tastier, more varied diet when they plant a mixture of local crops as opposed to a monoculture of HYV rice, as was promoted by the Green Revolution. "We don't like to eat rice only. It tastes better with green vegetables," one villager complained, and while this quality-of-life indicator may not show up well in development statistics, it is integral to locals' happiness and sense of wellbeing (McKibben, 2001).

Central Bangladesh is a very different environment than the Andes, yet farmers there have come to similar conclusions about the usefulness of Green Revolution techniques as those in Los Lipez. As will be discussed in the following chapter, farmers in Northern Potosí came to very similar

conclusions about the drawbacks of agrochemicals and other Green Revolution techniques for their own unique reasons.

The Promise and Problems of Indigenous Agriculture

These cases in Los Lipez, Bolivia and Central Bangladesh do not stand alone – there are more instances of successful development strategies based on indigenous agriculture. The use of polycultures is a prime example. In modern farming, monocultures of cash crops are encouraged because this is the best way for a farmer to engage in and profit from the market. Yet planting only one crop in a field means that the same few nutrients needed by that specific crop are leached out of the soil year after year. In contrast, polycultures involve planting the right mix of crops so that a process called facilitation can occur, in which one crop replaces in the soil the nutrients that another crop is extracting. For example, legumes fix nitrogen in the soil which potatoes then extract; therefore planting both crops together will improve soil fertility and reduce the need for chemical fertilizers. Farmers who find the right balance of crops in a polyculture can be successful in terms of producing adequate yields without exhausting the soil of its nutrients in the long term, while also avoiding dependence on imported agrochemicals (Altieri, 2002). While polycultures are more labor-intensive to harvest, and thus not the preferred method for large commercial farms, studies have shown that most polycultures produce higher yields than monocultures under controlled conditions (Altieri, 2002). Therefore, for a small-hold subsistence farmer polycultures are quite a productive strategy, even though they do not work well in the context of a large, commercial farm.

A more specific example of the way local innovation can prove as effective or more effective than Green Revolution-style agriculture in specific contexts involves AGRUCO, a nonprofit in Cochabamba, Bolivia that achieved higher yields using manure than using chemical fertilizer in a series of experiments. AGRUCO realized that in Bolivia organic manures lack phosphorous, so they guided

farmers to add phosphate rock and bone meal to the manure. These inputs are available locally and are less expensive than chemical fertilizers – an innovative use for an existing local resource that works well within the local context.

A final demonstration of the potential of traditional farming techniques is the use of terracing in the Andes. The archaeological record shows that terraces were a mainstay of agriculture during the Inca Empire, where they were used far and wide to turn steep, easily-eroded land into fertile farms. These same terraces, while labor-intensive to construct, still dominate the Andean landscape today because they reduce soil erosion, which is the primary cause of low soil fertility on marginal mountainside land (Treacy, 1989). For example, a terracing project in the Peruvian highlands was able to produce 45 percent higher yields than nearby non-terraced land and terracing was also shown to reduce the risk inherent in Andean farming, which is seen as a significant benefit by local farmers (Treacy, 1989).

Various studies have found alternative agricultural development projects like these to be very successful across Latin America based on a number of measures. A series of studies edited by John O. Browder showed that many alternative projects meet modern tests of financial viability and even have the potential to be commercially profitable, putting this style of agriculture on even footing with high-input chemical agriculture (1989). A separate analysis of similar NGO-led projects showed that many resulted in increases in production of 50% to 100% (Uphoff, 2002). Another researcher, Jules Pretty, found that indigenous agricultural development also produces more consistent, less risk-prone harvests while also conserving soil and improving crop biodiversity (Pretty, 1997). The key is to use locally-led innovation and experimentation to create agricultural solutions that are low-input, based on available resources and knowledge, and meet needs that are specific to subsistence farmers.

Yet if indigenous farming techniques are so successful, why are programs based upon them not more widespread? To begin with, the main strength of these programs – that they are precisely tailored

to be effective within a particular local context – is also their main weakness (DeWalt, 1994). The success of rural development projects based on traditional farming depends very much on the skills, knowledge and mindset of local people. Particularly, local people must be willing to innovate and experiment, and they must be creative and persistent in this process of experimentation. In contexts in which the Green Revolution is highly effective, this process of persistent experimentation may not seem worth the effort to farmers. In addition, the solutions they create apply very specifically to their locality, and will not necessarily work in many other places. Because of this, alternative agricultural development is less transferable between places and it is difficult to scale up compared to the Green Revolution. Indigenous strategies, as precisely adapted to local conditions are they are, cannot simply be distributed across a country or region like a packet of fertilizers and HYV seeds. It is a kind of development that is locally-created, not mass-consumed, and because of this it sometimes appears less attractive to development agencies or international donors than a more scalable and transferable model of development.

No matter what agricultural development strategy a farming community decides to use – agrochemicals or manure, HYV seeds or polycultures – this process of piecing together their own unique blend of techniques is important to their long-term success. In the next chapter, I will discuss my own field research in Northern Potosí and outline the decisions farmers are making there in an effort to construct their specific brand of agricultural development.

Chapter Four – Indigenous Agriculture in Northern Potosí

"Farmers want to care for their Pachamama…for Mother Earth"

- PRODII staffer, Interview, July 10, 2013.

Introduction

In 2013, I spent ten weeks from May to July in Northern Potosí, Bolivia. Northern Potosí is a region that comprises the northern section of the Potosí department in the Bolivian highlands, and all farming within the region is of the small-hold, subsistence variety.[5] My contact within the region was a local nonprofit called el Programa de Desarrollo Integral Interdisciplinario (the Program of Integral, Interdisciplinary Development), known as PRODII, which promotes sustainable, organic agriculture as a method of rural development.

Research Design and Method

The goal of my research was to investigate a local farming system in Northern Potosí and to discover how this farming system had been impacted –if it had been impacted at all – by the Green Revolution. In addition to a literature review, I carried out this research by observing agriculture during trips to rural areas in Northern Potosí, through informal conversations with PRODII staff members and farmers, and through more formal interviews with these staff members and farmers.

[5] A note on Bolivian spatial demarcations: a department in Bolivia is equivalent to a state in the United States. The next largest division is the municipality, which is roughly equivalent to a county in the US in terms of area, and is governed by a municipal government. Each municipality is further divided into smaller units called districts, which are groupings of 4-6 communities. Each community consists of a smattering of houses and fields containing no more than a couple hundred residents at the most.

While in Northern Potosí, I conducted 19 interviews with farmers, 6 interviews with PRODII staff and one interview with a member of Pocoata's municipal council; a total of 26 interviews. I will refer to the former interviews as farmer interviews and the latter as expert interviews.

The farmer interviews were-set up with the help of PRODII staffers, and conducted in three different districts: Esquencachi, in the municipality of San Pedro de Buena Vista; and Quesimfuco and 31 de Enero, both in the municipality of Pocoata. Each staffer would allow me to accompany him or her to one of these remote, rural districts, which required a 2-4 hour truck ride along mountainous dirt roads and sometimes an additional 15 to 30 minutes on foot. These communities were typically small and had moderate to little access to electricity, running water, and education. There are many communities than can only be reached by walking for over two hours beyond the nearest road, but I did not visit these due to how difficult they are to reach.

At bottom left, a remote community in the district of Quesimfuco

A more prosperous community located near the town of Pocoata, in the district of 31 de Enero

Once we had reached the community, the PRODII staffer would accompany me to the houses of various farmers, where he or she would introduce me to each farmer we found at home. I would explain the purpose of the interview to the farmer and obtain oral consent, and then we would begin the interview, which was also recorded with an audio recorder. The interviews ranged from 15-45 minutes in length and the majority involved the PRODII staffer translating between Quechua and Spanish so the farmer and I could communicate. A full list of interview questions can be found in Appendix B. The interview questions pertained to the use of agrochemicals, the effects of irrigation systems on farming, how farming had changed during the farmer's lifetime and what additional sorts of assistance farmers wished to receive from local NGOs and the municipal government.

Interviewing a prosperous farmer in his field in the district of Esquencachi, part of the municipality of San Pedro de Buena Vista.

A post-interview photo in the district of Quesimfuco, Pocoata municipality. Left to right: me, a farmer with her child, and fellow UNC student Sarah Pederson.

At the conclusion of each interview, I thanked the farmer for taking the time to speak with me and offered him or her coca leaves, which is a traditional way to express thanks in the Andes.

Limits to this Methodology

The fact that a PRODII staff member coordinated each interview was not ideal, considering PRODII has established beliefs about what makes for effective agriculture. However, I would have been unable to conduct the interviews without the help of PRODII staff due to the necessity of having a translator and the importance of their introduction, which established trust and made interviewees feel more comfortable. Fortunately, I did conduct 11 of my interviews in the district of Quesimfuco, in communities in which PRODII had never conducted an agricultural project and thus had not influenced agriculture. I conducted these with the help of a staff member who was a nurse, and therefore affiliated with PRODII's health program as opposed to their agricultural program. While the presence of a PRODII staffer at these interviews could have biased my data, I have no reason to believe the interviews were biased unduly and those conducted in Quesimfuco should be particularly free of bias. I was aware that there might be some differences of opinion between PRODII staffers and farmers and watched for any sign of conflict during the interviews, but farmers and PRODII staffers seemed to agree with each other on most subjects and I did not detect any tension.

Traditional Farming in Northern Potosí

Farming in the Andes is very different from farming in flatland areas, and requires a brief introduction in order to situate my research in its proper context.

Farmers in Northern Potosí use a technique that has existed for centuries, which researcher John V. Murra has termed "verticality" (2002). Verticality means that each family owns and farms

multiple plots at different altitudes, traveling on foot between them to spend a few days or weeks in the fields that are farthest from their homes. This technique is vital to highlanders' survival because it allows them to cultivate different kinds of crops at each elevation, which is useful not only in diversifying their diets but, more importantly, in diffusing risk. In the harsh and volatile climate of the Andes, it is all too common for an early frost to destroy the year's potato harvest, but using the verticality method means that even if one crop is decimated a family will be able to survive on the harvests from their remaining fields. Verticality also includes herding, which takes place at the highest altitudes that are otherwise impossible to cultivate. Andean families keep llamas as pack animals and sheep and alpacas to provide wool.

Another salient feature of agriculture in Northern Potosí and other parts of the Andes is the breathtaking genetic biodiversity that exists within the native crops (Zimmerer, 1996). While only a relatively small number of crops can grow in the *altiplano*, where the main harvests are the potato and the similar oca and ulloco tubers, as well as the grain quinoa and the legume-like tarwi, there are a wide range of varieties of each crop. For example there exist as many as 500 different varieties of Andean potatoes and other crops are similarly diverse (Huamán, 1986). This diversity is vitally important to the survival of the yearly harvest because farmers will make sure to plant several different strains of the same crop according to their specific variations. For example, a family will plant tastier but less hardy potato varieties, which are preferred, side by side with bitter, frost-resistant strains that serve as a kind of insurance in the event of bad weather.

Another aspect of Andean culture that impacts agriculture is that indigenous highlanders have a strong sense of communality and a history of organizing within their communities. This can be seen best through the structure of the *ayllus*. An *ayllu* is a kinship group that is based on cooperation and reciprocity. *Ayllu* members help each other in the fields, share rotating leadership positions called

cargos, and make decisions communality, such as determining which land should be kept fallow every year and which land will be used for grazing. The *ayllu* also provides a safety net in the event that a family falls on hard times, because they can rely on other *ayllu* members for support. This cooperation is rooted in immediate necessity: historically, it has been difficult for families to complete all necessary agricultural tasks, so the community works together to ensure its survival (De la Cadena, 1989). Historically, ayllus were also a means by which farmers from different areas shared seed varieties and other resources. As has been discussed, this historically strong organizational structure that exists within indigenous communities has lent itself well to the formation of NGOs.

Indigenous Agriculture in Northern Potosí: The Current System and Why it Exists

From my interviews, I have constructed a picture of indigenous agriculture in Northern Potosí: a collection of farming techniques based on tradition and local innovation that has superseded Green Revolution-style agriculture within the region. The most salient features of this agricultural system are that farmers have eschewed agrochemicals in favor of organic agriculture, that farmers are using biodiversity to adapt to climate change, and that NGOs are providing technical knowledge and structure to agricultural development.

The negative consequences of agrochemicals outweigh their benefits

The most striking trend that emerged from my farmer interviews was that the vast majority of farmers in Northern Potosí do not use agrochemicals. Moreover, they had specific reasons for refusing to use them: according to interviewees, chemicals not only damaged soil fertility and endangered long-term production, but also damaged human health and worsened the flavor of crops. As one farmer told me on July 17, 2013 in Yahuaco, a community in the Quesimfuco district and Pocoata municipality, agrochemicals "do damage…there are lots of living things in the soil and chemicals kill them." After using chemicals, according to the farmer, "land isn't any good." Another issue was lack of access to

agrochemicals – farmers did not have the economic resources to purchase agrochemicals and poor transportation infrastructure and the subsequent isolation of many rural communities made agrochemical use impractical and unrealistic for many farmers.

The reasons that agrochemicals are impractical in this area are worth exploring in more detail. Firstly, the soil in Northern Potosí is what researchers call fragile or marginal land. It is steep and thus easily eroded, meaning that maintaining soil fertility is a constant battle (Blaikie, 1985). Agrochemicals, as was outlined in chapter two, have been found to damage soil fertility in the long term, and Northern Potosí's fragile soil is particularly susceptible to this type of damage. This means that while agrochemicals do increase production in the short term in Northern Potosí, several years later the land will actually produce less than it did originally as a result of the use of chemicals. As one PRODII staffer told me on July 24th, 2013 in an interview in the PRODII office, "Unfortunately, in 4 or 5 years [farmers who still use chemicals] are going to have problems because this soil won't produce well. That's how it is, when farmers use chemicals." According to the staffer, "In the 80s...I would say that 40% [of farmers] used chemicals...but after 5 years they said 'no, we have problems.'" Another staffer, on June 12th, explained further how this processes works: "the soil contains micro-organisms that chemicals harm. They kill them completely, and leave the soil infertile….the people have seen that chemicals do damage to the earth, to their Pachamama, as they say, and for this reason they don't use them." A third staffer also mentioned the damage he had seen agrochemicals do to long-term soil fertility in an interview on July 22nd, showing that this is a well-accepted phenomenon in the Northern Potosí agricultural sector.

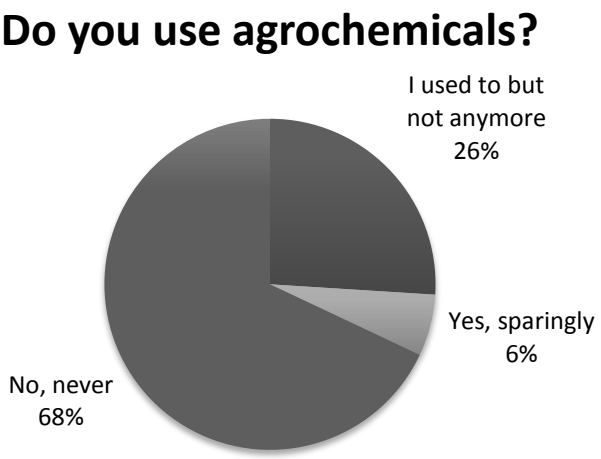
Secondly, when farmers apply agrochemicals to their fields in the United States or other parts of the developed world, they use basic safety equipment and observe safety precautions. For example, it is a common practice to wear gloves when applying chemicals and to stay out of the field as well as a defined buffer zone around that field for a length of time after fumigating with a pesticide (EPA, 2012;

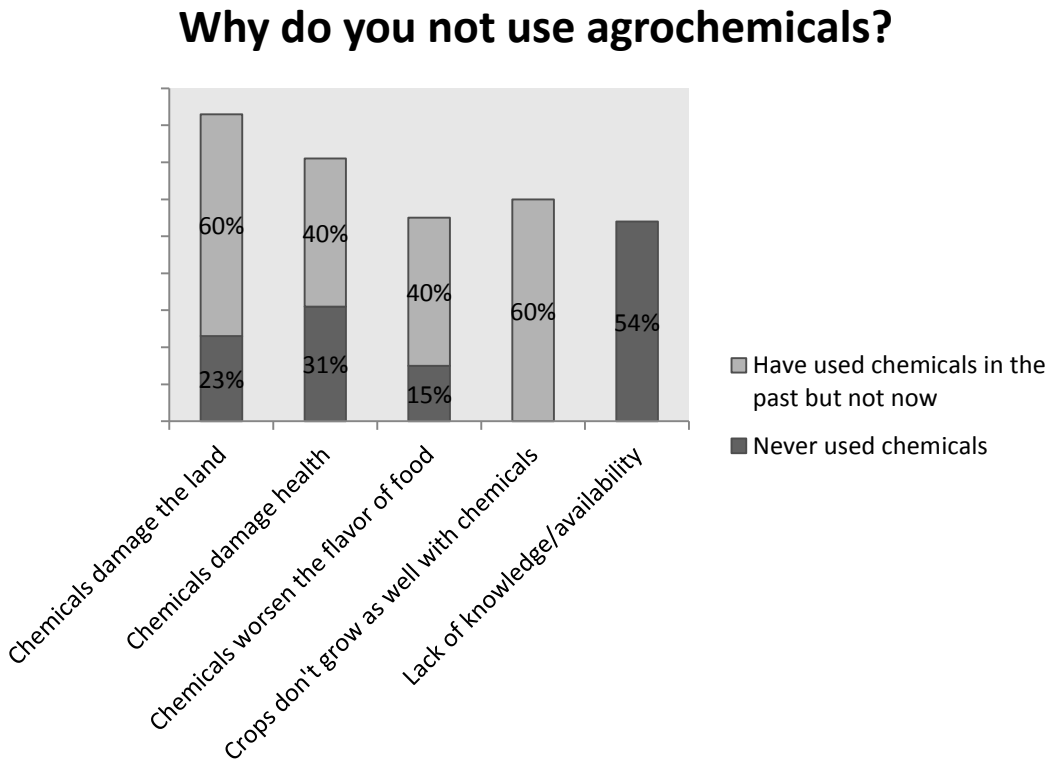
EPA, 2013). Additionally, residents of the developed world are accustomed to washing their produce before they eat it to avoid ingesting chemicals. By contrast, in rural Bolivia farmers rarely have adequate footwear, much less rubber gloves or any other kind of safety equipment. In addition, they are unaware of the importance of these safety precautions because most farmers are illiterate and also do not speak Spanish, and thus cannot read the safety instructions on agrochemical packaging. Moreover, communities rarely have running water in their homes and the water to which they do have access is not clean, so it is difficult to wash one's body after applying agrochemicals or to wash produce before consuming it. Because of these factors, agrochemical use presents a health risk to farmers in Northern Potosí that farmers in much of the developed world have the resources to avoid.

The negative consequences of agrochemicals were a frequent theme throughout the interviews. Out of all 19 farmer interviews I conducted, 18 did not use chemicals and the one farmer who did use them said he used them only sparingly because they damaged the land and because he could not always afford them. Five of the interviewees had previously used chemicals and decided to stop using them, three of whom cited both damage to land and lower productivity with chemicals compared to natural agriculture. Two farmers also mentioned harm to human health and two stated that their crops did not taste as good when grown with chemicals. In an interview I conducted on July 2, 2013 in the 31 de Enero district of the municipality of Pocoata, a farmer told me that her family had used chemicals in her youth but do not use them any longer. When I asked why her family decided to stop using chemicals, she said "they damage the land, the children. The land itself stopped producing crops well." Two more farmers from the same district, a wife and her husband, echoed this sentiment on July 23. When I asked if they used chemicals, she said, "No chemicals. All natural. They damage the land." I inquired if they had ever used chemicals in the past, and she said yes, five to seven years ago. "They damage the plants," her husband said. I followed up by asking which method had produced higher yields. "Natural agriculture produces more," he told me, "we've done well this year."

This statement about the efficacy of chemical versus natural agriculture was frequently repeated. None of these interviewees who had used chemicals in the past said that they had produced more with chemicals than with natural agriculture, and each said their fields produced either the same or better using organic techniques compared to when they had used chemicals. Even farmers who had never used chemicals were often frank in their belief that chemicals were bad for long-term soil fertility. One farmer, who I interviewed on July 17 in the Quesimfuco district of Pocoata, said that he had never used chemicals because "they say they do damage, they do bad things to the land. Because there are lots of living things in the soil and chemicals kill them, it's poison…and later the land isn't any good." Instead of using chemicals, farmers said they preferred to use natural, locally available fertilizers like manure and different forms of compost that PRODII and other nonprofits had taught them to make.

Seven interviewees, concentrated in the district of Quesimfuco, also noted lack of availability or knowledge about chemicals and lack of economic resources to purchase them as reasons they did not use chemicals, in addition to the other downsides of agrochemical use they had cited. While this problem of access may be surmounted in the future as the Bolivian government builds more and better roads, currently the difficulty rural farmers have in obtaining chemicals means that it is a cheaper and more realistic strategy for farmers to use natural fertilizers and pesticides than chemical ones.





In addition to the data on the prevalence of agrochemicals that I gathered from my farmer interviews, I also received estimates of chemical usage from the expert interviews I conducted with PRODII staff members. One staffer estimated that 80% of farmers in the district of Tomoyo farm without chemicals, while another staffer estimated that 99% of farmers in the district of 31 de Enero

farm without chemicals. Both districts are located in the municipality of Pocoata. The latter staffer informed me that the district of 31 de Enero had in fact been officially certified as organic by the government. This certification seemed to be largely a symbolic gesture with little practical significance, but it does indicate how widespread this preference for organic over chemical agriculture is within Northern Potosí. A third staffer estimated the rate of organic agriculture across Northern Potosí as a whole as 75%.

The expert interviews I conducted with PRODII staff and a Pocoata municipal councilman provided historical context to the story of agrochemicals in Northern Potosí. According to my interview subjects, in the 1980s nonprofits and various levels of government promoted the use of chemical fertilizers, chemical pesticides and genetically-modified seeds, bundled together in ready-to-use technological packets. Several staffers identified this introduction of chemicals with the Green Revolution, which was being implemented across the developing world at the time. One PRODII staffer estimated that 40% of farmers in Northern Potosí used chemicals in the eighties. While this is not an overwhelming percentage, it is higher than the number of farmers who use chemicals today. Over the years, however, farmers observed the damage chemicals inflicted on soil fertility in the long run, as well as the negative health consequences, and a consensus began to emerge that natural, organic agriculture was preferable to the use of agrochemicals. By 2013, when I conducted my research, the experts I interviewed informed me that no organizations promote the use of chemicals in Northern Potosí anymore, because it was widely accepted within the region that their negative consequences and the difficulty farmers had in obtaining them outweighed their potential benefits.

Adapting to local challenges: climate change

Another interesting topic that came up in the farmer and expert interviews was climate change, and how much farmers were having to adjust their livelihood strategies to adapt to changing

temperatures and the increased variability in weather. Farmers frequently mentioned global warming and the positive and negative effects it was having on their lives. Many farmers, for example, brought up the fact that they could now produce warmer-weather crops, such as corn, at a higher altitude than had ever been possible before. For example, one farmer I interviewed in July 2 in the district of 31 de Enero, in the Pocoata municipality, stated that crops produce better now than before, and some crops in particularly: "before we couldn't grow corn, for example…now we can grow corn because of global warming". She said that she had observed these changes during her lifetime and viewed them as positive.

Another farmer, who I interviewed on July 19 in the Quesimfuco district of Pocoata, echoed this sentiment. When I asked how agriculture had changed during his lifetime, he said, "it's hotter." "The climate has changed?" I asked.

> *"Yes, climate change…since I can remember, since I went to school, I remember that here a few things didn't grow. But since about four years ago the climate has changed. Here it's hot and we can grow corn. Before, we couldn't. So this change means we can produce new things but also some other stuff, like hail. Before there wasn't hail, or as many frosts…the rains come early or late, too, along with frosts. Sometimes [frosts] come in May. Everything is already green and then there's a frost. It's not good."*

As this quote indicates, farmers also complained that climate change caused more inclement weather and natural disasters and that the weather was more unpredictable than before. For example, frosts would come earlier, and it would rain at unusual times, which made farming more difficult. This complaint was echoed by several farmers.

These interviews show that farmers in the Andean highlands are confronting specific challenges that high-input chemical agriculture is not necessarily designed to address, and are having to use their

ingenuity to adapt to these challenges. Farmers were also drawing on a significant local asset that exists within the Andes in order to adapt: biodiversity.

Drawing on local resources: seed biodiversity

The way climate change is impacting Northern Potosí and other Andean communities has to do with the particular local geography. The peaks and valleys formed by the Andean mountain range, not to mention the huge variations in temperature across altitudes, have created a wide array of microclimates with different crop varieties to go with each microclimate. As global warming slightly changes temperatures in these microclimates, farmers informed me that they trade around seed varieties to make sure they are always using the most productive seeds for their particular conditions.

Farmers informed me that they drew on seed biodiversity for a variety of other reasons aside from climate change, as well. For example, if a certain plant disease became common in one area, farmers mentioned switching to other varieties that would produce better in the face of the new blight. In many places in the Andes this valuable natural biodiversity is being lost as farmers switch to planting monocultures or to imported HYV strains (Zimmerer, 1996) but according to my research this loss of biodiversity was not occurring in Northern Potosí. In 16 of the 19 farmer interviews I conducted, I asked the interviewees if farmers in their area planted the same seed varieties as they had in the past. Seven of the respondents said that they actually planted either more or better seed varieties than they had previously. No respondents expressed any real concern that biodiversity was being lost within their communities, and more frequently stated that they and their neighbors “plant all different varieties”, as one farmer from the community of Yahuaco, in the Quesimfuco district and Pocoata municipality, told me on July 17, 2013. Respondents said that these seeds had been brought into their communities by nonprofits such as PRODII, as well as the municipal government in Pocoata, and when I asked why they had switched to these new seed varieties, they said that they made the switch when their old seed

varieties stopped producing well. With one interviewee I asked why these old seeds had stopped producing well, and he attributed this to climate change.

The breathtaking biodiversity that exists within the Andes is one of the defining characteristics of agriculture there, and arguably the greatest resource that Andean farmers have at their disposal. This fact goes a long way in explaining why agriculture based on monocultures has not seemed like an attractive option to farmers in Northern Potosí. Imported high yield variety seeds are often an attractive option in areas with less natural biodiversity to draw upon. Yet in Northern Potosí, where such a wide spectrum of seed varieties exist, if a farmer becomes dissatisfied with the variety they are planting or if local conditions change it is relatively easy for them to switch to a different variety of that crop from the next valley over, an option that does not exist in many other areas of the world. This trading around of seed varieties works especially well when there exists an organizational structure that can facilitate these transfers across the region. In Northern Potosí, local NGOs and municipal governments are instrumental to this process.

The Role of the NGO: Irrigation Systems and the Provision of Technical Expertise

Local NGOs, working in conjunction with municipal governments, provide leadership, services and technical expertise that are instrumental in making Northern Potosí's system of indigenous agriculture function. One example of this is how NGOs like PRODII serve as a link between isolated communities by transferring seed varieties from one area to another across the region. NGOs are also important because they provide vital technical knowledge and support to local farmers, who require support due to limited access to education and to economic resources. Based on my observations, NGOs provide an organizational structure that can transfer resources and best practices between communities and provide vital services that these communities often lack.

NGOs are particularly well-suited to play this role because the strength of indigenous agriculture is that innovations are created at the local level, and can be fine-tuned to suit a particular place. This means that leaders within this process of innovation must be local actors, and NGOs are uniquely placed to lead these kinds of agricultural projects in a way that other actors are not.

One reason that NGOs are well-suited for this role within Bolivia in particular is the Bolivian state has not been seen as a local actor because its rural development projects are traditionally top-down processes led mainly by urban whites and mestizos (Bebbington, 1992). The perspectives of indigenous people have rarely been incorporated into the planning process in Bolivia and it has been common for project staff to only meet with the local community for the purpose of communicating to them what the project consists of, not for the purpose of planning the project (Bebbington, 1992). This is changing rapidly in Bolivia, with its first indigenous president and a new-found focus on indigenous culture, yet NGOs are still more likely to have stronger ties to local communities than is the state. The result is that their agricultural projects are more likely to be participatory than are those of the state, and they are more easily held accountable because the leadership of NGOs is located within the community instead of far away in La Paz (Bebbington, 1992). Because of this, NGOs appear to be the natural actors to spearhead alternative rural development projects, provided that they are community-based. NGOs in Northern Potosí often work closely with municipal governments, however, which have closer ties to communities than the federal government has, based on my observations.

NGO-led programs to build micro-irrigation systems in Northern Potosí are a good example of how NGOs can play an important role in an indigenous agricultural system. These micro-irrigation systems have been fine tuned to suit the particular culture and topography of Northern Potosí and have created a measurable improvement in local quality of life. To fully understand the phenomenon of

irrigation systems and what they demonstrate about Northern Potosí's specific model of agricultural development, it is important to understand more about the logistics of how they are built and operated.

The first step to constructing a micro-irrigation system is finding an adequate source of surface water. Once located, this surface water is routed through a pipe into a small reservoir. These reservoirs were formerly made of concrete but PRODII and other organizations have discovered that lining them with a plastic called geomembrane is cheaper and easier, because transporting the light plastic into isolated rural communities is much simpler and less costly than transporting heavy concrete. From there, the water travels through a pipe to the field, where it connects to a sprinkler that can be turned on and off to provide water when rainfall is scarce. PRODII uses a sprinkler to distribute water in these irrigation systems because they found that sprinklers waste much less water than flood irrigation. Additionally, PRODII and many other organizations in the area are careful to construct small, family-sized irrigation systems rather than the large scale communal irrigation systems that organizations had favored a few decades ago. This is because organizations discovered that it is easier and more effective for each family to manage their own micro-irrigation system than for families to try to coordinate the management of a large, multi-family system, which not only caused arguments within communities but also resulted in a tragedy of the commons-style misuse of water in which families would take more than was wise and would drain the communal tank dry over time.

Another relevant fact about micro-irrigation systems is that they are prohibitively expensive and require too much technical knowledge for most farmers to construct themselves. This means that the assistance of NGOs and municipal governments is crucial to these farmers' ability to irrigate their fields.

The reservoir of a micro irrigation system in the district of 31 de Enero, Pocoata municipality.

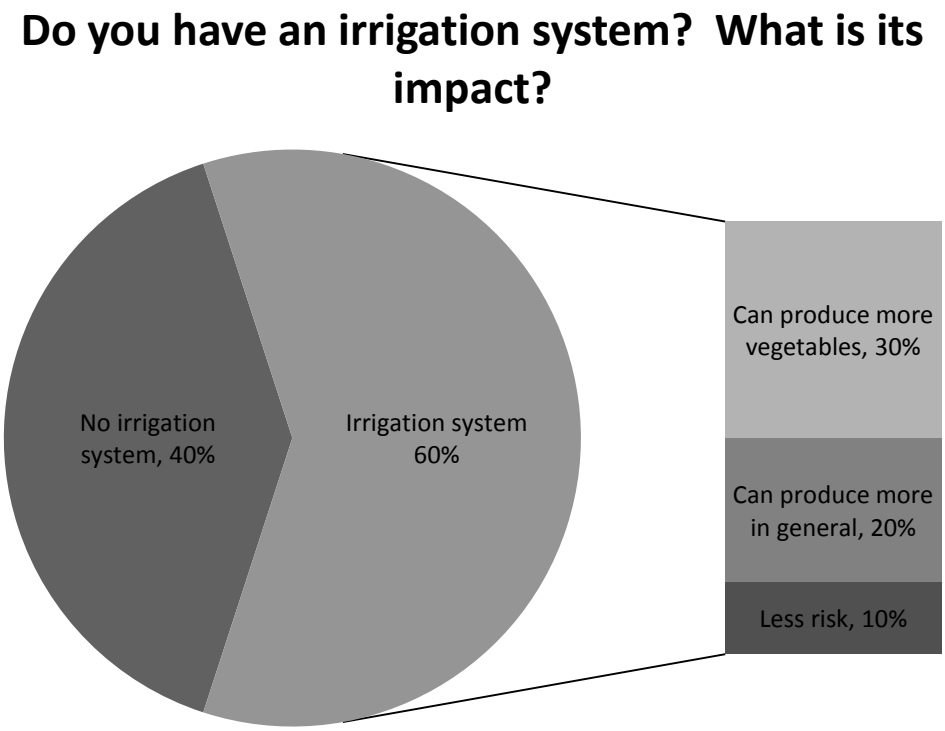
To examine the impact of these irrigation systems further, of the 19 farmers I interviewed, 11 farmers had an irrigation system. Out of those 11 farmers, 6 of them said that they could produce vegetables now, which they had not been able to produce before, [6] while 4 of them said that they produced more of all their crops than they had before the irrigation system, and 2 farmers stated that farming was less risky with their irrigation system because it provided a back-up source of water when rain was scarce. For example, a farmer I interviewed on July 23 in the 31 de Enero district of the municipality of Pocoata, said that they "produce more" since their irrigation system was constructed three years ago. Another farmer I interviewed on July 19 in the Quesimfuco district of Pocoata told me that water from an irrigation system reached a small corner of his land and that he was growing a garden there. I asked him how production was different in the part of his land the irrigation water

[6] These vegetables include green beans, carrots, lettuce, onions, radishes and turnips, among others, according to my expert interviews.

reached compared to the rest of his land. "Here there are three families here who are using the water to plant vegetables", he said. "Carrots, onions, cabbage, everything…Before I couldn't plant these things."

Of the 8 farmers who did not have a micro-irrigation system, many said they would like to have one because they believed they would be able to produce vegetables, which they would consider an improvement in their standard of living. When on July 17, 2013 I asked one farmer how he thought his life would change if he had an irrigation system, he stated, "An irrigation system would change everything. Before, we never planted vegetables. But now, we're all thinking about planting vegetables in order to live well."[7] When I asked him to explain explicitly why he defined planting vegetables as "living well," he responded that having vegetables would mean they would eat better. Additionally, when I asked farmers what kind of assistance they would most like to receive from nonprofits or the municipal government, an irrigation system was the most commonly-cited answer, mentioned by 6 of the 12 interviewees to whom I posed the question.

[7] This farmer was a resident of the Yahuaco community, in the Quesimfuco district and Pocoata municipality.



The impact of these irrigation systems is so significant that a municipal councilman I interviewed identified irrigation systems as one of the Pocoata municipality's top priorities. Food security was the municipality's most pressing concern, and he saw irrigation systems as instrumental to improving food security. In addition, these kinds of micro-irrigation systems have a multiplier effect attached to them, according to the interviews I conducted with PRODII staff members. Farmers with irrigation systems are able to produce more, which not only increases their food security but also increases how much extra food they have available to sell. These farmers exist mainly outside of the cash economy, but they do need to obtain cash to pay for a few essential items such as sugar, oil, soap, and clothes, as well as school uniforms and school supplies for their children.

Many farmers can only obtain this cash by migrating out of the community to work in construction in far-away cities like Cochabamba and Santa Cruz, or in the mines of Huaynuni and Llallagua within Northern Potosí. After growing tired of this constant seasonal migration it is common

for families to decide to migrate permanently. This migration can be devastating to communities, according to my farmer interviews, staff interviews, and observations, because as communities dwindle in numbers, local schools and health clinics will often shut down and move to other more populated locations, leaving those who still live in the community without access to basic education and medical care.

However, if farmers are able to produce a larger harvest using their irrigation system and can earn cash by selling the surplus on the market, they will often stay in their home communities instead of migrating. One staff member said he had observed this phenomenon in the district of Moscari, in the San Pedro de Buena Vista municipality. With their new irrigation systems, families in Moscari could harvest twice and sometimes even three times a year instead of just once because they were no longer dependent on rainfall. The farmers sold their surplus on the market for cash and migration decreased; consequently, there are now enough children in Moscari that the school is no longer in danger of shutting down, as it once was. As the staffer stated, on July 7, 2013:

> *"On the topic of irrigation...Migration has decreased in Moscari. There were families that went to Cochabamba or the Chapare three or four times per year but now they don't go. Or they go but they come back very quickly...we consider this to be a good indicator…[In] Moscari, for example, before there was a school that had two teachers, and that was enough for the number of kids there...Now there are four or five [teachers], there's stability, families aren't migrating. And the children stay and there are more of them, so they need more teachers. This is also a good indicator of our accomplishments."*

Thus, irrigation systems have the potential to revive dying communities, an impact of which the importance cannot be overstated.

Solutions like these micro-irrigation systems, implemented by grassroots NGOs and specially adapted to Northern Potosí's specific needs, are a prime example of the kind of projects that can make

indigenous agriculture such a successful alternative to the Green Revolution in areas where Green Revolution techniques are difficult or impractical to implement.

Conclusions

My research reveals an interesting model of agricultural development based on organic inputs, micro-irrigation systems and natural biodiversity. By combining tradition with locally-led innovation, Northern Potosí farmers and the NGOs that support them are improving local quality of life using agricultural strategies that differ notably from Green Revolution-style agriculture. This demonstrates that alternatives to the Green Revolution are viable and worth consideration. In the next chapter, I will analyze what conditions in Northern Potosí contributed to farmers' preferences for an indigenous style of agriculture over Green Revolution strategies. Finally, I will recommend that international development organizations look for specific characteristics in the area they are entering in order to decide what kind of agricultural program they should support.

Chapter Five – Recommendations and Conclusion

"Our past comes from the Pachamama

We are living our present on Pachamama

And our future will always depend on her"

- Rómulo Lizárraga Valencia*, Pachamama's Children: Mother Earth & Her Children of the Andes in Peru*

My research shows that while high-input, chemical agriculture can be very successful at increasing yields in many areas of the world, this style of agriculture does not work well to increase long-term standards of living everywhere. Alternatives to Green Revolution agriculture, like the indigenous mix of tradition and local innovation that I have explored in this thesis, can be viable in parts of the world where the Green Revolution falls short, and ought to be considered seriously by development agencies and NGOs that wishes to engage with agricultural development in the Global South.

But what is it about Northern Potosí or other regions that make indigenous agriculture preferred over Green Revolution agriculture? What local characteristics should international agencies look for to inform their decision to support one kind of agricultural development over another? Based on my research, I recommend that NGOs and agencies strongly consider supporting an indigenous style of agriculture over a high-input, chemical style in areas where the following conditions exist: the land is fragile or marginal; there is little access to imported inputs due to geographic isolation or lack of economic resources; farmers have very small land holdings; a region has significant local resources (like biodiversity) that a Green Revolution strategy would leave untapped; and the community already has an organizational or leadership structure in place to help direct the creation and implementation more local agricultural strategy.

Firstly, as I have explored throughout this thesis, land with poor soil fertility is referred to as marginal or fragile land. There are different reasons that land might be marginal, yet this is especially common in cases where the land is steeply sloping and prone to erosion, as in Northern Potosí. Evidence exists to show that the soil fertility of marginal land is particularly easy to degrade, and also that it is possible that chemical fertilizers and pesticides can damage long term soil fertility. Because of this, areas with marginal land could be good candidates for alternative agricultural models, especially if the locals' previous experience with chemical agriculture has been mainly negative like in Northern Potosí.

Another reason for using locally-sourced inputs over imported ones is geographic isolation or lack of economic resources. If it is prohibitively difficult for farmers to ensure continued access to agrochemicals because they cannot afford them or obtain them, it may make more economic sense for a farmer to use manure and compost for fertilizer and pest-resistant strains of seeds or natural pest deterrents.

Farmers are especially likely to have little economic resources in areas where very small land holdings predominate. This is because small land holdings indicate that very few farmers have been able to amass enough money to start buying land from their less successful neighbors. These farmers are most likely just barely surviving from year to year, and no matter how productive chemical inputs may be, these inputs are likely to simply be out of their reach economically. In a case like this, it would be unsuitable for an international development agency or donor to enter the area and attempt to promote the use of chemical inputs, because this is simply an unrealistic strategy for these small hold farmers.

Other characteristics that donors and NGOs should look for when attempting to engage with agricultural development are any particular local resources or strengths that could be leveraged to

improve standards of living. For example, the most significant attribute of the Andes in terms of agriculture is the biodiversity that exists there. The Andes are home to hundreds of seed varieties, and it is very effective to trade these varieties to confront shifting challenges like blights and climate change, and to plant a diverse array of crops as a kind of insurance policy in case one kind of crop grows poorly for a season. Other regions might have other attributes. For example, in central Bangladesh the soil is so fertile that chemical fertilizers are largely unnecessary. It is rational to draw on local strengths and resources when implementing or supporting an agricultural program, which may necessitate altering the Green Revolution model.

An alternative, and more locally-designed, style of agricultural development can be particularly effective at improving living standards in a farming community if there is an organizational structure that can guide the implementation of the agricultural program and provide technical support to farmers. If a ready local partner exists, development agencies should take advantage of this opportunity. Since indigenous agriculture is specifically based on utilizing local knowledge and is built on a deep understanding of specific local conditions, it is difficult to overstate the importance of a community partner as a resource. Even when attempting to implement a Green Revolution program, the success of certain agricultural strategies can vary greatly by location, as this thesis has shown. Local partner organizations are an asset to any style of agricultural development program because of their understanding of the local community, topography and climate. A community partner can come in the form of a local NGO, a municipal government, the agronomy program of a local university, a community council or some other traditional governing body. It is even possible for an international development agency or organization to work with a community partner that has little technical knowledge about agriculture. In this case, the international organization can provide long-term technical support while listening closely to what their partner organization can tell them about the local farming community's experiences, goals and needs.

If an area does not possess any of these characteristics – the land is not marginal, farmers have medium-sized land holdings and some economic resources at their disposal, and communities are connected to transportation infrastructure and have access to manufactured inputs – it is very possible that the Green Revolution may be a productive form of agricultural development as a way to improve local quality of life. In this case, an international NGO could implement a successful program in which they might subsidize access to chemical inputs and HYV seeds, provide technical knowledge and training on how to use those inputs and seeds, advise farmers on the cash crops they should plant based on pricing on the international market, or any number of agricultural services common in Green Revolution programs. However, if a development organization is considering engaging in an area where land is fragile and farmers have little access to manufactured inputs, or any of the other characteristics outlined here, it is my recommendation that this international development organization strongly consider investing in an indigenous form of agriculture over Green Revolution strategies. Based on my literary research and field work, alternatives to the high-input, chemical agriculture should be taken seriously as a viable means of improving quality of life within the many marginal farming communities that the Green Revolution has left behind.

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Appendix A – Translations

Chapter One - Introduction

Forward by President Evo Morales, la Constitución Política del Estado Plurinacional de Bolivia

> *"Tenemos la oportunidad histórica de cerrarle las puertas al racismo, a la discriminación y a la exclusión empezando a construir un Estado Plurinacional, intercultural y auténticamente democrático que se funde en la pluralidad cultural de nuestra patria…Para construir una Bolivia más justa...los pueblos indígenas nos señalan la ruta que debemos seguir. La Nueva Constitución establece que en el nuevo modelo de país los pueblos indígenas tendrán una profunda participación civil, política y económica" (Morales, 2009, p. 3-4).*

Chapter Two – Green Revolution Agriculture

Epigraph: "Pachamama", Historia Oral de Bolivia, Evelyn Ríos de Reyes

> *"Pachamama meditó largamente sobre la forma de ayudar a estos humanos para que mejorasen en su calidad de vida y creó unos frutos a los cuales puso el nombre de 'papas'...Estos frutos tenían una cáscara más oscura para protegerlos, pero la pulpa era deliciosa y era tan blanca como el corazón de Pachamama...Entonces [las mujeres] comprendieron la magnitud de aquel regalo de Pachamama y fueron en su busca y le prometieron que antes de cualquier comida harían una challa (ceremonia de agradecimiento) en su honor" (Ríos de Reyes, 2003, p. 20-21)*

Appendix B – Interview Questions

Farmer Interview Questions

These interview questions evolved throughout the course of my research. While the majority of these questions did not vary, there were some questions that I did not ask in every single interview.

1. Do you practice ecological agriculture, or do you use chemicals? Why? Have you always farmed this way?
2. Do you rotate your crops? What crops do you plant and on what schedule?
3. Do you let your land lie fallow? On what schedule?
4. Has farming changed during your lifetime?
5. Has farming changed since your parents' and grandparents' generations?
6. Do you sell your crops on the market? Why? Have you always done this?
7. Do you think migration has an impact on agriculture?
8. Do you think agriculture has become easier or harder during your lifetime, or stayed the same? What about since your parents' and grandparents' generations?
9. Do you think agriculture is the best way for you to make a living? Do you think it is the best way for your children to make a living?
10. Do you think farmers plant as many seed varieties compared to before? Why?
11. Are your fields terraced? Why? Have you always had/not had terraces?
12. Do you have an irrigation system? Why? If so, when was it build and what impact does it have on your production?
13. It seems like a lot of families in this area have a lot of children. How do families decide who will inherit the land? Are land parcels becoming smaller and smaller over time? Is it possible for all the young people to become farmers, or are they limited by a lack of access to land?

14. Are there projects that you think nonprofits like PRODII, or the government, could carry out that would help you to farm and live better?
15. Has quality of life improved here in the last few decades? What about compared to your parents' and grandparents' generations?

Expert Interview Questions

These interview questions evolved greatly during the course of my research based on which issues I was concentrating on when I conducted the interviews. I did not ask each of these questions at each interview, but each interview was made up of some compilation of the following questions.

1. What do you think about the use of chemicals in agriculture?
2. I understand that pesticides can damage the soil and health, because they are more or less a type of poison that is intended to kill plants and insects. But chemical fertilizer is mostly nitrogen, the same ingredient in organic fertilizer. So why does PRODII not promote the use of chemical fertilizer?
3. Are there farmers who use chemical fertilizers and pesticides in Northern Potosí? Why do they use chemicals while the rest do not? Do these farmers have any specific characteristics that influence their chemical use, for example their socioeconomic status or their location within the region?
4. If a farmer isn't producing much, and would like to increase his or her crop yields, what kinds of activities would you suggest? Imagine this is the average farmer in Northern Potosí.
5. With regard to irrigation systems, why are they constructed from plastic instead of concrete? Is this something PRODII invented? What's necessary in order to construct an irrigation system for a family? More or less what percentage of families in Northern Potosí have the right conditions for an irrigation system? What impact does an irrigation system have on crop yields?

6. How important do you think it is for a family to sell their crops on the market in order to advance economically? Why? Do you think the majority of families in Northern Potosí can realistically sell their produce on the market, or do most families experience too many obstacles? Is it possible to overcome these obstacles?
7. Has agriculture in Northern Potosí changed over the past five decades? For example, changes in the use of chemicals, in irrigation systems, or in terracing?
8. What influence does migration have on farming? Do you think migration is important and necessary, or do you think it would be better if there were less migration if possible?
9. What impact do terraces have on farming, and how great of an impact do they have? Do the majority of farmers have terraces?
10. Do you know of any development projects in the history of Northern Potosí that have failed? Or projects which were not led by locals?
11. What successful development projects can you tell me about?
12. Are there any projects that you think should be carried out in Northern Potosí but are outside the scope of PRODII?
13. Compared to a few decades ago, has quality of life improved in rural areas? Does this vary by location or other characteristics? Are you content with the rate of change that has occurred?
14. Which projects do you think have the greatest impact on quality of life in Northern Potosí?
15. I have spoken to some farmers in the community of Coyhuaruma in the municipality of Pocoata who say that they do not let their fields lie fallow because they have irrigation systems and because they have too little land for any of it to go unplanted. Do you think this will cause problems in the future? Is there a solution?
16. What is the national government's policy with regards to agriculture? Is it a priority for the government? What kind of agricultural development programs has the government implemented?

17. Are there organizations in Northern Potosí that still promote the use of chemicals or other strategies PRODII does not agree with?
18. It seems like a lot of rural families have a lot of children. How do they decide who inherits the land? Are land parcels becoming smaller and smaller over time? Is it possible for all the young people in rural areas to become farmers in the future, or are they limited by access to land?
19. Do you think it would be possible to expand agriculture to more and more marginal land by using organic techniques and caring for the soil? Is this a good idea?
20. In other places like the US and Eastern Bolivia, agriculture is controlled by large corporations who own vast tracts of land – commercial agriculture. Do you think one day agriculture in Northern Potosí will resemble this system, or do you think it will always consist of small-hold farmers pursuing subsistence agriculture? Why?
21. Do you think for most farmers, agriculture is the best way for them to make a living? What about for their children? Can most young people from rural areas realistically become professionals, or are their options mostly limited to being a farmer, a miner or a construction worker?
22. Exactly how do irrigation systems work? Where does the water come from and how does it reach the fields? How much does it cost to build one?
23. Does the municipality of Pocoata have a certification declaring it an organic region? What benefit comes from having this certification?
24. Has the government constructed many roads in the last few decades?