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CONSTRAINTS TO GREATER BEAN YIELDS IN HONDURAS

By

Hugh Edward Smeltekop

A DISSERTATION

Submitted to
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ABSTRACT

CONSTRAINTS TO GREATER BEAN YIELDS IN HONDURAS

by

Hugh Edward Smeltekop

Securing profitable agricultural production for impoverished small-scale farmers is crucial for economic growth in developing countries. A participatory methodology, like the Local Agricultural Research Committee model, blends effectively with constraints field trials while supporting other aspects of development, like better access to information, skills training and access to loans. Research was focused on fertilizer and common bean variety to identify possible increases in bean production, and weed control to examine savings from field labor to test the effect of traditional versus recommended inputs for bean production in on-farm trials. In 2003, four full factorial (four replications) and five supplemental trials (no replication) were sown in a broadly agro-ecologically representative area of Honduras called Los Limones (Morocelí). Factorial experiment results indicate that increased fertilizer causes a significant increase in yield in some cases; the supplemental experiments showed with 85% certainty that the recommended package of improved variety, increased fertilizer and herbicide increased yield. In 2004, the factorial experiment was repeated without herbicide, with an additional traditional variety and with two additional fertilizer levels on seven farms (three farms with three replicates, two farms with one replicate). Due to terminal drought, one early maturing traditional variety out-yielded the improved variety in one case, and in an analysis using data from all five plots. Fertilizer had no effect on yield

under these conditions. On a field day in 2005, farmers misidentified the worst-producing plot in one case, and misattributed the best production to the local variety Marciano three times. Misidentifications of bean variety production were likely due to variety biases that farmers had based on observations in other contexts. A similar experiment was performed in another community called Lavanderos (Morocelí) at a higher altitude. Results from one farm indicate a slight decrease in yield after the midseason application of urea fertilizer; and a much higher yield from the traditional variety compared to the two improved varieties. Surveys revealed that farmers usually save seed, and one in ten farmers report seed-borne anthracnose as important diseases in 2003 and 2004, with similar numbers for mosaic viruses, so farmers likely underestimate the importance of seed quality. Planting densities varied, and many farmers would benefit from a higher planting density, up to 60 kg/ha. The Local Agricultural Research Committee model was an effective way to test new technologies and disseminate new production information.

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LIST OF ABBREVIATIONS

BGYMV: Bean Golden Yellow Mosaic Virus

CIAL: Comité de Investigación Agrícola Local (Local Agricultural Research Committee in English)

CDR: complex, diverse and risk-prone

ha: hectare

kg: kilogram

L: liter

LARC: Local Agricultural Research Committee (Comité de Investigación Agrícola Local in Spanish)

Lp: Lempiras, monetary unit in the Republic of Honduras

m.a.s.l.: meters above sea level

Mt: metric tons

WUE: Water Use Efficiency

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PREFACE

I have a *compadre* named Victoriano Mamani who lives in the small community of Chovacollo. His is one of forty-odd families with farms carved out of the hillside in a cloud forest only a few hours from the capital of Bolivia, La Paz. He has three hectares of coffee, citrus, and coca, interspersed with some food crops like taro, manioc and vegetables. He owns two cows and a few chickens. He and his wife Cenovia and their two daughters and two sons work very, very hard, and earn less than five hundred dollars a year; most of that income comes from the sale of coca. And although his coca is considered legal, coca production is contentious.

What hope is there for Victoriano and the millions of farmers like him, in Bolivia and throughout Latin American and the world? Economic development may be the answer, but it is an incomplete answer. Every social system must respect the value of every human life.

My time at Michigan State, with the generous support of Dr. Freed, has allowed me to contemplate our fate as human beings one this one, fragile earth, and has renewed hope in me that I, and every one of us, can make a difference by bringing respect for all human life – and ultimately all life in earth – to every aspect of our living. Though each of us has his or her own path, if we strive to bring each moment of our lives into concert with our values, we can create a world of economic growth and respect for all life.

CHAPTER 1

INTRODUCTION

A Green Revolution-type strategy for identifying production constraints has helped address the problems of poor food security and poverty in the past, though hunger persists. Working with small-scale bean farmers in Honduras can provide insight into how to relax those constraints and increase food security.

1.1. Addressing Poverty in Honduras and the World

Over one billion people in the world are considered extremely poor, unable to meet their basic needs for survival, and 800 million are malnourished, with one fourth of these under the age of five (United Nations, 2005). Economic development that benefits the poor must include agricultural development when there are significant numbers of poor living in rural areas, an idea known as structural transformation (Staatz and Eicher, 1998). One model that was successful in staving off large numbers of deaths due to starvation was the Green Revolution, and current strategies for poverty alleviation benefit from a look back to those times.

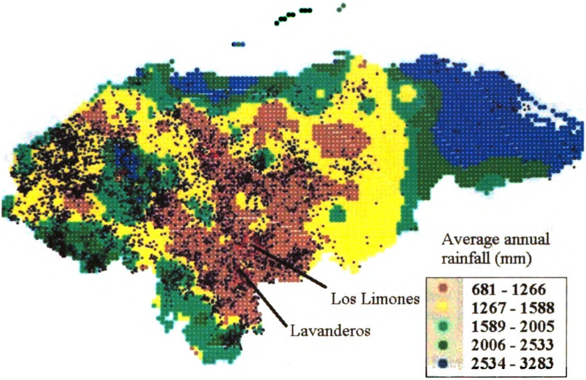
Starting in the 1950s, the Green Revolution increased wheat (*Triticum aestivum*) and rice (*Oryza sativa*) production by creating packages of improved varieties and agricultural input strategies to increase production and feed undernourished populations. When increases in production are made in the context of the livelihood of the small-scale farmer

– that is, in the context of farmer capabilities and means of living – farmers increase their production options while conserving the sustainability of their profession.

One potential area for improving the quality of life in the developing world is the case of small farmers in Honduras and the production of common beans (*Phaseolus vulgaris*). Common beans are a staple food in the Honduran diet, which, when eaten with maize (*Zea mays*), constitute a source of protein nutritionally equivalent to meat. In Honduras, 56% of national production of common beans is produced on farms of ten hectares or less, which includes 75% of Honduran farms.

In order to better understand the situation of the producers most in need, maps that represent key factors were generated. First, all farms that grew beans in 1993 (the most recent census data) (Secretaría de Planificación Coordinación y Presupuesto, 1993) who had five hectares or less of land were identified. Next, this data is compared with average rainfall (Figure 1) and altitude (Figure 2).

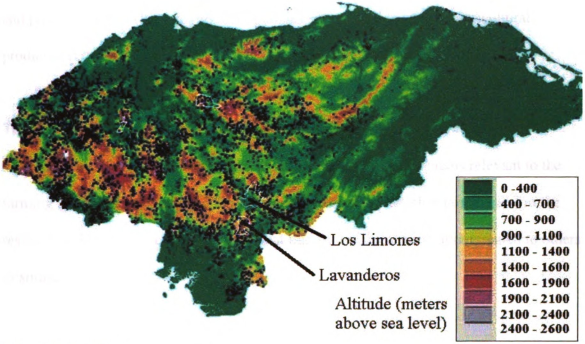
Figure 1. Producers of beans with 5 hectares or less* (1993) and average annual precipitation (1999) in Honduras.



* 1 black dot = 15 farms

Sources: Mapping data from CIAT and Honduras Census (Centro Internacional de Agricultura Tropical, 1999a; Centro Internacional de Agricultura Tropical, 1999b; Secretaría de Planificación Coordinación y Presupuesto, 1993)

Figure 2. Producers of beans with 5 hectares or less* (1993) and altitude (1999) in Honduras.



* 1 black dot = 15 farms

Sources: Mapping data from CIAT and Honduras Census (Centro Internacional de Agricultura Tropical, 1999a; Centro Internacional de Agricultura Tropical, 1999b; Secretaría de Planificación Coordinación y Presupuesto, 1993)

These maps identify key areas for possible interventions and strategies for improving the plight of small-scale common bean farmers. From these farms, one-half of production in eaten, and the other one-half is sold, a fact which highlights the importance of common beans both as a staple food and as a crop with potential for increasing farm income (Martel et al., 2000). In addition, since similar conditions exist throughout Central America and Mexico, this work is consequential for that entire region.

Addressing this issue entails examining agronomic factors (changes in management and their consequences for the agro-ecology of the farming systems), economic factors (costs

of proposed management changes and availability of funds to make these changes, farmer attitude about risk and ways to reduce risk), social factors (ability to access information), and political factors (how government policies support/fail to support agricultural production).

These issues can be approached with a participatory model that combines farmer knowledge with researcher knowledge to research production problems relevant to the farming system in question, and to make recommendations to other farmers and to the research and extension communities so that this knowledge can be disseminated to others in similar situations.

CHAPTER 2

LITERATURE REVIEW

Common beans are an important source of food for people worldwide, and have been for over two centuries. Securing profitable agricultural production for impoverished small-scale farmers is crucial for economic growth in developing countries, and research to eliminate production constraints is a useful tool to achieve this. Constraints research has two parts: surveys to identify constraints, and on-farm field trials to test solutions to production problems. A participatory methodology, like the Local Agricultural Research Committee model, blends well with constraints field trials while supporting other aspects of development, like better access to information, skills training and access to loans. Whereas modernization in Honduras has improved the economy in general, more must be done to specifically improve the lot of impoverished small-scale farmers. The Honduran government's plans to eradicate poverty in the rural sector are a step in the right direction.

2.1 History of Common Bean Cultivation

Evidence of the cultivation of common beans has been uncovered in Mesoamerica as early as 4000-5000 B.C.E., though the pattern of distribution at archeological sites suggest that "*Phaseolus* beans may not have been an important part of the diet until the Late Pre-Classic and Classic Periods," around 100-700 C.E. (Kaplan and Kaplan, 1988) The cited authors continue that

> rapid changes in population growth, settlement patterns, land use and other areas of human activities may have required the production of crops having a short harvest season; in contrast with the extended season characteristics of vining beans, bush beans may be become more important at

> this time. ... In later Post Classic times, conquest and the exacting of tribute which had become marked in Classic times no doubt affected agricultural practices by stimulating the production of short season harvests of storable, transportable crops like maize and bush beans.

Common beans were also discovered at sites in the South American Andes, including specimens from Guitarrero cave in Peru around 5730 B.C.E. There is evidence of exchange of crops between Mesoamerica and northern South America, so it is conceivable that common beans were transported to the Andes and continued to evolve into a major gene pool; however, species exist in the Andes from which modern cultivars could have been domesticated, so domestication in the Andes is a possibility. Debouck has since identified a third major gene pool in the northern Andes (Debouck, 1999).

Common beans have become the third most important food legume after soybeans (*Glycine max*) and peanuts (*Arachis hypogaea*), and they are the most widely eaten pulse worldwide (Table 1). They are grown on all continents except Antarctica, and accounts for 90% of all area sown to *Phaseolus* species (Singh, 1999).

Common beans continue to be an important source of calories and protein in Honduras. In 2004, the Food and Agricultural Organization reported that Hondurans produce 69,949 metric tons of common beans per year, equaling a production of about 10 kg/person/year (Food and Agriculture Organization, 2005b).

Table 1. Worldwide production area and gross production for cereals and pulses from 1961 and 2002.

	Area ('000,000 ha)		Production ('000,000 tons)	
Crop / Year	1961	2002	1961	2002
Total cereals	648.1	663.8	876.8	2036.8
Total pulses	63.8	70.9	40.7	57.0
Dry Bean*	22.8	26.9	11.2	19.3
Pea (*Pisum sativum*)	7.5	6.1	7.3	9.9
Chickpea (*Cicer arietinum*)	11.8	10.5	7.7	8.3
Cowpea (*Vigna unguiculata*)	2.2	10.0	0.8	3.6
Pigeon pea (*Cajanus cajan*)	2.7	4.3	2.2	3.1
Lentil (*Lens culinaris*)	1.6	3.7	0.9	2.9
Favabean (*Vicia faba*)	5.4	2.7	4.8	4.2

*includes *P. vulgaris* and other *Phaseolus* and some *Vigna* species.

Source: Food and Agriculture Organization, 2005a

2.2 Constraints Research: The "Yield Gap" Model

It is widely understood that increasing agricultural production is beneficial to development at all levels. This belief is grounded in the principles of structural transformation, the idea that agriculture makes important contributions: "it could provide labor, capital, foreign exchange, and food to a growing industrial sector and could supply a market for domestically produced industrial goods" (Staatz and Eicher, 1998). The benefits of growth in the agricultural sector are not evenly distributed, but growth does unambiguously help net sellers of labor; and all participants in the market benefit as the costs of production fall (Table 2).

Table 2. Effects of improvements in agricultural technology based on household initial asset position.

Household initial asset position	Direct and indirect effects of agricultural technology improvement*					
	Food production rises, costs fall	Labor demand rises	Wage rises	Food price falls	Net effect	Comments
Net seller of food, net seller of labor	+	+	+	-	Ambiguous	Shift more land to cash crops and sell more; employment income rises
Net buyer of food, net seller of labor	+	+	+	+	+	Food expenditure falls, employment income rises
Net seller of food, net buyer of labor	+	-	-	-	Ambiguous	Shift more land to cash crops and sell more; wage expenditure rises
Net buyer of food, net buyer of labor	+	-	-	+	Ambiguous	Food expenditure falls but wage expenditure rises
Landless; buyer of food, seller of labor	n.a.	+	+	+	+	Food expenditure falls, employment income rises

* "+" indicates a beneficial effect for the actor, "-" indicates a negative effect.

Source: Kerr, 2004

One important model used to investigate the constraints to increased bean production is the "yield gap" model (Barker, 1979). The "yield gap" is the difference between actual and potential yields, and it can be defined in different ways. Yield gap can be defined by the highest yield on a farm or experiment station compared to the national average yield. This comparison is not necessarily helpful for understanding why farmers are not producing efficiently: the national average is an average of a large diversity of agro-ecological situations. Another way to conceptualize yield gap as the difference between an experiment station yield and farmer fields in a similar agro-ecological zone. This can lead to more relevant comparisons.

Some have attempted to quantify the constraints that cause the yield gap. For example, Herdt and Wickham (Herdt and Wickham, 1975) defined the yield gap as the difference between the maximum yield at the experimental farm (8 tons rice/ha) compared to the national average (1.8 tons rice/ha) in the Philippines. They determined that 40% of the yield gap was due to socio-economic factors (lack of inputs, non-adaptation of technology, and other economic constraints) and 60% due to environmental factors and lack of water control.

This kind of partitioning of the yield gap leads to a greater understanding of the constraints to increasing production. The yield gap can be partitioned into two general groups that represent different constraints. Yield Gap I can be considered non-transferable technology and environmental differences, factors outside the control of the farmers. Yield Gap II includes the biological constraints (variety, weeds, disease, pests and soil fertility) and socio-economic constraints (costs, credit availability, tradition, knowledge, and input availability). A researcher's job then becomes measuring the Yield Gap II, the difference between the actual and potential bean yields in a given area; and then determining whether changes can be made that would be ecologically sustainable and profitable for farmers.

The concept of economic slack – the difference between the present product and the product made when all resources are used optimally – is also useful in a discussion of yield gaps (Barker, 1979). Economic slack can be created in different ways, and includes things like advances in technology, programs that increase the supply of inputs, and investment in infrastructure and land reform. This slack falls under the realm of Yield Gap II and becomes the area of study for determining what changes can be proposed to farmers.

One problem with examining yield gap without the context of the farm family is that the goals of experimental farms and farmers are different. Commonly, experiment stations desire to maximize yield whereas farmers want to maximize profit, as noted by Davidson and Martin (Davidson and Martin, 1965). This understanding lead to the concept of economically recoverable yield gap, the amount the gap can be reduced through the maximization of farm profit. Once the economically recoverable yield gap is eliminated, the economic slack has been taken up.

In the face of the non-adaptation of new rice varieties where researchers felt that they were appropriate, and the poor yields on new varieties where they were being used, researchers at the International Rice Research Institute met and developed the *Handbook on the Methodology for an Integrated Experiment-Survey in Rice Yield Constraints* (Gomez et al., 1979a). The approach used surveys and controlled agronomic experiments in fields managed by farmers. The objectives of the study were to compare actual farm yields with yields achievable through appropriate technologies, and to determine to what degree these technologies could be profitably implemented, to identify the social and institutional factors preventing the implementation of these technologies, and to determine the extent to which these physical, social and institutional factors constraining yield could be removed.

The constraints methodology was utilized throughout Southeast Asia in the late 1970s and the results were mixed and country-specific. For example, in Bangladesh, researchers found that new rice varieties were more profitable but that the intensive rice cultivation did not fit well into the cropping systems (Hoque et al., 1979). Researchers in the Philippines discovered that institutional arrangements about weeding (pay based on hand-weeding and harvesting labor) made hand-weeding more desirable, despite an increase in profit with chemical weed control (Gomez et al., 1979b). Overall, however, it was found that farmers underestimated the yield effect and economic benefit of nitrogen fertilizer, especially in the dry season (Herdt, 1979).

Working with other crops, researchers in other areas of the world have also successfully used this model. Kamanga and Shamudzarira (Kamanga and Shamudzarira, 2001) use a constraints approach (described as a "mother-baby design" (Snapp, 2002), where the mother plots are managed by farmers) to test the integration of legumes into maize cropping systems. They found that farmers had preferences for different legume intercrops based on many different criteria unique to their situations (e.g. effect of legume on aphids in maize, suitability as forage). Similar experiments were performed on-farm to examine constraints to common bean production in Tanzania, comparing differing levels of fertilizer, insect control and bean variety factors. Researchers found that soil infertility and poor performing varieties were the two largest constraints to production (Edie et al., 1991).

2.3 Participatory Development

Participatory development is simply the participation of the people who wish to improve their states of being in that process. The idea of participatory development, *as it is understood today*, grew out of the realization in the 1960s and 1970s that packages of technology were not always helpful to farmers whose situations were complex, diverse and risk-prone (CDR). CDR farmers usually have livelihood strategies that encompass many small enterprises. Thus, a failure in some activities is offset by success in others (Chambers, 1997). Sometimes the technology packages offered by extension agents to farmers in CDR environments were too expensive, required more time away from other activities, or were geared toward circumstances that were not applicable to those farmers (such as non-marginal soils, or non-drought conditions). In areas with farmers who did not benefit from available technologies, farming systems research and increasing on-farm experimentation resulted in the idea that farmers would benefit from an integral participation in the development of useful technologies.

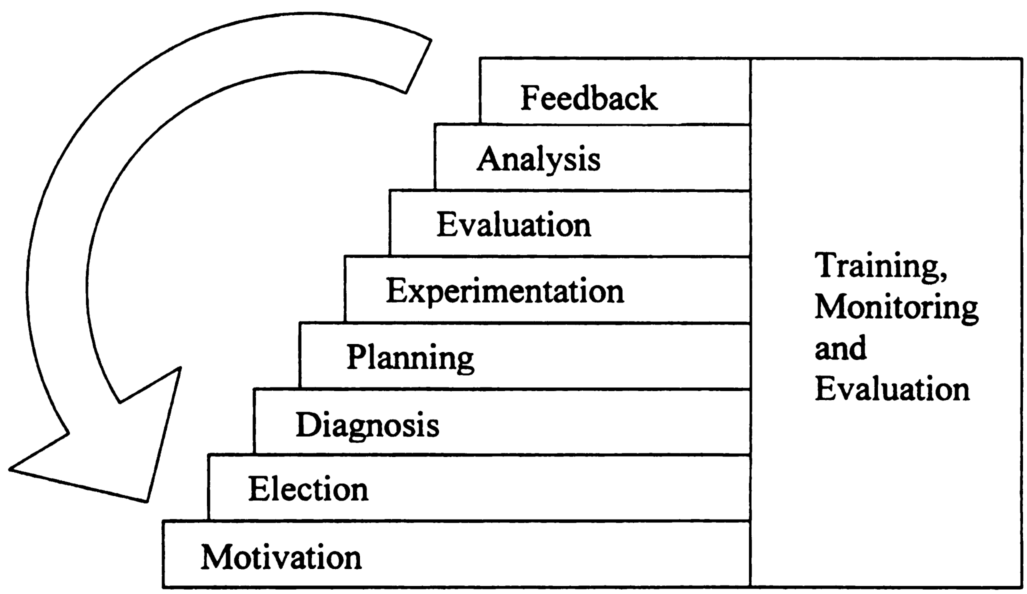
Research into production constraints became more participatory as researchers grew in awareness of the benefits of direct farmer participation in the selection of on-farm trial factors like plant varieties. For example, Witcombe (2002) maintains that conventional breeding approaches were successful in providing rice varieties suitable to low-input production systems that have been widely distributed. However, "it is certainly true that the rate of development and adoption of improved cultivars has been lower in rainfed lowland than in irrigated environments, and that adoption of improved upland varieties has been minimal outside of very favourable environments." He adds that participatory variety selection and participatory plant breeding have begun to address these issues.

Participatory variety selection has also been utilized for common beans. Rosas et al. collaborated with farmers in Honduras to select segregating plant material, allowing farmers to use their own selection criteria, and concluded that "*a veces es dificil entender la complejidad de análisis que emplean los agricultores para tomar decisiones. Por lo cual, el incremento de las interacciones con los agricultores es fundamental para lograr mayor adopción de variedades mejoradas*" ["sometimes it is difficult to understand the complexity of analysis that farmers use to make decisions. That is why increasing interactions with farmers is fundamental to achieving greater adoption of improved varieties."] (Rosas et al., 2003).

One organizational entity that was born from the participatory development movement and is compatible with constraints research is the Local Agricultural Research Committees (LARC, *Comité de Investigación Agrícola Local* in Spanish). In short, a LARC is a "farmer-run research service that is answerable to the local community" (Ashby et al., 2000). LARCs have many advantages to offer constraints research. Since LARCs are local, they are responsive to local agro-ecological conditions, cultural preferences, and economic constraints of local people. LARCs reduce the level of intensity of extension because farmers can test new technologies themselves; and LARCs can be used to gather information about community needs.

LARCs are formed in a community meeting, where community members decide what problems are most important. Farmers volunteer to work with an extensionist to learn to design and implement experiments to test new technologies relevant to the problem identified by the community. For farmers to execute formalized research requires a period of training, which includes eight steps. These steps are reiterative: they require a return to the "Motivation" stage once the process reaches the "Feedback" step. These steps are Motivation, Election, Diagnosis, Planning, Experimentation, Evaluation, Analysis, and Feedback (Figure 3).

Figure 3. Diagram of the eight steps in the reiterative process used for organizing a Local Agricultural Research Committee (LARC).



Source: Humphries et al., 2000

According to Ashby et al. (2000), the capacity to manage all steps of the process require at least four cycles of diagnosis, planning, evaluation, analysis and providing feedback to the community; and each cycle includes three phases or experimental trials: a preliminary/exploratory trial, a verification trial, and a production trial.

One criticism of participatory research is that it is not the most efficient way to advance agricultural research or provide technologies to farmers in a cost-effective way; one reason for this is that farmer participatory research often serves "certain social and development goals" (Sumberg and Okali, 1997). In fact, LARC practitioners on Colombia have identified benefits to LARC membership that go beyond technical help. Ashby et al. (2000) include the following as the possible benefits of LARCs in an examination of these organizations around Colombia:

- Increased local capacity
- Improved local planning, management and organizational skills
- Higher crop yields
- More local experimentation
- More experimentation with soil conservation practices
- Higher biodiversity in cropping systems
- Improved access to credit
- Greater availability to improved seed
- Improved food security
- Establishment of small enterprises
- Increased social status of women and other marginalized groups.
- Improved access to formal research services and products.

Source: Ashby et al., 2000

Snapp et al. (2003) add that when farmers participate in research, there is greater accountability and client orientation; and that participation can "address complex training requirements and organizational linkages." Similarly, the Centro Internacional de Agricultura Tropical evaluated 68 LARCs in 1998 and found that

> (a) [LARCs] directly resulted in more rapid technology adoption; (b) the [LARC] process itself has led to people learning useful skills and forming valuable social linkages; and (c) [LARC] communities had experienced improvements in welfare. Welfare improvements came about partly by people starting agro-enterprises based on the results of the experiments and the new skills and linkages they had developed. For example, some [LARCs] have started to commercially produce

the seed of the best crops identified in their trials. [LARC] communities have been encouraged by the experimentation to try more new crops, and as a result have more crops and more varieties in their fields, than farmers in similar villages without [LARCs]. This diversity helps villages with [LARCs] to better cope with risk. Moreover, the speed of adoption of technologies was faster in villages with [LARCs], and the poorest strata of farmers were just as likely to adopt as the richer strata. Therefore, [LARCs] help communities benefit faster from improved varieties, whether developed by the formal research sector or farmers themselves. The study also suggests that [LARCs] may improve food security because farmers in villages with [LARCs] reported fewer "hungry months" of seasonal food shortage.

Source: Quirós Torres et al., 2004

Humphries et al. (2000) worked with LARCs in Honduras and found that "participatory research using formal methods was not found to be sufficiently engaging for very poor farmers whose primary concerns were more likely to be achieving immediate household food security." In light of this, LARCs in Honduras came to emphasize functions in addition to participatory experimentation, such as building social capital (managing funds, learning time management, increasing comfort with public speaking, identifying problems in the community), and providing loans to members and non-members alike.

2.4 Survey Design and Implementation

Surveys use two basic methods to describe human behavior and its results. The first type of method is the quantitative method. Quantitative methods are good for explanation, description, or evaluation, and especially the development of an understanding that accurately reflects what is happening in the world. This method generally yields countable things, such as the amount of beans produced in a particular plot. The second is the qualitative method. Qualitative methods are good for exploration, developing an "authentic" understanding of a social process or social setting. Qualitative data may describe how a farmer feels about a farming practice, or explain why a farmer chooses to sow one variety over another[1] (Schutt, 2004).

Sallant and Dillman list four requirements for an accurate survey:

1. The sample is large enough to yield the desired level of precision.
2. Everyone in the population has an equal (or known) chance of being selected for the sample.
3. Questions are asked in a way that enables people in the sample to respond willingly and accurately.
4. The characteristics of the people selected in the sampling process but who do not participate in the survey are similar to the characteristics of those who do.

Source: Sallant and Dillman, 1994

These requirements must be fulfilled so that the experience of a few farmers in the survey can be generalized over a larger population.

Related to accuracy is error, specifically the minimization of error in the design, implementation and analysis of survey data. Errors can fall into one of four possible categories:

1. Coverage error – target population is not represented completely.
2. Sampling error – statistical error, and can be measured. If the sampling error is too large, the results may be considered inconclusive.
3. Measurement error – difference between respondent's answer and the "correct" answer. This happens when the tool used does not measure what we intend it to measure.
4. Non-response error – selected people do not answer and their answers would have been different from others.

Source: Sallant and Dillman, 1994

One might also include causal validity error: the incorrect conclusion that A leads to B, that one event has caused another (Schutt, 2004). These considerations must be taken

[1] It should be noted, however, that although qualitative data are often descriptive, they can be quantified, *i.e.* coded.

into account for survey data to be precise and free of bias, and to be able to make generalizations about a population with similar characteristics.

2.5 Development Trends in Honduras

In 1821, following the Honduran war for independence, productive land was distributed to military heroes, and much of this land lay idle (Map of Honduras, Figure 4). In response to the growing number of impoverished farmers who did not have their own land but desired it to provide basic staples (*i.e.* maize and beans) for their families, the Honduran government passed the Agricultural Reform Law in 1962. The principle of this law was that land was for the people who used it, and idle land was defined as land that was not currently in use, but also rented land, sharecropped land, and land farmed by tenant farmers. The Agricultural Reform Law put restrictions to how much land one family could own and the National Agricultural Institute (*Instituto Nacional Agrario*) was formed to enforce it (Thorpe et al., 1995).

Figure 4. Map of Honduras.

While agrarian reform moved in fits and starts, most believe that agricultural reform contributed to political stability. However, little by little the Agricultural Reform Law lost ground. In 1963, a coup d'état brought in a military regime that repressed farmer organizations and practically did away with the National Agricultural Institute. By 1975, a second land reform law was passed, one that supported the formation of farm cooperatives that required that farmers possess land in common. There was some redistribution of land, but even these intended reforms were abandoned by 1978 under new military rule (Franco, 2003). By the 1980s, since governments decided that the threat of land redistribution was preventing larger landowners from making long-term investments in their land, it adopted a policy of more intensive land titling of government and communal land. Thus, most of the basic tenants of land reform were abandoned.

In the 1980s, Honduras suffered from high fiscal deficits that were financed externally, and the balance of payments slowly deteriorated (International Monetary Fund and International Development Fund, 2001). Finally, in 1990, the government passed the Agricultural Modernization Law (*Ley de Modernización Agrícola*), part of a larger stabilization program (see a summary of Honduras' structural adjustment program, Appendix 1). The government implemented a neo-liberal model that considered previous agricultural reform as a drag on social and economic development. The new model also presumed that agricultural reform generated insecurity related to land ownership and exaggerated the dependence of the farmer on the state (Thorpe et al., 1995).

The program began to correct the internal and external balances. One component was the *liberalization of the exchange rate*; related is *trade liberalization*. Because the exchange rate appreciation decreased the prices of imported goods, it reduced the rate of inflation. This was paired with the elimination of price supports for basic grains, like beans, in favor of a price band[2]. Large farmers with better access to markets and farmers close to large towns benefited from the improved prices, whereas farmers further from the markets were not able to capture this guaranteed price because they sold to intermediaries who paid under this price. Of the basic grains, prices for beans fared the best (Table 3).

[2] The price band system uses international grain prices and import tariffs to fix ceiling and floor prices.

Table 3. Real producer prices for basic grains, 1989-1996 (Lempiras/hundredweight).

	Year								**Average**
Crop	*1989*	***1990***	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	***1991-96***
Maize	86.2	**114.8**	99.0	104.7	104.0	131.0	121.5	122.0	**113.7**
Beans	68.8	**111.5**	119.7	67.0	159.8	149.0	128.8	129.7	**125.7**
Sorghum	79.6	**118.5**	101.9	70.3	74.7	75.3	67.1	65.6	**75.8**
Rice	87.1	**110.2**	102.8	101.6	103.3	129.6	118.3	116.9	**112.1**

Note: 10.09 Lempiras (Lp) = 1.00 U.S. Dollar (January 1, 1996. 1989 prices are used as an indicator of the immediate pre-adjustment producer price; the effects of liberalization become apparent in 1990.
Source: Thorpe, 2002

While the *liberalization of domestic trade*, another component of the modernization program, was expected to help basic grain producers, it did not increase production and productivity, probably due to lack of access to production inputs and the real appreciation of the national currency.

All in all, trade liberalization and market deregulation policies "were not associated with increases in net exports of agriculture in Central America. The main result would appear to have been import stimulation, with weak effects in exports" (Weeks, 1999).

One key structural factor of Honduran bean markets is the availability of credit to farmers. Thorpe (Thorpe, 2002) reports that early national banks created to help agricultural producers favored larger producers. Reforms created to correct this disequilibrium (like rural credit desks and land banks) have not been effective in reaching producers due to inadequate funding and poor management. In the bean sector, credit disequilibrium has reinforced distinct market channels, with heavily financed larger growers producing more for national and international markets and for value added uses, and small growers producing for local and regional markets. In addition, national banks have recently pardoned the repayment of loans to farmers, equaling a subsidy to farmers able to secure loans, i.e. large and medium-sized farmers (n.a., 2003b).

Discussing the absence of a Green Revolution in Sub-Saharan Africa, Lynam notes that

> other preconditions are necessary to facilitate such a rapid increase in yields. These preconditions, such as markets, credit, extension, and information systems, are developed outside the research sector itself and together with land/labor ratios and rural population growth define the stage of crop yield development. Agricultural research cannot substitute for these larger systems but rather research must adapt its design strategies to each stage. The important point is that the relative importance of breeding versus crop and natural resource management strategies changes at each of the stages, with breeding generating its huge potential only when crop management systems and larger support systems are relatively well developed. While this would seem a rational argument, the other driver in the organization of agricultural research is advances in the biological sciences. The international agricultural research system, as an example, has responded to the pull of these two forces in the organization of its research.
> Source: Lynam, 2004

To support the development of small-scale common bean farmers in Honduras, the government intends to support access to loans and inputs for small-scale farmers, even in basic grain crops; and increase access to reliable information through effective extension and learning opportunities.

Land tenure also plays a role in financing. With a farm title as collateral, lending institutions are more willing to grant loans. As mentioned above, land reform has been on the national agenda since the 1960s, yet actual land titling has not reached many farmers. The Global Campaign for Agrarian Reform (FIAN and La Via Campesina, 2000) reports that "according to the official statistics on agriculture more than 126,999 peasant families have neither access to land nor a secure place of employment. This figure represents 27% of the rural population. If we add to this group the 80,000 peasant families (at least), who own less than 1 hectare of land, we are confronted with the disturbing figure of more than 200,000 families, or 44% of the rural population who have either no or very limited access to land."

Thus one way to increase the likelihood of borrowing is to complete land titling. In circumstances where farmers need collateral for a loan, land titles can serve to monetize what would otherwise be considered "dead capital" (Soto, 2000). When farmers are assured that the land they are working will stay in the family, they are also more likely to invest in that land, including making long-term investments in land architecture (low-cost terracing, fencing) and more crop fertilizers.

Another possible way to release this constraint is to encourage the development of local banks. Locally-managed savings and loan cooperatives have been shown to increase the propensity of borrowing and stimulate local economies (Dunn and Arbuckle, 2001; Jain, 1996), and sometimes work to conserve natural resources (Anderson et al., 2002). Successes with microcredit has been documented in Honduras, including the *Caja Rural de Ahorro y Crédito* (CRAC, Rural Credit and Savings Bank in English) model (Economic Commission for Latin America and the Caribbean, 1999). The growth of microcredit enterprises in rural areas will also likely increase borrowing in rural communities.

Encouragement of the purchase of agricultural inputs may also be stimulated by the sale of these inputs at the moment when crops are being sold. To determine whether improved seed and fertilizer use could increase yield economically, an NGO in western Kenya worked intensively with randomly selected farmers in three communities over six years to plant small plots of the improved seed with fertilizer or fertilizer only to compare to a traditionally managed plot (Duflo et al., 2004). Increased fertilizer use had positive farm returns (231% over six seasons with small amounts of top dressing, and less but positive returns with greater amounts of fertilizer).

The authors note that experimentation with an unproved technology could cause some time and financial losses in the first year. They continue, "[i]f a farmer knows that after this initial investment, he will only be able to use fertilizer on a very small scale for a long period of time (because he cannot have access to the funds to do it on a large scale), he might rightly consider it worthless to do the initial investment to master the technology" (Duflo, 2003). In their study, the NGO assumed the financial risk for the farmers, and helped them analyze the results. Therefore, if resistance to experimentation or incomplete understanding of the results were the main barrier to adoption, the participants would show an increased use of fertilizer.

In fact, 37% of participants did use fertilizer, whereas only 20% of those farmers who were not chosen to participate used fertilizer in a given season. The question remains: why did the other 63% of participants not use fertilizer, even in small quantities on small part of their field?

When asked why farmers did not use fertilizer, 98% responded that they had no money. The authors hypothesized that the farmers found it difficult to save or borrow even the small amount of money needed to start using fertilizer. To test this hypothesis, the NGO arranged for farmers to buy fertilizer immediately after the maize harvest, which the NGO would store for them, or deliver right away. This offer doubled the rate of fertilizer usage.

What explains this behavior? The authors comment,

> We are far from understanding fully why this program was so successful. Did farmers value the opportunity to commit their money to be used for fertilizer purchase because they knew that if they kept the money they would be tempted to use it on other things before the time for purchasing and using the fertilizer occurs (Laibson, 1991)? Are they particularly keen to exchange cash for fertilizer because maize is not likely to disappear quite as rapidly? Are they protecting the cash against themselves (they know now that they need to tie their hands), or are they worried about their families or their neighbors? Were farmers just lured by fertilizer as one possible purchase, and would they have been just as happy with a radio or some alcohol? Were farmers particularly aware of the value of fertilizer, after we had just weighed and valued the output of the two plots, and would this have lost its salience if they had waited longer?

The authors turn to three tenants of "behavioral economics" to explain how humans differ from the unboundedly rational, forward-looking, and internally consistent model that neo-classical economics proposes. The first is the limited ability of humans to analyze, compute and remember information. The second, a bounded willpower: humans do not always make choices that are in their best long-tern interest. Third, human decisions are not purely self-interested.

That said, it is further recognized that being poor (and near poor) affects the way people think and make decisions. The way people think when considering the survival of their family, social norms and other stresses is possibly radically different depending on their socio-economic status.

In addition to national tenure changes, the Agricultural Modernization Law repealed the ban against joint ventures with firms in other countries. From 1990-1995, joint ventures generated Lp 30.5 billion (US$ 6.1 billion in 1995), and eight of 99 joint ventures included the production of basic grains like beans (Thorpe, 2002).

Although farmers cannot easily get titles to land, opportunity for the use of communal land and renting land are present. Poor farmers may produce a small plot of basic grains primarily for consumption but with the intention of selling excess; which represents a diversification strategy that reduces risk in the context of a livelihood. Higher investment in production technologies (*e.g.* more fertilizer, herbicide), however, is a barrier for small-scale bean farmers. Poor soils, lack of appropriate varieties and lack of production information increase risk, which most farmers are not willing to take; the inability to secure credit, as mentioned above, is a further limitation to growth into more profitable bean production. While cooperatives have been in existence since the 1970s, they are generally ineffective due to an inflexible structure that does not allow them to adjust to changing markets (Thorpe, 2002).

Recently, the Honduran government acknowledged that to further stimulate the economy and address rural poverty, it must help small farmers. One attempt was to invigorate the production of agriculture for small and mid-sized farmers was the Farm Sector Solidarity Law of 2001 (*Ley de Solidaridad con el Productor Agropecuario*). This law allowed the refinancing of debts and access to new loans. However, the law was ignored by farmers who got better debt readjustment deals and loans under other programs (n.a., 2003a). Additionally, the most marginalized farmers do not have access to loans due to lack of access to banks and lack of effective collateral (land titles) (Thorpe, 2002).

Some attempts to stimulate the economy through the agricultural sector encouraged the Honduran government to adopt policies designed to increase productivity while reducing exchange and marketing costs. These policies were based on the principles of structural transformation (Staatz, 1994). World Bank suggestions to the Honduran government encourage this kind of development, namely investment in agriculture in areas where it is most profitable and the improvement of access to market information (Appendix 2). The government of Honduras seems to be adopting this model. This model results in a move away from basic grains and toward higher value products. While productivity and profitability for some farmers may increase, its effect on the bean market is not expected to be significant.

In 2003, the Vice-minister of Agriculture outlined three steps for eradicating rural poverty by 2021 through the stimulation of the agricultural sector (Vásquez, 2003). First, the government will adopt policies that strengthen agricultural development, including popular participation, stronger public sector agricultural services, better links with institutions, resolution of some land issues and credit availability[3]. Farmers from the bean sector stand to gain from these improvements. In addition, the government will execute the Central American Common Market (*Unión Aduanera Centroamericana*). Since the signing of the General Treaty for the Economic Integration of Central America (*Tratado General de Integración Económica Centroamericana*) in 1960, the economic union of Central America has evolved into a block of countries that wish to establish a common market and a free trade zone, create a common trade policy with countries outside of the zone (Superintendencia de Administración Tributaria, 2003). Since the stability of the bean market will then depend on the agricultural policies of the Common Market, farmers have reason to follow its development.

Second, it plans to approve and ratify the Central American Free Trade Agreement (CAFTA-DR, *Tratado de Libre Comercio de Centro América* in Spanish), institute an "intelligent market" and complete land titling. In fact, Honduras signed CAFTA-DR in May 2004, which its congress ratified CAFTA-DR in March 2005 (n.a., 2005).

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[3] In reality, few effective steps have been taken by the Honduran government to make credit available to small farmers. For example, the Honduran government has pardoned Lp 2.5 billion in loans to farmers, Lp 60 million of loans from the national agricultural bank BANADESA (Banco Nacional de Desarrollo Agrícola in Spanish), and the rest from private banks (n.a. 2004. Gobierno Ha Destinado 2,200 millones al Agro, pp. 20 El Heraldo, 7911 ed, Tegucigalpa. Honduras.). Since banks do not land to farmers without collateral, and whose programs do not reach rural farmers effectively, the pardoned loans amount to a subsidy for medium and large farms, putting small farmers at a disadvantage.

The third step is the reduction/elimination of tariff barriers, compliance with international agricultural export standards, and the formation of producer groups called clusters. This policy is considered unrealistic by farm groups (Vásquez, 2003), and again, it represents another change in policy that will threaten the markets for basic grains including beans.

CHAPTER 3

RESEARCH JUSTIFICATION AND OBJECTIVES

Common bean producers can be divided into categories that represent unique agro-ecological areas, and working with producers in low rainfall areas in the central part of Honduras can yield results that may be used to generalize for producers in a broader ecological region.

3.1 Justification

Based on the data reviewed in Chapter 1 (Figures 2 and 3), three rainfall and two altitude regions are identifiable. The northwest (Copán) region represents bean producing farms with intermediate rainfall (1267-1588 mm). Since farmers in this region grow black beans and production is more similar to Guatemala, the breeding program would not benefit from research done there. The extreme southwest (Lempira) region with high precipitation (1589-2533 mm) has the highest concentration of impoverished farmers. However, it is very isolated and does not have a system of Local Agricultural Research Committees (participatory research committees that are trained to be collaborators), and it is currently heavily supported through FAO programs.

Most of the remaining small-scale bean farmers are found in areas with 681-1266 mm of precipitation; and their farms are distributed over many altitudes. In order to assess production constraints in this area in 2003 and 2004, research trials were conducted in the community of Los Limones because it represented farms 0-900 meters above sea level (m.a.s.l.). In 2004, trials were conducted in Lavanderos because it represented farms from 900-1400 m.a.s.l. The trials were focused on bean production in the postrera season because around 67% of bean production occurs in this season (Secretaría de Planificación Coordinación y Presupuesto, 1993).

In addition to rainfall and altitude, the presence of Bean Golden Yellow Mosaic Virus (BGYMV) could be included as an additional criterion. Although farms below 1000 meters above sea level are generally considered effected, the actual presence of BGYMV must be verified in the field, and interpretations must be sensitive to the presence of BGYMV.

3.2 Research Objectives

Based on the current limitations to increasing profitability for small-scale producers and the analysis of the characteristics of those same producers, the following objectives are proposed:

Objective 1: To quantify the socio-economic limitations to increasing bean yields with the proposed technology.

Objective 2: To determine which bean management factors can be profitably changed in small-scale farmer cropping systems in the *postrera* season.

Objective 3: To evaluate the effectiveness of the constraints methodology and the Local Agricultural Research Committee in order to satisfy objectives one and two.

CHAPTER 4

RESEARCH METHODS

Surveys were taken in 2003 and 2004 in 6 communities in rural Honduras with small-scale producers to identify agronomic, economic and social constraint to production; as well as the benefits of participation in Local Agricultural Research Committees. Participatory field research in two communities representing two altitudes focused on fertilizer and common bean variety to examine possible increases in production, and weed control to examine savings from field labor. Farmers were asked to assess bean production in experimental plots to examine accuracy of farmer observation.

4.1 Survey Methods

Farmers were surveyed in Los Limones in 2003 and in Los Limones and five other communities in 2004[4] (Table 4). The surveys conducted in 2003 were designed to describe community households, identify the diversity of farming practices, and identfiy farmer perceptions regarding constraints to bean production in the community of Los Limones (Appendix 3); the 2004 surveys were designed to describe community households, identify farming practices and costs of production, identfiy farmer perceptions regarding constraints to bean production, and discover farmer-identified advantages to belonging to a LARC (Appendix 4 and 5). All data collection was analyzed using SPSS (Statistical Package for the Social Sciences), version 13.0.

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[4] Communities were chosen based representation of an agro-ecological zone of interest, and on whether the community had a Local Agricultural Research Committee (LARC) to examine the effect if LARC membership on farming practices and profitability.

Table 4. Surveys implemented in six communities in the department of El Paraíso, Honduras, 2003 and 2004.

	2003		2004	
Community	**LARC* member**	**Non-LARC member**	**LARC member**	**Non-LARC member**
Los Limones	6	28	6	16
Lavanderos	-	-	5	4
Tabla Grande	-	-	4	2
Los Pozos	-	-	7	2
Mesias	-	-	3	6
Carrizal	-	-	5	6
TOTAL	**6**	**28**	**30**	**36**

*LARC = Local Agricultural Research Committee

In Los Limones, survey participants were chosen by asking key informants to list all *postrera* bean farmers, then trying to contact everyone on that list over a period of three or more days (December 2003 and December 2004/January 2005). Since farmers absent from the community were not contacted (7 of 41 in 2003, 17 of 39 in 2004), it is possible that the few farmers not contacted constituted a unique subset of bean farmers (for example, farmers who found off-farm work to supplement farm income). However, key informants believed that this was not the case. Survey participants in other communities were selected due to their participation in the LARC groups, and the direct neighbors of the LARC members. All but five participants were male.

According to Sallant and Dillman (1994), there are four requirements for an accurate survey. The first is that the sample is large enough to yield the desired level of precision. The total sample size was 66, enough for a 95 percent confidence level with ±10% sampling error for a 80/20 split on the characteristic in question. A sampling size of 96 is required for a 50/50 split for the same level of confidence and sampling error, which was not achieved with this survey (Sallant and Dillman, 1994).

The second requirement is that everyone in the population has an equal (or known) chance of being selected for the sample. An attempt was made to contact all members of the community of Los Limones, which would represent the entire population. Members of other communities were chosen due to their LARC membership, and all of these members were chosen; and so were their direct neighbors, to strive for geographical homogeneity. Randomness of selection was rejected in favor of a reduction in bias due to geographically determined access to resources, and comparisons within the data set offer no significant differences between LARC members and non-members for the key socio-economic characteristics determined.

The third requirement was that questions be asked in a way that enables people in the sample to respond willingly and accurately. Questions were pre-tested for clarity with farmers that collaborate with the Pan-American School of Agriculture, and modified before administration to the format present in Appendixes 3, 4 and 5.

The fourth requirement is that the characteristics of the people selected in the sampling process, but who do not participate in the survey, are similar to the characteristics of those who do. All of the selected participants agreed to participate fully and none refused to answer a question.

4.2 Economic Analysis

Data from the agronomic and survey portions of the study were used for an economic analysis. First, since the proposed common bean recommendations require only small management changes, production data was used to construct partial profit budgets according to Dillon and Hardaker (Dillon and Hardaker, 1993). The necessary data about prices was taken from the survey data.

Second, the survey data was used to identify relationships between high common bean yields and specific management practices; and to examine the relationship between yield and profitability. All regression statistics were calculated using SAS 9.1 (SAS Institute Inc., 2003).

4.3 Experimental Field Plot Methods

The agronomic experiment was designed to identify what physical management factors contribute to the yield difference between farmer yields and experiment farm yields (the phenomenon called "yield gap") based on the data collected in the survey. Farmer-level and recommended-level inputs were used as test factors. A typical experimental design for a yield gap experiment is a factorial design with three levels:

1) The complete factorial experiment permits analysis of the interactions between all test factors at farmer and recommended levels. This identifies the interactions of all combinations of factors.

2) The mini-factorial experiment permits analysis of the interaction of practices where all but one practice is at recommended levels. This allows the identification of the contribution of test factors when we expect the absence of one single factor to be significant.

3) The supplemental experiment permits a comparison of farmer and recommended practices and simply allows the measurement of the yield gap.

(Barker, 1979)

In Honduras, variety selection, fertility management, and weed management are three very significant farm practices that impact bean yields. Disease management was not included as a factor because farmers typically use fungicide ineffectively (farmers apply fungicide after the disease is well established in the field, and they often use fungicides that are not appropriate for the disease present). Insect management was not included because the producers seemed content with their control methods (despite that they did not follow university recommendations), and generally do not have a great impact on bean yields when managed by farmers.

Weed management was not included as a production constraint factor in 2004 for two reasons. First, the recommended weeding practices did not contribute to yield differences in trial plots in Los Limones in 2003; Secondly, farmers typically applied herbicide before plowing, which adequately controlled weeds at least until the bean seedlings emerged. Since this was the time when herbicide application was recommended, it was deemed unnecessary, and was excluded from trials in 2004.

4.3.1 Experimental Plot Locations

The experiments were executed in the community of Los Limones in 2003, and in Los Limones and in Lavanderos in 2004 (Table 5).

Table 5. Locations of communities where agricultural research and surveys were implemented, Department of El Paraíso, Honduras, 2003 and 2004.

Community	Municipality	Altitude (meters above sea level)	Latitude	Longitude
Los Limones	Morocelí	700	14° 5' 54"	-86° 50' 10"
Lavanderos	Güinope	1,380	13° 56' 20"	-86° 56' 38"
Tabla Grande	San Antonio de Oriente	1,240	13° 59' 39"	-86° 55' 38"
Los Pozos	Morocelí	860	14° 8' 36"	-86° 49' 29"
Mesías	Morocelí	1,100	14° 7' 9"	-86° 47' 22"
Carrizal	Morocelí	900	14° 12' 10"	-86° 50' 26"

4.3.2 Experimental Plot Design

4.3.2.1 Los Limones Plots 2003

On four farms, the eight treatments were installed with four replications in a randomized complete block design (Table 6). On five other farms, the supplemental experiment plots were installed with only one replication. The recommended management package corresponded to treatment number one and the farmer practices corresponding to treatment number eight. Plot size was three meters by five meters, with 50 cm between rows, and 10 cm between plants in the row. Soil pH was calculated with a 1:1 soil to water ratio; percent soil organic matter (%OM) with Walkley and Black (Walkley and Black, 1934); percent soil nitrogen (%N) as 5% of %OM, soil phosphorus (P) and potassium (K) with Mehlich-3 extraction (Mehlich, 1984). These results are listed in Table 7.

Table 6. Management components for full factorial trials, Los Limones, Morocelí, Honduras, Postrera, 2003.

Treat-ment	Common bean variety	Fertilizer type	Fertilizer quantity (kg/ha)	Weed management strategy
1	Amadeus-77	18-46-0 urea	130 32.5	One chem. application and by hand
2	Amadeus-77	18-46-0 urea	130 32.5	By hand only
3	Amadeus-77	18-46-0	65	One chem. application and by hand
4	Amadeus-77	18-46-0	65	By hand only
5	Seda*	18-46-0 urea	130 32.5	One chem. application and by hand
6	Seda	18-46-0 urea	130 32.5	By hand only
7	Seda	18-46-0	65	One chem. application and by hand
8	Seda	18-46-0	65	By hand only

*Also known as "Rojo de Seda"

Table 7. Experimental plot soil type, pH, percent organic matter (%OM), percent nitrogen (%N), Mehlich phosphorus (P) and Mehlich potassium (K) for nine plots, Los Limones, Morocelí, Honduras, 2003.

Farmer	Soil type	pH*	%OM	%N	P** (ppm)	K*** (ppm)
1	Sandy loam	6.3	1.6	0.08	7	190
2	Clay loam	5.9	2.2	0.11	51	180
3	Sandy loam	6.0	1.3	0.07	116	178
4	Sandy loam	6.4	3.2	0.16	4	216
5	Loam	6.3	3.8	0.19	29	534
6	Loam	5.8	2.7	0.13	25	264
7	Sandy loam	5.7	1.9	0.10	25	172
8	Loam	6.4	1.8	0.09	4	278
9	Sandy loam	5.8	2.3	0.11	11	250

* Normal range 6.0 to 6.8

** Normal range 13 to 20 ppm.

*** Normal range 98 to 195 ppm.

Researchers and farmers chose the research sites together, taking care that the plots were as homogenous and free from border effects as possible. Planting dates were chosen by the farmers, and farmers and researchers staked and planted the seed and applied the NPK fertilizer together. Researchers applied 0.5 liters per hectare of paraquat herbicide to herbicide treatment plots after sowing. Farmers undertook the daily management of the plots, including the subsequent weeding (usually at 20 days post germination), urea (46-0-0) application (concurrent with weeding, spread next to plants and mounded up over bean row), disease and insect management. Plots were visited at peak flowering to determine plant population (two replicates of plants per 1 meter of row), disease and insect damage (0-9 scale), and weed biomass with representative cuts (two replicates of 0.5 m^2 per plot). In the complete factorial plots, rain gauges were installed and rainfall data were collected every week for 60 days starting at planting. At harvest, two rows of beans were harvested (two meters each), beans hand-threshed, analyzed for moisture content and weighed, and the yield was calculated at 13.5% moisture. Farmers received bean seed to replace the beans that were harvested from the field.

4.3.2.2 Los Limones Plots 2004

On three farms, the 12 treatments were installed with 3 replications in a randomized complete block design, representing the full factorial design (Table 8). In four other farms, the 12 treatments were installed with only one replication, allowing for a spatial comparison of all treatments as well as a traditional versus recommended comparison[5]. Plot size was 3 meters by 5 meters, with 50 cm between rows, and 10 cm between plants

[5] Of the four unreplicated plots, two were lost due to insufficient rainfall.

in the row. As in 2003, researchers and farmers chose the research sites together, taking care that the plots were as homogenous and free from border effects as possible. Planting dates were chosen by farmers, and farmers and researchers staked and planted the seed and applied the NPK fertilizer together. Farmers undertook the daily management of the plots, including the subsequent weeding (usually at 20 days post germination), urea (46-0-0) application (concurrent with weeding, spread next to plants and mounded up over bean row), disease and insect management. Replicated plots were visited at peak flowering to determine plant population (two replicates of plants per 1 meter of row) and disease incidence (0-9 scale). Rain gauges were installed and rainfall data were collected every week for sixty days starting at planting. At harvest, two rows of beans were harvested (two meters each), beans hand-threshed, analyzed for moisture content and weighed, and the yield was calculated at 13.5% moisture. Farmers received bean seed to replace the beans that were harvested from the field. Plot soil characteristics were not reevaluated, and plots in 2004 correspond to the numbers listed in Table 6.

Table 8. Management components for full factorial trials, Los Limones, Morocelí, Honduras, 2004.

No.	Common bean variety	Fertilizer type	Fertilizer quantity (kg/ha)
1	Seda	18-46-0	65
2	Seda	18-46-0 urea	65 32.5
3	Seda	18-46-0	130
4	Seda	18-46-0 urea	130 65
5	Marciano	18-46-0	65
6	Marciano	18-46-0 urea	65 32.5
7	Marciano	18-46-0	130
8	Marciano	18-46-0 urea	130 65
9	Amadeus-77	18-46-0	65
10	Amadeus-77	18-46-0 urea	65 32.5
11	Amadeus-77	18-46-0	130
12	Amadeus-77	18-46-0 urea	130 65

4.3.2.3 Lavanderos Plots 2004

A full factorial experiment was performed in Lavanderos in 2004 to permit comparisons with the plots in Los Limones (Table 9). On one farm, the two experiments were established with three replications in a randomized complete block design; on another farm, the experiments were installed with two replications[6]. Planting dates were chosen by farmers, and farmers and researchers staked and planted the seed and applied all fertilizer except urea together. Farmers undertook the daily management of the plots, including the subsequent weeding (usually at 20 days post germination), urea (46-0-0) application (concurrent with weeding, spread next to plants and mounded up over bean

[6] Experiments were sown with a total of six farmers from Lavanderos, but three were lost due to excessive rainfall which caused seedling death from *Rhizoctonia* root rot, and one was planted very late in the season with irrigation thus inappropriate for comparison. Three replicates were planned, but the second farmer did not have enough land for a third replicate.

row), disease and insect management. Urea was applied by farmers and researchers together at the first and only weeding, at about 20 days after germination. Plots were visited at peak flowering to determine plant population (two replicates of plants per one meter of row) and disease incidence (0-9 scale). Rain gauges were installed and rainfall data were collected every week for 60 days starting at planting. At harvest, two rows of beans were harvested (two meters each), beans hand-threshed, analyzed for moisture content and weighed, and the yield was calculated at 13.5% moisture. Farmers received bean seed to replace the beans that were harvested from the field. Plot size was three meters by five meters, with 50 cm between rows, and 10 cm between plants in the row. Soil pH calculated with 1:1 soil to water ratio; percent soil organic matter (%OM) with Walkley and Black (Walkley and Black, 1934); percent soil nitrogen (%N) as 5% of %OM, soil phosphorus (P) and potassium (K) with Mehlich-3 extraction (Mehlich, 1984). Results listed in Table 10.

Table 9. Management components for factorial trials, Lavanderos, Güinope, Honduras, Postrera, 2004.

No.	Fertilizer type	Fertilizer quantity (kg/ha)	Common bean variety
4	18-46-0	65	Tío Canela
5	18-46-0 urea	65 32.5	Tío Canela
6	18-46-0	65	Amadeus-77
7	18-46-0 urea	65 32.5	Amadeus-77
8	18-46-0	65	Paraicito
9	18-46-0 urea	65 32.5	Paraicito

Table 10. Experimental plot soil type, pH, percent organic matter (%OM), percent nitrogen (%N), Mehlich phosphorus (P) and Mehlich potassium (K) for two plots, Lavanderos, Güinope, Honduras, 2004.

Farmer	Soil type	pH*	%OM	%N	P** (ppm)	K*** (ppm)
1	Sandy loam	5.4	2.6	0.13	3	130
2	Sandy loam	5.9	4.1	0.20	65	164

* Normal range 6.0 to 6.8
** Normal range 13 to 20 ppm.
*** Normal range 98 to 195 ppm.

4.3.2.4 Farmer Perceptions of Bean Variety Performance

Toward the end of the 2004 growing season in Los Limones, the farmers with experimental plots visited all of the research plots as a group to give their impression of the study and a visual appraisal of the plots. Farmers were asked to judge the quality of the soil, report their highest yield from each parcel in the past, identify experimental plots that they expected to have best and worst yields, and assess which variety would produce the highest bean yield (Appendix 7). Plants in all plots had at least 50% of pods with fully developed seeds, with traditional varieties Seda and Marciano developmentally ahead of the improved variety Amadeus-77 by about 10 days (example in Figure 5).

Figure 5. Example of bean plot observed for plot visit by farmers from Los Limones, Morocelí, Honduras at 60 days post-sowing, November 23, 2004.

Images in this dissertation are presented in color.

CHAPTER 5

RESULTS AND DISCUSSION

In surveys taken in 2003 and 2004 in 6 communities in rural Honduras with small-scale producers, farmers identified drought as the largest constraint to production, followed by the lesser constraints of insects, disease, weeds and lack of fertilizer. Since farmers said they can adequately control insects and disease, research was focused on fertilizer and common bean variety to examine possible increases in production, and weed control to examine savings from field labor.

Experiments were designed to test the effect of traditional versus recommended inputs for bean production in on-farm trials. In 2003, four full factorial (four replications) and five supplemental trials (no replication) were sown to examine the effect of variety, fertilizer and herbicide use in a broadly agro-ecologically representative area of Honduras called Los Limones in the province of Morocelí. Factorial experiment results indicate that increased fertilizer causes a significant increase in yield in some cases; the supplemental experiments showed with 85% certainty that the recommended package of improved variety, increased fertilizer and herbicide increased yield. The results of an economic analysis indicated that the marginal benefit/cost ratio was 7.0 using the improved package of inputs.

In 2004, the factorial experiment was repeated without herbicide, with an additional traditional variety and with two additional fertilizer levels on seven farms (three farms with three replicates, two farms with one replicate). The additional fertilizer treatments were to try to identify the level of fertilizer that yielded the highest possible farmer income. Due to terminal drought, one early maturing traditional variety (60 day) out-yielded the improved, longer-season (70 day) variety on one farm and over all five farms. Fertilizer had no effect on yield under these drought conditions.

A similar experiment was performed in another community called Lavanderos at a higher altitude, representative of another agro-ecological area. Results from one farm indicate a slight decrease in yield after the midseason application of urea fertilizer; and a much higher yield from the traditional variety compared to the improved varieties.

On a field day in 2005, farmers in Los Limones were asked to assess bean production in each experimental plot. Farmers misidentified the worst-producing plot in one case, believing that the improved variety Amadeus-77 produced the least instead of the local variety Marciano; and attributed the apparent poor production to blight when the plants were in fact only drying down early from drought stress. Farmers also misattributed the best production to the local variety Marciano three times, when in fact the other local variety Seda had produced the most. Misidentifications of bean variety production were likely due to variety biases that farmers had based on observations in other contexts.

Surveys revealed some information relevant to agronomic and economic recommendations. Farmers usually save seed, and one in ten farmers reported seed-borne anthracnose as important diseases in 2003 and 2004, with similar numbers for mosaic viruses, so farmers likely underestimate the importance of seed quality. Planting densities varied, and many farmers would benefit from a higher planting density, up to 60 kg/ha. About half of the farmers fertilized at planting, which may result in an economic loss in drought conditions; farmers that split applications or apply fertilizer later in the season can decide not to apply if the crop is suffering a debilitating drought.

Members of local agricultural research committees (LARCs) reported access to technical information as an important benefit, along with access to loans, group cohesion, help for their communities, and other educational opportunities. These benefits, however, were not correlated to other production or economic benefits.

Misperceptions about bean variety performance on the part of the farmers emphasize the importance of collaborative strategies for development of new bean varieties. Not only do farmers lack some technical skills that would aid them in making better management decisions (like the ability to identify disease and understand effective treatments), but also prejudices based on experiences that are generalized from similar but not identical experiences (like assuming that improved varieties always do poorly in drought conditions).

5.1 Survey Results

5.1.1 Household and Land Characteristics

Survey participants were generally in their mid-forties with incomplete primary schooling in a household with five members (Table 11).

Table 11. Characteristics of Survey Population from Six Communities, Department of El Paraíso, Honduras, Postrera, 2004 (Head of household unless otherwise indicated) (N=72[7]).

	Mean	Median	Standard Deviation
Age	44.3	42	14.8
Years of school	3.8	4	2.5
Family members	5.0	5	2.1
Total land cultivated	1.75	1.4	2.1
Total land owned	2.01	0.7	4.8
Percent without land title	42 %		

There were notable differences among the farms where surveys were conducted. About one-half the farmer families sowed less than one hectare of beans, while around three quarters of families sowed less than two hectares (Table 12). Around half of the farm families sowed only one plot, whereas the other half sowed two to four total plots. Around 70% of farmers described their plots as flat, and very few (6-7%) described their plots as steep. About one-half of farmers described their soil as good, and most of the rest described as fair, with few farmers considering their soil poor.

[7] In some cases a survey question was improperly recorded, so whereas a total of 72 individuals were surveyed, the number of responses for a given question may be as low as 50 respondents in this and all subsequent tables unless otherwise noted.

Table 12. Distribution of bean plot size, number of plots sown, plot slope and soil quality indicators reported by farmers, El Paraíso, Honduras, Postrera, 2003 and 2004 (N=72).

	YEAR	
	2003	**2004**
Bean Plot Size	**%**	**%**
0.1 – 1.0 ha	45.2	45.0
>1.0 – 2.0 ha	30.1	35.0
>2.0 – 5 ha	24.7	20.0
Number of Bean Plots Sown		
1	58.9	45.0
2	27.4	41.7
3	11.0	11.7
4	2.7	1.6
Plot Slope		
Flat	71.7	68.0
Gradual slope	21.7	26.0
Steep Slope	6.6	6.0
Soil Quality		
Good	56.7	54.0
Average	35.0	42.0
Poor	8.3	4.0

Although 42% of farmers do not have titles to the land that they farm to beans, becaseu they had access to other family land – considered borrowed land – most farmers did not have to rent land (Table 13). In fact, 81 to 95% of farmer plots were owned by the farmer or borrowed, and some of these same farmers (7%) also rent land for beans. Some farmers do not have access to "free" land to sow to beans in *postrera*, so they rent land; and a small number (4%) illegally occupy land without the land owner's consent.

Table 13. Distribution of bean plot tenure reported by farmers, El Paraíso, Honduras, Postrera, 2003 and 2004 (N=72).

	YEAR	
	2003	**2004**
Bean Plot Tenure	**%**	**%**
Own	50.7	47.1
Borrowed	30.4	48.0
Rented	21.7	7.9
Occupied	4.3	3.9

Note: Percentages do not add to 100% because some producers farm both their own and rented land.

5.1.2 Typical farming practices

There were some marked trends in how farmers managed their bean crops across communities and landscapes.

5.1.2.1 Herbicide Use and Tillage

While 39 to 50% of farmers applied paraquat herbicide to their bean parcel before any tillage operations, 49-57% did not use herbicide before tillage (Table 14). Farmers then tilled their land with oxen (58-76%) or by hand (22-36%). Planting density was very variable: from 20 to 60 kg seed per hectare (average 35 kg/ha).

Table 14. Distribution of herbicide use and tillage reported by farmers, El Paraíso, Honduras, Postrera, 2003 and 2004 (N=72).

	YEAR	
	2003	**2004**
Herbicide Use	**%**	**%**
None	48.6	56.9
Paraquat	51.4	43.1
Tillage		
By hand	37.0	22.2
Oxen	58.9	75.9
No preparation	4.1	1.9

5.1.2.2. Sowing

Fifty-nine to 76% of farmers sow only one bean variety in significant quantities, while 22-40% sow two varieties and only 1-2% sow three (Table 15). Of the varieties sown, 17 to 26% of farmers sow improved varieties. Sixty-five to 78% of farmers plant beans as a monocrop, while the rest intercrop beans and maize or sorghum, mostly with three or four rows of beans for each row of the cereal crop.

Table 15. Distribution of number of varieties sown, farmers sowing at least one improved variety, and rows of beans per row of grain crop (intercrop) reported by farmers, El Paraíso, Honduras, Postrera 2003 and 2004 (N=72).

	YEAR	
	2003	**2004**
Number of varieties sown	**%**	**%**
1	76.7	58.3
2	21.9	40.0
3	1.4	1.7
Farmers sowing at least one improved variety	25.6	16.7
Rows of beans per row of maize/sorghum		
No intercropping	77.6	65.0
1	1.5	1.8
2	3.0	3.3
3	9.0	13.3
4	7.5	13.3
5	1.5	3.3

Of the beans sown, about 90% are from saved seed from the past harvest and/or from a neighbor (Table 16). Forty percent of farmers select their seed prior to sowing based on visual characteristics (uniformity, size, color, lack of damage and disease). The remaining farmers obtained seed from a local NGO, Zamorano, or a local supply store. Only two percent had even done a germination test to know how well their seed would germinate.

Table 16. Distribution of seed source as reported by farmers, El Paraíso, Honduras, Postrera, 2003 and 2004 (N=72).

	YEAR	
	2003	2004
Seed source	%	%
Past harvest	60.3	80.0
Neighbor	35.7	30.0
Local Ag. Research Committee	4.1	5.0
NGO	2.8	1.7
Store	1.4	3.4
University	2.7	0

Note: Percentages exceed 100% because some producers acquire seeds from more than one source.

5.1.2.3 Fertilizer Application and Weeding

In 2003 when there was less concern about rainfall, 46% of farmers who applied fertilizer only applied it at planting; another 18% split fertilizer application between planting and at first weeding (Table 17). Thirty-one percent waited until they weeded, presumably to ensure that there was enough moisture to make a fertilizer application worthwhile. In contrast, in 2004 when there was more concern about drought because of low rainfall in the first *primera* season, only 21% of farmers fertilized at planting, with 29% splitting the fertilizer application between planting and first weeding. Forty-eight percent waited until the first weeding to apply fertilizer. In both years, about 19% of farmers used a foliar fertilizer spray, and a few of the foliar sprays were concocted by the farmers themselves with local materials. The average fertilizer application was 15.9 kg nitrogen/ha and the median was 11.7 kg nitrogen/ha, with a range of zero to over 100. Most plots were fertilized far below the 26.8 kg nitrogen/ha as recommended by the university at Zamorano (Rosas, 2003). No farmers applied *Rhizobium* inoculant to encourage nitrogen-fixing noduation on bean plant roots, and although no systematic observations were made about nodulation, occasional plants that were observed in the field during this study did not have nodules.

Table 17 Distribution of timing of fertilizer application as reported by farmers, El Paraíso, Honduras, Postrera, 2003 and 2004 (N=72).

	YEAR	
	2003	**2004**
Timing of fertilizer application	**%**	**%**
None	8.2	13.3
At planting	42.5	20.0
At first weeding (about 21 days after sowing)	28.8	41.7
Split between planting and first weeding	16.4	25.0
Foliar spray	16.4	16.7

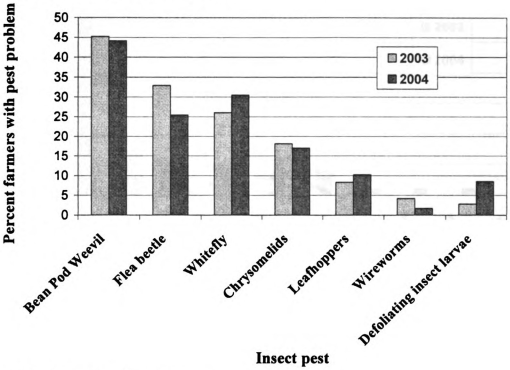
Note: Percentages exceed 100% because some producers use both a granular fertilizer and a foliar spray.

Ninety percent of farmers weeded only once throughout the bean growing season, generally at about three weeks after germination.

5.1.2.4 Insect and Disease Management

Over 25% of farmers surveyed noted that bean pod weevil (*Apion godmani*), flea beetle (*Aphis* sp.) and whitefly (*Bemesia tabaci*) were their principal insect pest problems in *postrera* (Figure 6). Other insect pests were serious pests for a smaller number of farmers. These pests included chrysomelids (*Diabrotica* spp, *Cerotoma* spp), leafhoppers (*Empoasca* spp), wireworms (Family: *Elateridae*), and defoliating insect larvae (Order: Lepidoptera) (see Appendix 8 for local names). Twenty-one to twenty-two percent of farmers chose not to use chemical control for insects; a few farmers used a self-made preparation with local plants extracts to control insects. When farmers opted for insect control, 72-79% used parathion, and another 6-9% used parathion mixed with another chemical. Other insecticides used in small quantities included methamidophos, chlorphoxim, malathion, and lambda-cyhalothrin.

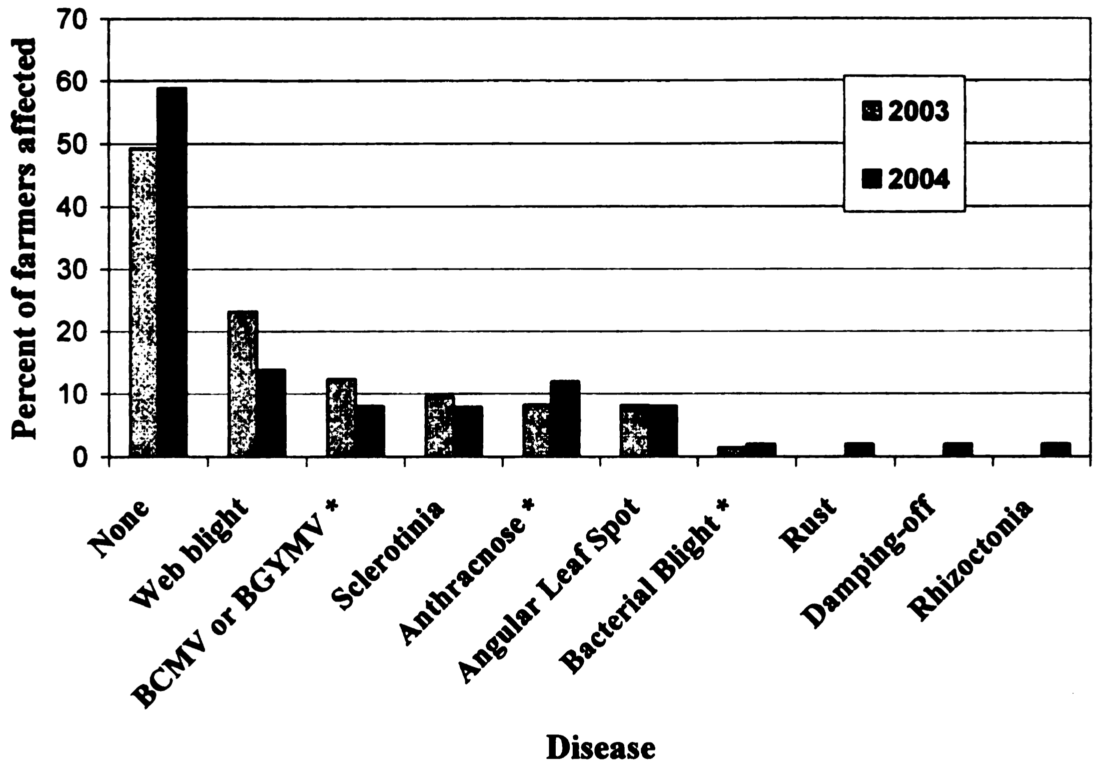
Figure 6. Percentage of farmers (N=72) who reported insect pest problems, El Paraíso, Honduras, Postrera, 2003 and 2004.



Note: insect names identified by farmers

Most farmers did not report significant amounts of disease in their bean crops in *postrera* in 2003 and 2004 (Figure 7). Web blight (*Thanatephorus cucumeris*) was the most commonly reported disease (see Appendix 9 for local names). Chemical control of diseases was very uncommon, including only 10-18% of farmers. When chemical control was used, farmers used a large variety of products, including mancozeb, copper sulfate, othiocarbamate, calixin, copper oxychloride, copper hydroxide chlorotalonil, and benomyl.

Figure 7. Percentage of farmers (N=72) who reported significant infection by disease, postrera, 2003 and 2004, El Paraíso, Honduras, Postrera, 2003 and 2004.



Note: diseases identified by farmers
* indicates a seed-borne disease

Slugs were reported as problems in 12-17% of farmers' bean fields. By the time slugs were a pest in a bean field, farmers opted for chemical control with a commercial molluscicide.

5.1.2.5 Harvest and Storage

Once beans reached harvest maturity, the bean plants were generally pulled up by hand and dried in bunches upside down in the field, and then threshed with long poles on the ground once they were completely dried. Bean seeds were stored in 100 pound woven polypropylene sacks and stored for sale or future use.

5.1.3 Bean Yield Analysis

Bean yields were highly variable, ranging from zero to 2,080 kg/ha. According to farmers, low yields were caused mainly by drought conditions, and infrequently by slug and wireworm infestations. There were no statistically significant relationships between yields and fertilizer use or other input uses; and no relationship between planting density and yield. However, when low-yielding plots resulting from drought, flooding or severe slug infestations were removed from the analysis (yields < 99 kg/ha), a moderate linear relationship between planting density and yield ($r = 0.403$, $P=0.0001$) become apparent (Figure 8). When only high-yielding plots are considered (yields > 850 hg./ha), the linear relationship improves ($r = 0.464$, $P=0.0086$) (Figure 9). This data supports the Pan-American School of Agriculture recommendations of planting densities of 170,000 - 215,000 plants per hectare, or about 50-60 kg viable seed per hectare for common beans with a weight of 30 grams per 100 seeds, typical for the beans in this study (Rosas, 2003; Tshering, 2002). Some of the other variation unexplained by the regression analysis was probably caused by differences in germination.

Figure 8. Relationship between seeding density of common beans and yield where yield was >99 kg/ha (N=121), El Paraiso, Honduras, Postrera, 2003 and 2004.

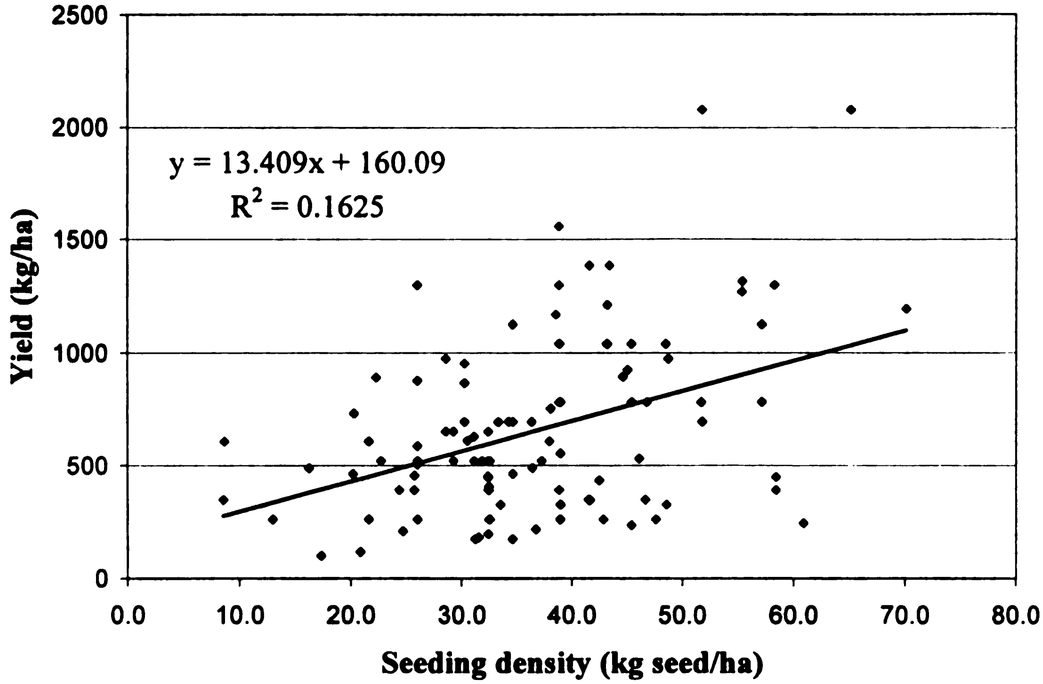
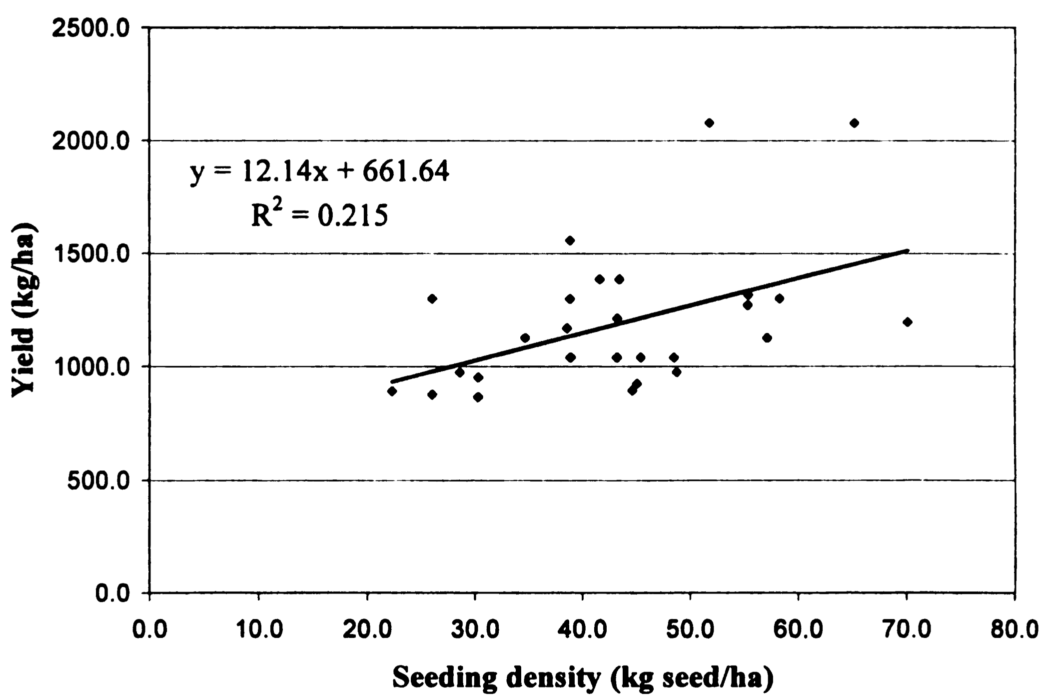


Figure 9. Relationship between seeding density of common beans and yield where yield was >850 kg/ha (N=32), 2003 and 2004, El Paraiso, Honduras.



There is no apparent relationship between N use and yield, neither looking at the plots without very low yielders, nor looking only at high-yielding plots. Since *Rhizobium* inoculant was not used in farmer-managed systems and fertilizer nitrogen was present, there was no expected biological nitrogen fixation; as previously mentioned, although no systematic observations were made about nodulation, occasional plants that were observed in the field during this study did not have nodules.

Some survey questions were chosen in order to give insights into why some farmers were better producers than others. These questions were specifically about intrinsic farm conditions like land slope and soil quality, and extrinsic factors such as soil fertility management, pest management, cropping systems, variety choice, and cropping systems. These factors occur often enough to predict management choices that result in higher plant yields, especially in uniform environments.

Despite the general similarities in rainfall and altitude, microclimate and unnoted management differences likely played a role in confounding the ability to make generalization about successful management strategies. These could include precipitation patterns, residual fertilizer, rotation effects, and micronutrient deficiencies.

Generalizations about successful management strategies may be confounded if farmers have different risk strategies for economic gains. For example, if a farmer wants to spread out farm income over many different income-generating projects, he or she may spend less on inputs and accept a mediocre harvest in any given season (the "minimax" risk strategy mentioned in section 5.1.4). Another farmer may invest more resources in fewer projects, and accept losses in a season unfavorable to production while benefiting more in a favorable season, a strategy with higher tolerance for risk. If some farmers in this survey used a minimax strategy and other a more risky strategy, the correlation between management and production may not be apparent.

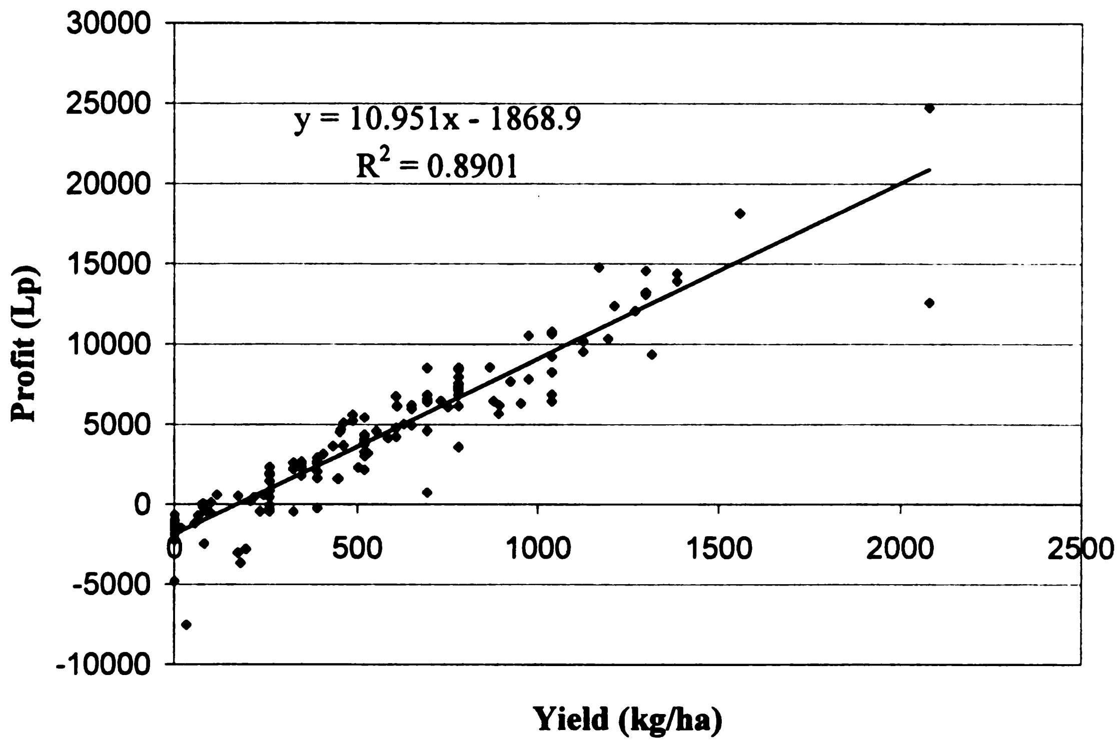
5.1.4 Farmer Financial and Social Factors

If farmers did not have animal traction, they hired oxen to plow the bean field, but otherwise farmers generally did not hire others to help them except for weeding and harvest.

Once beans were harvested, farmers sold a portion of the harvest to pay loans and to supply cash to the household; otherwise, beans were stored and sold when the household needed more cash. Beans were generally sold to intermediaries (74%) or to buyers in the market in the capital city (23%). Only 24.2% of farmers did not sell any of the beans they harvested in postrera; the remaining farmers sold from 17 to 98% of their harvest. Storing beans was preferred to selling immediately because the price generally went up as harvest grew distant and beans grew scarce. Farmers desired to be self-sufficient in beans, but many households (42%) reported selling beans for cash and then purchasing them at a later date.

One way to determine the profitability of producing common beans is to calculate the cost of production (including family labor) and the value of the crop, and comparing the net return to the returns from the next best investment. Data for all direct bean production costs were collected with the survey; and family labor was estimated using data reported by Tshering (Tshering, 2002) and valued at the average price paid to field workers in the survey (Lp 45.50/day). Returns from the sale of beans were fixed at Lp 13.20/kg, the median price at harvest for 2004[8]. It was discovered, as one might expect, that as yield increases, so do profits (R^2=0.890, r=0.943, P<0.0001) (Figure 10). Most of the costs of bean production (65%) were accounted for by labor costs when family labor was included in the calculation.

Figure 10. Relationship between profit (Lp) and yield (kg/ha) (N=148), El Paraiso, Honduras, Postrera, 2003 and 2004.



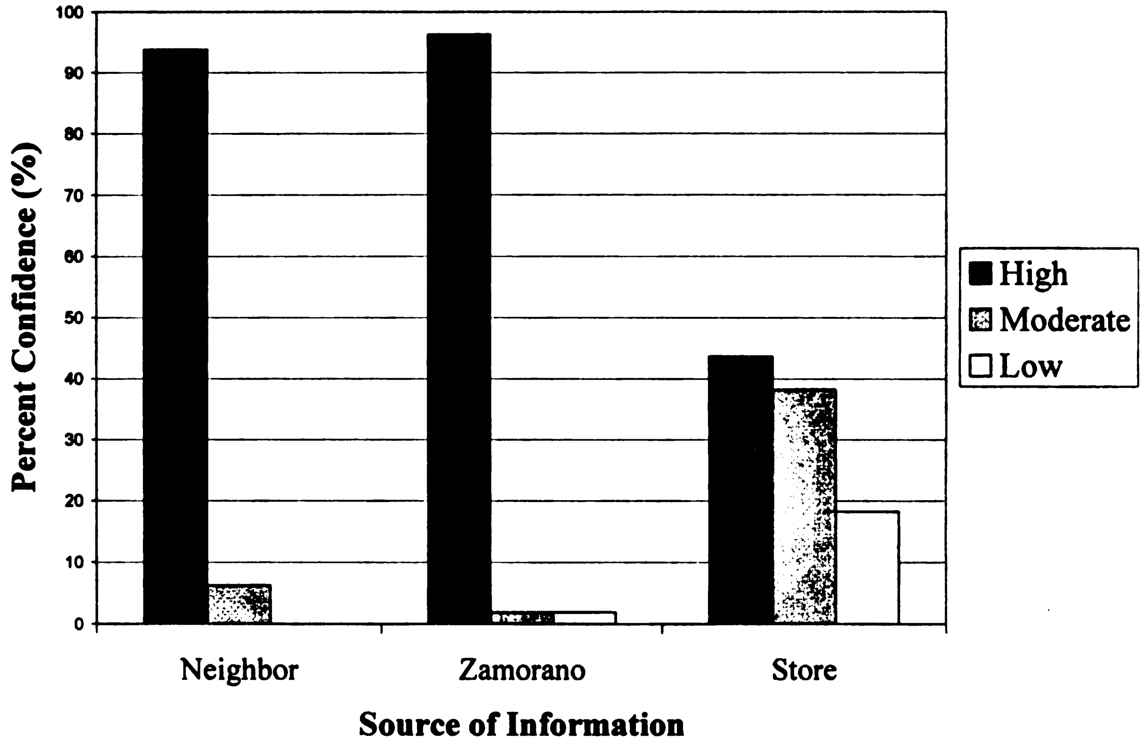
[8] Prices at harvest time are the lowest, so profitability will be underestimated if farmer is able to sell some of the crop when the price rises as beans become scarcer.

One way to determine whether farmers are making more money on a plot of beans relative to other activities is to estimate the returns from that plot per day of family labor, and comparing that to what a farmer might earn as a day laborer. To calculate this hypothetical wage, costs of production (paid labor and input costs) are subtracted from gross profits to calculate the net returns before farm labor. When net returns are divided by farm labor, the result can be compared to day laborer wages to show the profitability of growing beans.

When this type of analysis is performed, 68.9% of farmer fields yielded enough beans to make farming more profitable than working as a day laborer. Theses results are not surprising considering that 12.2% of the fields in this analysis had no yield at all, and another 6.1% harvested under 99 kg beans/ha.

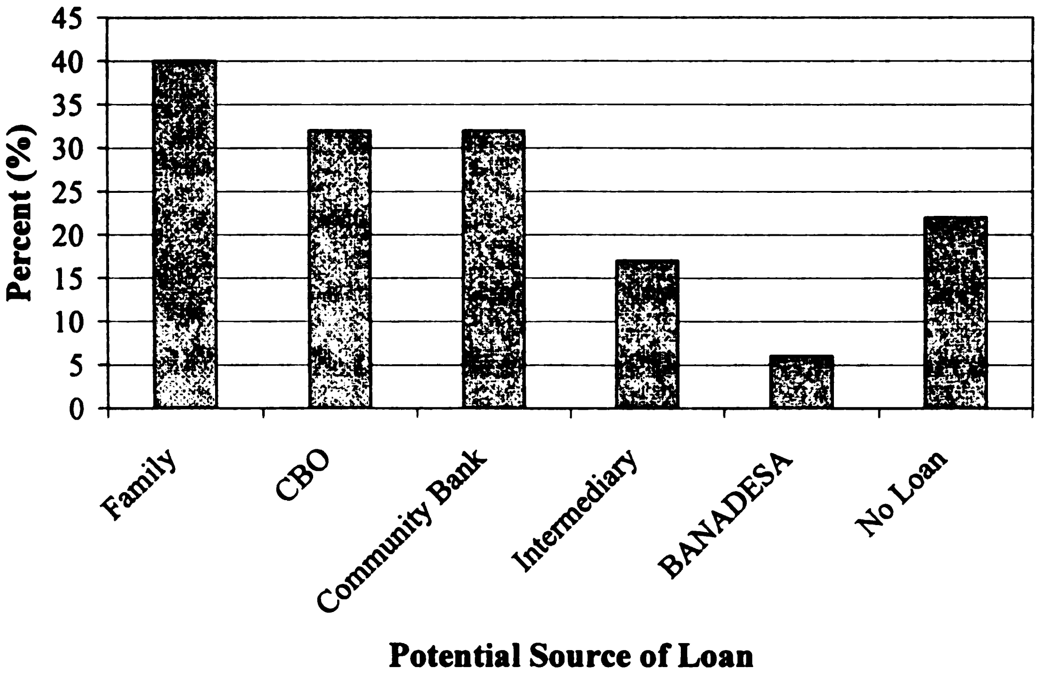
Farmers differed in where they got their information, and how much they trusted the information that they got. Many farmers (44.2%) reported getting their bean production information from their neighbors, and trusted that information (Figure 11). Almost forty-one percent of farmers had access to technicians from Zamorano, and confidence in that information was also high. The remaining farmers, 14.7%, got information from supply stores, and confidence in this information was not as high (43.6% high and 38.2% moderate) because "*los agropecuarios quieren vender sus productos nomás*" ("store owners just want to sell their products") and "*los vendedores no son productores de frijol y a veces no saben*" ("the salesmen are not bean producers and sometimes they do not know [about bean production]"). Interestingly, 16.4% of farmers claimed that they do not actively seek information about bean production.

Figure 11. Producer-reported level of confidence in available source of information (N=72), 2004, El Paraiso, Honduras.



When farmers were asked about where they could get a loan for bean production, 40% of farmers responded that they could get loans from family members, with interest rates from 0 to 10 percent over the period of the loan (four months, the length of the bean season) (Figure 12). Thirty-two percent of farmers revealed that they could get loans from the community's LARC or another community based organization, and the same percentage of farmers mentioned community banks as an option; both of these options charge 2 or 3% to members and up to 7 percent to non-members. Seventeen percent of farmers mentioned intermediaries, who normally charge 20%, or buy beans at a lower-than-market price to cover the amount of the loan. Six percent spoke of the Honduran national bank BANADESA, who charged 1%. Twenty-two percent of farmers said that they had no options for loans for bean production, and many of those who listed options said that they were unwilling to take loans even if they were available. Why farmers were shy about taking loans was not asked, although most farmers who expressed this sentiment said that they were afraid of debt.

Figure 12. Farmer perception of availability of loan for bean production (N=66), El Paraiso, Honduras, 2004.



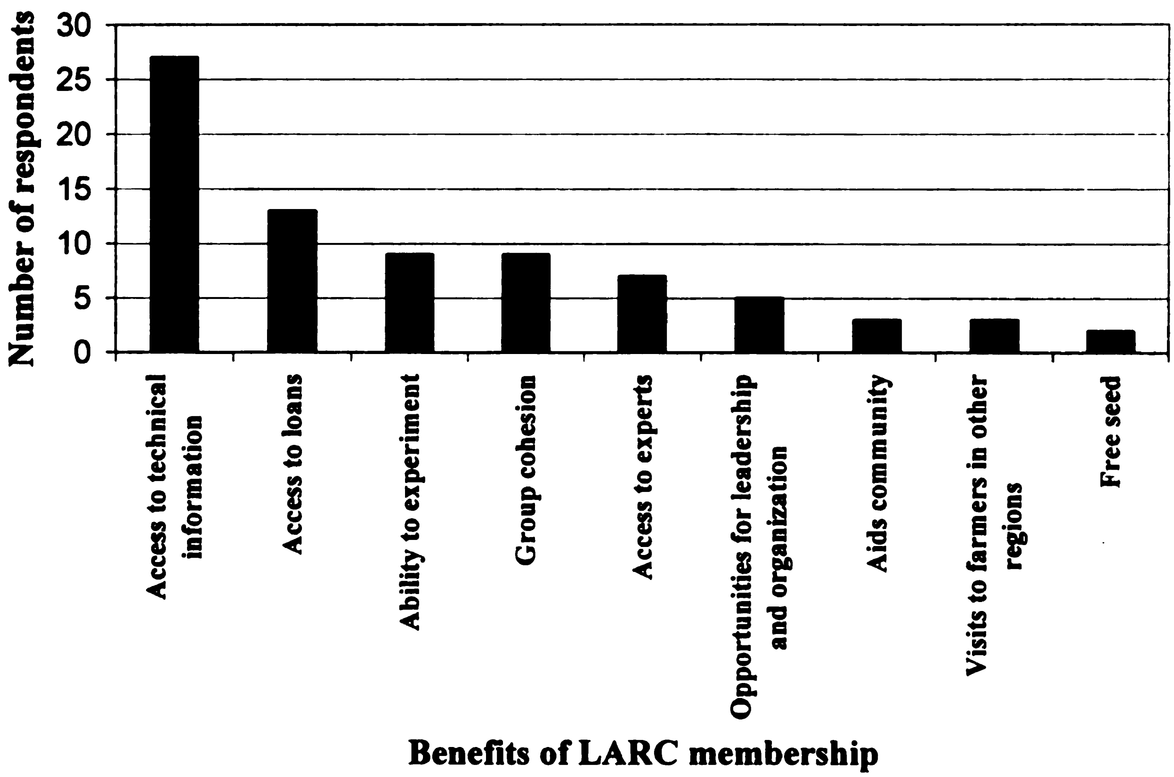
Note: CBO = Community Based Organization, including Local Agricultural Research Committees (LARCs); BANADESA = *Banco Nacional de Desarrollo Agrícola*, the Honduran National Agricultural Development Bank.

Farmers generally did not rely wholly on bean and other crop production for income. When farmers were asked what other activities farm families engaged in to earn money in the 2004 survey, 52% of the 66 respondents claimed that someone in the household worked as agricultural day laborers. Twenty percent responded that someone sold eggs, and 20% of households grew and sold coffee. Nine percent of families had members who rented out their oxen and worked in construction; seven percent baked and sold bread or ran a store from their home. Six percent had a household member that worked in the city or made clay roof tiles. Fewer than five percent of households had members who cut sugar cane, worked as a carpenter or mason, repaired fences, worked for a patron in another household, and raised and sold animals. Only one of the 66 households surveyed reported that a family member washed clothes for pay, collected and sold wild fruit, sold soft drinks from their home, worked in a *maquila* (a clothing factory in the city), ran a pool hall, worked as an elementary school teacher, prepared and sold food, worked at a local brick factory, slaughtered animals, sewed clothes, managed dairy cows for others, sold fresh milk, ran a bar, sold beans for seed, used his vehicle as a taxi service in his community, ran a small saw mill, cut fence posts, grew and sold bananas and sold vegetables. Only four of the 66 households in the 2004 survey claimed that they had no other source of income apart from bean and corn production.

5.1.5 Benefits of LARC Membership

It was difficult to determine what made the members of LARCs different from other farmers in the communities where the research was conducted. One survey question asked what benefits LARC members perceived by being a member of their LARC. Of the 33 LARC members surveyed, practically all members (82%) mentioned access to technical information (Figure 13). Thirty-nine percent mentioned access to loans as a benefit of LARC membership. About a quarter of members noted that LARCs created a sense of togetherness ("*compañerismo*") among members, and a quarter of the members also mentioned their skill as experimenters. About 20% noted that membership permitted access to technical help from experts, 15% mentioned the leadership and organizational opportunities, 9% stated that participation in LARCs helped their communities solve production problems, 9% stated that LARCs permitted them to visit and learn from other communities with similar problems, and 6% noted that a benefit was getting free seeds.

Figure 13. Self-reported benefits recognized by members of Local Agricultural Research Committees, El Paraíso, Honduras, 2004.



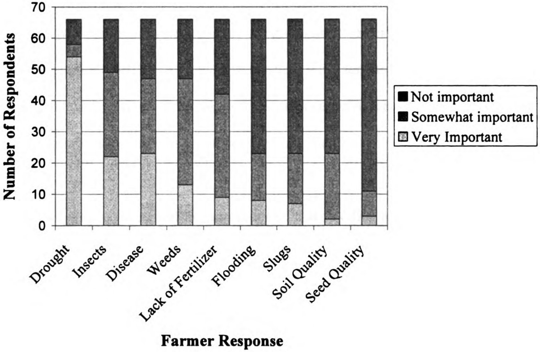
The results of some of these benefits one might expect to see reflected in other aspects of the survey, notably increased bean production, greater adoption of improved varieties, more mention of Zamorano and NGOs as sources of information, and greater access to loans. These benefits, however, were not reflected in the survey.

One concern is that LARCs favor farmers that are more educated, thus exclude farmers with more need for education (Humphries et al., 2000). In this study, however, there was no relationship between LARC members and education.

5.1.6 Farmer Perception of Production Constraints

When asked about constraints to production, most farmers answered that their biggest constraint was drought (Figure 14). There are two major kinds of drought in Honduras. Intermittent drought is a break in rainfall during the development of the plant, and requires that the plant limit growth-related activities until rainfall begins again. Terminal drought is when rainfall ends and does not resume over the life of the plant. In the region under study, and in a significant part of Honduras in *postrera*, terminal drought is the most common form of drought. The agronomic study supports the idea that drought is a constraint to better beans production, and bean varieties bred to produce well in areas that suffer terminal drought is one solution to this constraint. Irrigation, another solution to drought in general, is generally not considered a viable solution due to the low price of beans compared to other, higher value crops. However, irrigation is required for bean seed production.

Figure 14. Responses to question, "What are the biggest constraints to increased bean production in *postrera*?" (N=66), El Paraíso, Honduras, 2004.



The other constraint that was most evident was the lack of fertilizer. In years of sufficient rainfall, fertilizer has the potential to increase yield and profit, as this research in Los Limones in 2003 demonstrates. Castro-Zúniga, in a similar study in central-eastern Honduras, showed that increased fertilizer significantly increased yield in 45% of the cases under study (Castro-Zúniga, 1998). However, only 14% of farmers consider the lack of fertilizer in their beans in postrera very important (or extremely important), and only 36% consider it not important at all. It is possible that farmers are risk-adverse, so do not consider increasing fertilizer a priority when its success is not guaranteed. Farmer's dislike of credit supports this assertion.

Insects, disease and weeds are identified as greater constraints than a lack of fertilizer in 2004. Farmers noted that since these constraints can generally be controlled through chemical application and weeding, they are much more under the control of the farmer than precipitation. Still, in a drought year where fertilizer has a lesser effect on production than in a normal rainfall year, farmers perceive fertilizer as less important even though the question was about *postrera* in general.

Twelve and eleven percent of farmers reported that flooding and slugs, respectively, were very important. Since flooding is specific only to certain physical areas, and considered undesirable for crop production, it is not surprising that flooding is not a very important constraint to bean production. However, since 12% of farmers did respond that flooding was very important, it is probable that some farmers are sowing beans in poor soils due to a lack of available good quality soils; and farmers may be more willing to sow in soils that are prone to flooding in the postrera season since the chance that they will not flood when rainfall is lower.

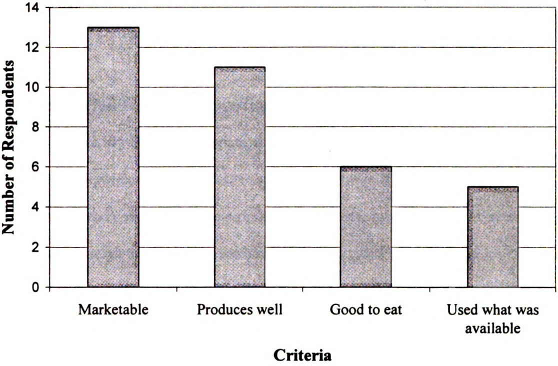
Similarly, slugs in beans in postrera are generally problematic where they were present in the previous maize crop but not eradicated at that time (Rosas, 2003). Most farmers seem to control slugs effectively and they are not considered problematic.

Seed quality was considered very important for only 5% of respondents, and not important at all by 83%. Since many diseases are seed-borne, seed quality is an important factor in controlling important diseases like common mosaic virus, common bacterial blight, and anthracnose. In fact, about ten percent of farmers report mosaic viruses and anthracnose as important diseases in *postrera* (Figure 7), and anthracnose is probably more common in the wetter *primera* season. These results indicates that farmers are not aware that seeds can be major sources of disease, and this lack of understanding may limit success to encourage farmers to buy clean seed.

Lastly, soil quality was considered very important by only 3% of respondents. Since inherent soil qualities are not under the control of the farmer, farmers give it very little importance when thinking about how to improve production.

In 2003, farmers in Los Limones were asked why they chose the variety they planted that year. Over half (59%) reported that they chose a traditional variety because of its marketability; half responded that the traditional variety produced well. About one quarter (27%) claimed that the traditional variety is what they prefer to eat, and 22% claim that they just used what seed was available to them at the time (Figure 15).

Figure 15. Preference for traditional varieties as reported by farmers (N=22), Los Limones, Morocelí, Honduras, 2003.



Note: Multiple answers acceptable.

Survey results indicate a 5% price discount for darker-colored red beans like Amadeus-77 and Tío Canela, which plays a part in the reluctance of farmers to sow these varieties.

The question of whether traditional varieties produce well is relative to the farmer's risk strategy. Farmers who are very risk-adverse may choose to produce a low-yielding variety that yields consistently than choose to produce a high-yielding variety that may fail in an exceptional year, the aforementioned "minimax" strategy. Nevertheless, a farmer may choose to plant some fields to traditional varieties and others to improved varieties. This way the farmers can take advantage of the high potential yields in fields sown to improved varieties in normal rainfall seasons while guaranteeing yield security with the harvest from the fields sown to the traditional varieties in low rainfall seasons. This strategy can maximize farmers' returns in the long run without sacrificing yield security.

Male farmers in Los Limones claim that the taste of dark red Amadeus-77 and traditional light red varieties like Seda are identical, and that the color of the beans themselves are indistinguishable when cooked. These observations seem to indicate that differences in common bean seed coat color create a perception that there is a difference in taste where there is none (though these conclusions have not been studied objectively).

Ninety percent of farmers in this study saved seed from a past harvest to sow in the future, and farmers view purchasing seed as an unnecessary expense. As mentioned above, reluctance to buy high-quality seed is due in part to a poor understanding of disease transmission by infected seed; and one in ten farmers report seed-borne anthracnose as important diseases in 2003 and 2004, with similar numbers for mosaic viruses. As farmers understand the connections between disease and seed quality, the desire to buy disease-free seed may increase.

5.2 Field Results

5.2.1 Los Limones Plots 2003

There were similarities between the bean yields among the four complete factorial plots (Table 18) (more detailed tables are given in Appendix 6). When considered alone, the yields of the improved variety Amadeus-77 and the traditional variety Seda (also known as Rojo de Seda), were similar in all four factorial plots. Data from preliminary trials with Amadeus-77 in farmer fields in 2002 indicated that Amadeus-77 has a yield advantage under local, non-drought conditions (Rosas and Escoto, 2002), so the lack of difference was unexpected, and not correlated with weed density, disease pressure, or insect damage; although overall, variability in the field was high and a lack of differences may have become apparent with more replications. The addition of urea played a significant role in increasing bean yield in two of the four plots, indicating that under some circumstances, the plants were able to increase production at the levels of fertilizer used in this experiment. There was no apparent effect from the use of paraquat herbicide; in retrospect, due probably to the fact that it was used at a time when weed seedlings were not actively germinating. Weed densities at mid-flower in the experimental plots were measured at 0 to 658 kg/ha dry matter, though no correlation was discovered between weed biomass and plot yield. There were no significant interaction effects.

Table 18 Bean yield (kg/ha) for producers 1-4, factorial trials, Los Limones, Morocelí, Honduras, Postrera, 2003.

	CONSTRAINT FACTOR*			PRODUCER			
Trt	**Variety**	**Fert. mgt.**	**Weed mgt.**	**1**	**2**	**3**	**4**
1**	R	R	R	1,740	1,240	1,660	1,070
2	R	R	T	1,760	1,830	2,440	730
3	R	T	R	1,490	1,430	2,040	560
4	T	R	R	1,640	1,570	2,500	870
5	R	T	T	1,410	1,490	2,110	640
6	T	R	T	1,700	1,790	2,230	940
7	T	T	R	1,340	1,170	2,170	460
8***	T	T	T	1,290	1,490	2,160	710
PRECIPITATION IN 60 DAYS (mm)				140	148	134	120
COMPARISONS OF INDIVIDUAL FACTORS							
Variety							
	R			1,600	1,500	2,070	760
	T			1,490	1,500	2,260	760
	P-value			0.35	0.81	0.33	0.87
Fertilizer management							
		R		1,700	1,610	2,210	900
		T		1,390	1,400	2,110	600
		P-value		0.01	0.36	0.67	0.04
Weed management							
			R	1,540	1,360	2,100	740
			T	1,540	1,660	2,230	760
			P-value	0.93	0.18	0.50	0.86

* R=Recommended, T=Traditional.
** Equivalent to the recommended management package.
*** Equivalent to the traditional farmer package.

The results of the complete factorial experiments give insight into how the constraint factors interact; while the results of the supplemental experiments compare the relative performance of the recommended versus the traditional management strategies. To analyze the supplemental plots, the results from the complete factorial trial that represent the traditional plots (Seda, less fertilizer and no herbicide) and the recommended plots

(Amadeus-77, more fertilizer and herbicide) were added to the supplemental experiment results and analyzed as a single data set to maximize the amount of data (Table 19).

Table 19. Supplemental trial bean yields (kg/ha) for 9 farmers, Los Limones, Morocelí, Honduras, Postrera, 2003*.

Producer	RECOMMENDED PACKAGE Improved variety + extra fertilizer + paraquat	TRADITIONAL MANAGEMENT Traditional var. - typical fertilizer - paraquat	Difference
1	1,740	1,290	+ 450
2	1,240	1,490	- 250
3	1,660	2,160	- 500
4	1,070	710	+ 360
5	910	1,170	- 260
6	3,340	2,130	+ 1,210
7	3,410	770	+ 2,640
8	1,630	930	+ 700
9	1,290	1,030	+260
AVERAGE	**1810**	**1300**	**+510**

* Differences determined with Tukey's mean separation, significant at α=0.15

In general, the plots using the recommended practices (Amadeus-77, more fertilizer and herbicide) produced more beans than plots using the traditional farmer practices. However, in three cases, the traditionally managed plots yielded more beans (Table 19, Farmers 2, 3 and 5). Farmers gave no explanation for this, and weed, disease and drought notes also do not explain this difference. In addition, one recommended practice plot produced much better than the traditional farmer management plot (Table 19, farmer 7). The farmer claimed that this difference was due to a severe attack of web blight that affected the traditional variety but not the improved variety. When analyzed as a whole, we can say with only 85% certainty that there were true differences between the farmer and recommended practices. The economic implications of these results are discussed in Section 5.1.5.

5.2.2 Los Limones Plots 2004

In four of five cases, rainfall in the Los Limones experimental plots was lower in 2003 than in 2004 (that is, under 120 mm precipitation over 60 days). Although rainfall data alone does not adequately reflect the quantity and timing of water available to plants, it gives insight into the water constraint that defines the area in which these producers grow their crops, and serves as a proxy for drought conditions.

Other researchers have calculated water use ratios for beans in different cropping systems and environments. Researchers in Kansas (Hattendorf et al., 1988) calculated the daily water use rate (WUR) for pinto beans and calculated it to be between 3.95 and 5.2 mm/week (mean=4.76 mm/week) over the 80 to 90 days the crop was growing; seed yields were 1,458 to 2,909 kg/ha (mean=2,077 kg/ha). Similarly, Yonts (Yonts, 1996) reports that common beans use 5.6 mm/week at peak growing (rapid vegetative growth and flowering and pod development), and less during stand development and pod fill and maturation.

On the farm where rainfall was 124 mm from September to December, there were no significant differences in bean yield due to variety or fertilizer, and yield was below what the farmer reported as the typical yields for that field (900-1100 kg/ha) (Producer 1, Table 20). When rainfall was around 100 mm, there were significant differences between all three varieties (Producer 2, Table 21), with the traditional variety Seda yielding better than either the other traditional variety Marciano, and the improved variety Amadeus-77. In Producer 3's field, where rainfall was only 72 mm, yields were extremely low, and there were small differences between Amadeus-77 and Seda, but not with Marciano (Table 22). In no case were there differences due to fertilizer. A combination of the replicated complete factorial fields and the un-replicated plots shows differences between Seda and the remaining two varieties; and no differences in fertilizer (Table 23).

Table 20. Factorial trial bean yields (kg/ha), Producer 1, 2004, Los Limones, Morocelí, Honduras, Postrera, 2004*.

Variety Fertilizer	Seda (trad.)	Marciano (trad.)	Amadeus-77 (improved)	AVERAGE
65 kg/ha 18-46-0	840	535	822	**733 a**
65 kg/ha 18-46-0 32.5 kg/ha urea	638	772	679	**696 a**
130 kg/ha 18-46-0	793	673	956	**807 a**
130 kg/ha 18-46-0 65 kg/ha urea	910	787	1122	**939 a**
AVERAGE	**795 a**	**691 a**	**895 a**	
Interaction fertilizer x variety: P=0. 0.8260				

Note: Rainfall during growing season was 124 mm.
* The different letter in a row or column indicates a significant difference in yield (Tukey's mean separation, α=0.05).

Table 21. Factorial trial bean yields (kg/ha), Producer 2, 2004, Los Limones, Morocelí, Honduras*.

Variety Fertilizer	Seda (trad.)	Marciano (trad.)	Amadeus-77 (improved)	AVERAGE
65 kg/ha 18-46-0	420	309	173	**301 a**
65 kg/ha 18-46-0 32.5 kg/ha urea	420	355	204	**326 a**
130 kg/ha 18-46-0	505	354	194	**351 a**
130 kg/ha 18-46-0 65 kg/ha urea	474	351	312	**379 a**
AVERAGE	**455 a**	**342 b**	**221 c**	
Interaction fertilizer x variety: P=0.9210				

Note: Rainfall during growing season was 103 mm.
* The different letter in a row or column indicates a significant difference in yield (Tukey's mean separation, α=0.05).

Table 22. Factorial trial bean yields (kg/ha), Producer 3, Los Limones, Morocelí, Honduras, Postrera, 2004*.

Variety / Fertilizer	Seda (trad.)	Marciano (trad.)	Amadeus-77 (improved)	**AVERAGE**
65 kg/ha 18-46-0	105	73	41	**73 a**
65 kg/ha 18-46-0 32.5 kg/ha urea	94	67	60	**74 a**
130 kg/ha 18-46-0	62	66	43	**57 a**
130 kg/ha 18-46-0 65 kg/ha urea	117	57	44	**73 a**
AVERAGE	**95 a****	**66 a**	**47 a**	
Interaction fertilizer x variety: P=0.9073				

Note: Rainfall during growing season was 72 mm.

* The different letter in a row or column indicates a significant difference in yield (Tukey's mean separation, α=0.05).

** Seda and Amadeus-77 were significantly different at the α=0.06 level

Table 23. Factorial trial bean yields (kg/ha), combination of 5 farms, Los Limones, Morocelí, Honduras, Postrera, 2004*.

Variety / Fertilizer	Seda (trad.)	Marciano (trad.)	Amadeus-77 (improved)	**AVERAGE**
65 kg/ha 18-46-0	410	265	289	**321 a**
65 kg/ha 18-46-0 32.5 kg/ha urea	302	342	209	**284 a**
130 kg/ha 18-46-0	403	272	317	**331 a**
130 kg/ha 18-46-0 65 kg/ha urea	400	328	317	**348 a**
AVERAGE	**379 a**	**302 b**	**283 b**	
Interaction fertilizer x variety: P=0.4320				

* The different letter in a row or column indicates a significant difference in yield (Tukey's mean separation, α=0.05).

5.2.3 Lavanderos Plots 2004

The factorial experiment showed significant differences for variety and fertilizer treatments in the plot of Producer 1 and no differences in the plot of Producer 2 (Tables 24-25). Farmer one experienced much higher yields with the traditional variety Paraicito compared to the improved varieties Tío Canela and Amadeus-77 (Table 24). These differences cannot be explained by variety alone, though observations of weed pressures, disease and insect damage did not reveal the cause of these extreme differences in yield. Perhaps the reduction in yield due to the absence of disease pressure on the traditional variety accounts for some of the difference. The addition of urea fertilizer also had a net negative effect when examined across all varieties. The urea fertilizer was applied at the same time that the plots were weeded so the soil around all plants was disturbed by the hoeing; however, the additional action of incorporating the urea fertilizer, plus perhaps some toxicity from root contact with the fertilizer, may have caused the reduction in yield. Another explanation could be that the urea stimulated weed growth which debilitated the bean plants at a critical stage in growth, causing the lower yield. The application of urea may also have further acidified the soil (Table 9), causing some toxicity from low pH, like aluminum toxicity which is common at pH under 5.0.

Table 24. Factorial trial bean yields (kg/ha) of Producer 1, 2004, Lavanderos, Güinope, Honduras, Postrera, 2004*.

Variety Fertilizer	Tio Canela (improved)	Amadeus-77 (improved)	Paraicito (trad.)	AVERAGE
65 kg/ha 18-46-0	500	360	1370	**740 a**
65 kg/ha 18-46-0 32.5 kg/ha urea	290	420	890	**530 b**
AVERAGE	**390 a**	**390 a**	**1130 b**	

Note: Rainfall during growing season was 235 mm.
* The different letter in a row or column indicates a significant difference in yield (Tukey's mean separation, α=0.05).

Table 25. Factorial trial bean yields (kg/ha) of Producer 2, 2004, Lavanderos, Güinope, Honduras*.

Variety / Fertilizer	Tio Canela (improved)	Amadeus-77 (improved)	Paraicito (trad.)	AVERAGE
65 kg/ha 18-46-0	680	370	440	**500 a**
65 kg/ha 18-46-0 32.5 kg/ha urea	690	620	590	**630 a**
AVERAGE	**680 a**	**500 a**	**520 a**	

Note: Rainfall during growing season was not recorded, estimated at 235 mm.
* Statistical analysis with Tukey's mean separation, $\alpha=0.05$

5.2.4 Farmer Perceptions of Bean Variety Performance

On the field day in Los Limones in December, farmers responded to questions about their perceptions of soil quality, bean performance and personal preferences for cultivation. When asked about the qualities of the soil where the beans were planted, the farmers identified soil properties that correspond to better production, albeit in their own vocabulary. Specifically, to explain that the soil has a better water holding capacity, one farmer said, "*Ese suelo tiene más barro, y agarra mejor el agua*" ("This soil has more clay, and holds onto the water better"). And to explain that the soil was richer in nutrients, different farmers at different times said that the soil had more "*vitaminas*" ("vitamins").

After asking how much the parcel had produced in the past, farmers were asked why they thought that piece of land produced that much. In every case, the farmers answered that it depended on the quantity of rain that fell that year. In the farmer survey in Los

Limones, farmers identified drought more often than any other factor as a very important constraint to increased common bean production in postrera.

At each experimental plot, the farmers were asked to examine all of the plots in one block (one replicate) and choose the best- and worst-producing plots (Table 26). Farmers always chose an Amadeus-77 plot as their example of the plot that would produce the least. In most cases they were correct that Amadeus-77 had the poorest production, and chose a plot that, if not the least production, was close to the worst. However, in the plot with the highest rainfall (Plot 1, Table 26), farmers chose an Amadeus-77 plot when the plot with the lowest production was actually of the local variety Marciano.

Table 26. Farmer belief about highest- and lowest-producing plots and actual production, rainfall and maximum yield, Los Limones, Morocelí, Honduras, Postrera, 2004.

	Highest yielding variety		**Lowest yielding variety**			
Plot	**Farmer belief**	**Actual production**	**Farmer belief**	**Actual production**	**60-day Rainfall (mm)**	**Max. yield* (kg/ha)**
1	Marciano	Seda	Amadeus-77	Marciano	124	974
2	Marciano	Seda	Amadeus-77	Amadeus-77	103	742
3	Seda	Seda	Amadeus-77	Amadeus-77	72	909
4	Seda	Seda	Amadeus-77	Amadeus-77	70	935
5	Marciano	Seda	Amadeus-77	Amadeus-77	107	742

*Maximum yield is the highest yield that the farmer could recall for that field since he had been farming it.

The reason that the farmers gave for the poor production of Amadeus-77 was that it produced more slowly then the traditional varieties by about 10 days, and thus performed poorly in drought conditions. Farmers also stated that Amadeus-77 was suffering from "*hielo*" ("blight," usually anthracnose), and that was another reason that it produced less. In truth, Amadeus-77 was not suffering any significant disease (except a little bacterial blight) (Figure 16), but rather dying back due to lack of water before reaching physiological maturity.

Figure 16. Amadeus-77 plants at 60 days post-sowing in Los Limones, Morocelí, Honduras, November 23, 2004.

It is probable that since farmers expected Amadeus-77 to produce poorly in all plots due to less than average rainfall, their judgment about what plants would produce poorly was clouded by this supposition. Their belief that the Amadeus-77 plants were suffering blight probably also contributed to their prejudice against the production abilities of Amadeus-77.

Farmers also stated that Seda was more resistant to drought than Marciano, and their decisions about what plants would produce the best reflected that: Farmers stated that Marciano would produce better in moderate drought conditions, and that Seda would produce better in more extreme drought conditions. This belief was incorrect: In every block where farmers looked at plants, there was at least one plot of Seda that produced better than every other plot.

Use of local variety Marciano became more popular in the community over the course of this work. In 2003, LARC members in Los Limones wanted to use local variety Seda as the variety of comparison with the improved variety Amadeus-77; in 2004, the LARC members wanted to use both Seda and Marciano for comparison, stating that Marciano was as good a producer as Seda, and in some cases better. This trend appears to be true for the entire community: according to 2003 survey data, 79% of farmers planted Seda, and only 26% had sown Marciano; one year later, only 55% of farmers were planting Seda, and 64% were sowing Marciano. Since Marciano was gaining in popularity yet was not as extensively cultivated in the community, farmers did not have much experience producing Marciano yet, and it could be that farmers had an exaggerated idea about the production potential of Marciano.

When asked which bean variety farmers would use to maximize their bean production based on their experiences in the past, all farmers stated that they would plant Seda and Marciano, insisting that these two varieties performed differently based on soil and rainfall, but that both produced well in their environments. They pointed to the plots sown with Amadeus-77 to explain why they do not have confidence in this variety, stating that they did not want to risk having a low yield in any year. Farmers in complex, diverse, risk-prone situations often try to minimize the maximum economic losses for all income-generating activities (a "minimax" strategy), so choosing a variety that produces some beans in both non-drought and drought years (i.e. a variety with a good yield stability over the range of local precipitation) instead of a variety that produces well in a non-drought year and poorly in a drought year is likely a rational management decision.

Researchers often idealize how much farmers understand about their farming systems and the potential and performance of their crops, even about basic skills like making yield comparisons by examining crops in the field. After all, farming these crops is a full-time profession for these men and women, and their skill as farmers in large part determines their survival. Yet these data indicate that the generalizations that farmers make about variety performance based on direct observation can be incorrect, and can bias farmers to the facts of variety performance.

Part of the bias may be explained by the way that farmers understand experimentation. Stolzenbach explains that farmers understand experimentation as "a continuous and innovative element of the craft of farming," and that farmers are not accustomed to looking at individual elements in an experiment, but rather perceive improvement in a farm activity as a continuous series of experiments, as "reflection in action" (Stolzenbach, 1994). It seems likely that farmers were responding to other cues in the field, like the perception of disease in the improved variety, which skewed their perception of plot yield.

5.2.5 Economic Analysis of Field Results

We can compare the strategy that most resembles the area's typical cropping system with the strategy that is recommended to the area's producers to see if the recommendation makes sense for the producers (Table 27). In the case of Los Limones in 2003, one would compare the traditional variety Seda, and 65 kg/ha 18-46-0 fertilizer, and no herbicide with the improved variety Amadeus-77, 130 kg/ha 18-46-0 fertilizer, and one pre-germination herbicide application. Savings from reduced weedings, initially expected from the use of the herbicide, was not included because the herbicide application was considered ineffective at the time of application (see section 4.1).

Table 27. Partial budget under traditional vs. recommended management, Los Limones, Morocelí, Honduras, Postrera, 2003 (N=9 plots).

Item	**Seda**	**Amadeus-77**
Variable costs		
18-46-0 fertilizer @ Lp 5.83 /kg	Lp 379 *65 kg/ha fertilizer*	Lp 758 *130 kg/ha fertilizer*
Urea fertilizer @ Lp 4.8 /kg		Lp 156 *32.5 kg/ha urea*
Paraquat application @ Lp 95 /L		Lp 136 *1.43 L herbicide*
Total variable costs	**Lp 379**	**Lp 1,050**
Additional investment		**Lp 671**
Revenue		
Weeding		(no savings expected)
Light red seed @ Lp 11 /kg	1,300 kg x Lp 11/kg = Lp 14,300	
Dark red seed @ Lp 10.5 /kg		1,810 kg x Lp 10.5 /kg =Lp 19,005
Total revenue	**Lp 14,300**	**Lp 19,005**
Additional returns		**Lp 4,705**

Note: 18.16 Lempiras (Lp) = 1.00 U.S. Dollar (January 1, 2005)

In this case the recommended variety Amadeus-77 plus the greater amount of fertilizer and herbicide was economically worthwhile because with the additional costs of Lp 671 per ha (cost of additional fertilizer and herbicide), the farmers receive an additional Lp 4,705. That is to say, farmers can expect, on average, a Lp 4,705 increase in income from the additional Lp 671 spent on extra inputs. The marginal benefit to cost ratio is 7.0

(Lp 4,705 / Lp 671), a seven-fold increase in returns with the additional investment of inputs.

In Los Limones in 2004, the traditional variety Seda with 65 kg/ha 18-46-0 fertilizer is compared against the improved variety Amadeus-77 with 130 kg/ha of 18-46-0 fertilizer without the addition of herbicide (Table 28).

Table 28. Partial budget under traditional vs. recommended management, Los Limones, Morocelí, Honduras, Postrera, 2004 (N=5 plots).

Item	**Seda**	**Amadeus-77**
Variable costs		
18-46-0 fertilizer at Lp 5.83 /kg	Lp 379 *65 kg/ha fertilizer*	Lp 758 *130 kg/ha fertilizer*
Urea fertilizer at Lp 4.8 /kg		Lp 272 *32.5 kg/ha urea*
Total variable costs	Lp 379	Lp 1,030
Additional investment		Lp 651
Revenue		
Light red seed @ Lp 11 /kg	410 kg x Lp 11 = Lp 4,510	
Dark red seed @ Lp 10.5 /qq		317 kg x Lp 10.5 = Lp 3,328.5
Total revenue	**Lp 4,510**	**Lp 3,328.5**
Additional returns		**(Lp 1,181.5)**

Note: 18.16 Lempiras (Lp) = 1.00 U.S. Dollar (January 1, 2005.

In this case, where drought resulted in low yields for both varieties, the traditional variety Seda out-yielded the improved variety Amadeus-77, and Seda proved more profitable. With the additional fertilizer costs of Lp 651 per ha, the farmers also lose Lp 1,181.5. The marginal benefit to cost ratio is -1.8 (Lp -1,181.5 / Lp 651), a decrease in returns with the improved variety and the additional fertilizer investment.

A similar comparison can be made with the data from Lavanderos. Looking at the data from Farmer 1 (the trial that showed significant differences due to variety and fertilizer use), the traditional variety Paraicito with 65 kg/ha 18-46-0 fertilizer is compared with the recommended variety Amadeus-77 and the same fertilizer plus the addition of 32.5 kg/ha urea fertilizer (Table 29).

Table 29. Partial budget under traditional vs. recommended management for Producer 1, 2004, Lavanderos, Güinope, Honduras.

Item	**Paraicito**	**Amadeus-77**
Variable costs		
18-46-0 fertilizer @ Lp 5.83 /kg	Lp 379 *65 kg/ha fertilizer*	Lp 379 *65 kg/ha fertilizer*
Urea fertilizer @ Lp 4.8 /kg		Lp 156 *32.5 kg/ha urea*
Additional cost of urea application @ 1 day/ha		Lp 50
Total variable costs	Lp 379	Lp 585
Additional investment		Lp 206
Revenue		
Light red seed @ Lp 11 /kg	1370 kg x Lp 11 = Lp 15,070	
Dark red seed @ Lp 10.5 /kg		420 kg x Lp 10.5 =4410 Lp
Total revenue	**Lp 15,070**	**Lp 4,410**
Additional returns		**(Lp 10,660)**

Note: 18.16 Lempiras (Lp) = 1.00 U.S. Dollar (January 1, 2005)

The difference in yield between Paraicito and Amadeus-77 for Farmer 1 in Lavanderos was large, and lead to a large difference in benefits for the traditional system over the recommended system. With the additional fertilizer and application costs of Lp 206 per ha, the farmers also lose Lp 10,660. The marginal benefit to cost ratio is -51.7 (Lp -10,660 / Lp 206), a large decrease in returns with the additional fertilizer investment and improved variety.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

This study concludes with a summary followed by recommendations for breeders and agronomists, extensionists, and policy makers. Limitations to the study and recommendations for future studies are also included.

6.1 Project Summary

Common beans are an important source of food for people worldwide, and have been for over two centuries. Securing profitable agricultural production for impoverished small-scale farmers is crucial for economic growth in developing countries, and research to eliminate production constraints is a useful tool to achieve this. Constraints research has two parts: surveys to identify constraints, and on-farm field trials to test solutions to production problems. A participatory methodology, like the Local Agricultural Research Committee model, blends well with constraints field trials while supporting other aspects of development, like better access to information, skills training and access to loans. Whereas modernization in Honduras has improved the economy in general, more must be done to specifically improve the lot of impoverished small-scale farmers. The Honduran government's plans to eradicate poverty in the rural sector are a step in the right direction.

In surveys taken in 2003 and 2004 in 6 communities in rural Honduras with small-scale producers, farmers identified drought as the largest constraint to production, followed by the lesser constraints of insects, disease, weeds and lack of fertilizer. Flooding and slugs were important constraints to a few farmers, and soil and seed quality were considered important to even fewer. Since farmers said they can adequately control insects and disease, research was focused on fertilizer and common bean variety to examine possible increases in production, and weed control to examine savings from field labor.

Experiments were designed to test the effect of traditional versus recommended inputs for bean production in on-farm trials. In 2003, four full factorial (four replications) and five supplemental trials (no replication) were sown to examine the effect of variety, fertilizer and herbicide use in a broadly agro-ecologically representative area of Honduras called Los Limones in the province of Morocelí. Factorial experiment results indicate that increased fertilizer causes a significant increase in yield in some cases; the supplemental experiments showed with 85% certainty that the recommended package of improved variety, increased fertilizer and herbicide increased yield. The results of an economic analysis indicated that the marginal benefit/cost ratio was 7.0 using the improved package of inputs.

In 2004, the factorial experiment was repeated without herbicide, with an additional traditional variety and with two additional fertilizer levels on seven farms (three farms with three replicates, two farms with one replicate). The additional fertilizer treatments were to try to identify the level of fertilizer that yielded the highest possible farmer income. Due to terminal drought, one early maturing traditional variety (60 day) out-yielded the improved, longer-season (70 day) variety on one farm and over all five farms. Fertilizer had no effect on yield under these drought conditions.

In 2004, a similar experiment was performed in another community called Lavanderos at a higher altitude, representative of another agro-ecological area. This experiment involved two farmers with two levels of fertilizer and three varieties (two improved and one traditional). Results from one farm indicate a slight decrease in yield after the midseason application of urea fertilizer; and a much higher yield from the traditional variety compared to the improved varieties.

On a field day in 2005, farmers in Los Limones were asked to assess bean production in each experimental plot. Farmers misidentified the worst-producing plot in one case, believing that the improved variety Amadeus-77 produced the least instead of the local variety Marciano; and attributed the apparent poor production to blight when the plants were in fact only drying down early from drought stress. Farmers also misattributed the best production to the local variety Marciano three times, when in fact the other local variety Seda had produced the most. Misidentifications of bean variety production were likely due to variety biases that farmers had based on observations in other contexts. Misperceptions about bean variety performance on the part of the farmers emphasize the importance of collaborative strategies for development of new bean varieties. Not only do farmers lack some technical skills that would aid them in making better management decisions (like the ability to identify disease and understand effective treatments), but also prejudices based on experiences that are generalized from similar but not identical experiences (like assuming that improved varieties always do poorly in drought conditions).

Surveys revealed some information relevant to agronomic and economic recommendations. Farmers usually save seed, and one in ten farmers reported seed-borne anthracnose as important diseases in 2003 and 2004, with similar numbers for mosaic viruses, so farmers likely underestimate the importance of seed quality. Planting densities varied, and many farmers would benefit from a higher planting density, up to 60 kg/ha. About half of the farmers fertilized at planting, which may result in an economic loss in drought conditions; farmers that split applications or apply fertilizer later in the season can decide not to apply if the crop is suffering a debilitating drought. No farmers used a *Rhizobium* inoculant, a practice that can greatly increase production in the absence of sufficient fertilizer (Giller, 2001).

About half of the farmers do not own the land they use for beans, precluding the use of land as capital in these cases. Farmers most commonly relied on local sources for loans, and far fewer took loans from intermediaries. Farmers were generally wary of credit.

Members of local agricultural research committees (LARCs) reported access to technical information as an important benefit, along with access to loans, group cohesion, help for their communities, and other educational opportunities. These benefits, however, were not correlated to other production or economic benefits.

Half or more of farmers surveyed identified marketability and high production as the important characteristics of their preference for traditional varieties.

6.2 Breeding and Agronomic Recommendations

This study emphasizes the need for common bean varieties that produce well in environments that are typical *and* in environments that are prone to terminal drought, such as early maturity (drought avoidance) or some form of drought tolerance. Farmers also desire improved varieties that have market characteristics similar to their traditional varieties, especially color and size.

These results also indicate that farmers would benefit from raising their planting densities to 50-60 kg of viable seed per hectare to maximize economic yield, and wait to apply some fertilizer until the first weeding in order to assure that there is enough rainfall so that plants can take up the nutrients provided my fertilizer. Three of the five replicated factorial trials showed a significant increase in yield due to fertilizer (two in 2003 and one in 2004), so increased fertilizer use for very low-input farmers to up to 26.8 kg nitrogen/ha can be recommended with the expectation of a yield increase in more situations than not. Results from 2003 indicate that packages of improved technologies most likely benefit farmers on average, and that improved plant varieties have potential to improve farm profitability.

Some farmers in the survey used foliar sprays made from local materials; a few farmers also used green manures, despite the loss of production this rotation entailed. Crop rotation, conservation tillage and practices that increase soil organic matter can also have highly beneficial results for farmers, and should be recommended when appropriate.

6.3 Extension Recommendations

Farmers have a unique and detailed understanding of their own environments, but lack skills in some areas that would make them better farmers. Learning formalized experimental methods, and understanding the theory behind crop system ecology (like pest and disease cycles) and newer technologies (like how pesticides are different and when to use them most effectively) would help farmers make better decisions about their own local situations.

Support of farmer experimentation with the use of low-cost technologies like cover crops, soil conservation and locally-made foliar fertilizers and insecticides may also help farmers increase their profitability and take advantage of low-input technologies.

6.4 Policy Recommendations

Many farmers in this study (22%) perceive themselves without loan options for the purchase of farm inputs for common bean production; and other farmers are resistant to the idea of taking a loan even when an option is available. Understanding farmer reticence to debt accumulation would be useful in order to relax that constraint once farmers decide how to increase production. Creating the conditions for loan taking, such as changing community norms, ensuring collateral, providing insurance, increasing opportunities to take loans, and other factors can help the development of policy to increase agricultural production through the purchase of effective technologies that are currently unaffordable. Some kind of crop insurance, if it can be profitably conceived, would possibly help farmers in risky production areas. Local banks may also be part of the solution since farmers often increase borrowing when local banks are available (Dunn and Arbuckle, 2001; Jain, 1996).

6.5 Limitations to the Study

On-farm research typically has a very large amount of variability between farms, thus requires many replications in order to observe a trend in the experimental variables. The applicability of the constraints methodology, an on-farm methodology, depends in large part on the number of replicates. With only nine replicates in 2003, and five in 2004, being able to identify significant differences in yield due to management practices was difficult. Future constraints studies would benefit from increasing the number of farms, especially the more cost-effective supplemental experiments that do not require much follow-up. Because of the year-to-year difference in rainfall, studies that are conducted over many years also help to refine understanding of responses to inputs under different moisture regimes.

The large differences in responses to inputs between farms beg the question of whether the constraints methodology used for making blanket recommendations to farmers is useful in this situation. In areas where soil and water resources are more homogeneous, being able to make generalizations about production is useful for the farmers that live in that agro-ecosystem. This was the case with Southeast Asian rice producers with irrigation where the constraints methodology was developed. In areas where conditions are quite variable and out of the practical control of the farmers, one may be able to make generalizations about production on an "average farm," but when applied to individual cases, individual farmers may not be better off with the recommended technology. This is perhaps the case in this study: even on farms with four replicates (2003), fertilizer had a significant effect in only two of four cases, and no differences due to variety were evident. However, when analyzed together, nine farms in the same area showed an effect due to variety and fertilizer. This result makes it tempting to recommend that all farmers use more fertilizer and an improved variety. If farmers in a given community pooled all of their bean harvests and divided their profits, such recommendations make perfect sense; when considered as separate entities, farmers benefit more with a strategy tailored to his or her farm, with some farms using the package of technology that is recommended, and other using parts or none of it.

How can farmers come to know their specific agro-ecological situations better, and decide whether to use the technologies that are available to them? When the constraints methodology is used as a way of involving farmers in the research process so that they can develop an understanding of how technologies perform on their specific farms, farmers learn to make decisions based on their own agro-ecosystems. The addition of the LARC technique to the constraints methodology created a community-wide dynamic where technologies could be vetted by interested "early adaptor" and "innovator" farmers and discussed in a community forum for the diffusion of the appropriate technologies, and advice based on the experiences of individual farmers as well as the LARC group as a whole.

Whereas no differences between LARC members and non-LARC members were identified in this study, more survey questions might have elucidated differences. For example, research with LARCs in Honduras have noted higher participation in leadership positions (Humphries et al., 2000), and stronger group leadership, knowledge of research methodologies, use of improved varieties, and implementation of sustainable farming practices (Zurita Ramírez, 2003).

This study lacked some important information to truly understand the dynamics proposed in the objectives. For example, did water availability explain all of the variability in yield? If not, what other factors played a role, and how does that effect whether a farmer should consider the use of a given technology? Rainfall did not explain yield very well, but total water availability might, so the inclusion of data that predicts water use would be helpful (especially soil water content at the beginning of the season, but also estimations of solar radiation, and minimum and maximum air temperatures, all of which can be recorded by a farmer or school).

The data from this study show that very few farmers in this group had adopted improved varieties. Although farmers were asked why they preferred traditional varieties, more could be known about why these farmers have not adopted newer varieties. Poor performance of improved varieties in Los Limones in 2004 gives a hint about why farmers in low-rainfall areas are reluctant to plant them, but questions to get at this were not included in the survey *per se*. Also, most major gains seen by improved varieties are in areas that are highly affected by Bean Golden Yellow Mosaic Virus (BGYMV) (Mather et al., 2003), and this study area did not register a large BGYMV intensity. The conclusions about variety performance in this study, thus, should be interpreted as relevant for areas where BGYMV is not considered important.

6.6 Future Research

Current improved varieties are not as tolerant to drought as local, traditional varieties. *Breeding for beans that perform well in drought situations is worthwhile,* especially considering the world-wide shift of beans to drier and less fertile environments. This would be an interesting task for participatory breeding since drier regions are often also more diverse, complex and risk-prone.

No single variety will perform well in every situation. The agronomic trials in 2003 indicate that improved variety and greater fertilizer application may result in higher yields in years with adequate moisture. Unfortunately, it is impossible to know if a drought will occur in a given *postrera* season. However, it is possible to use historical rainfall data to predict over a long period of time how frequent droughts will occur. Given this data, ***it is possible to determine whether there it is possible to plant some area to a traditional, drought-tolerant variety and the remaining area to an improved (though less drought-tolerant) variety to maximize the production and economic returns in a farming system*** over a longer period of time.

Farmers do not use a nitrogen-fixing *Rhizobium* inoculant. Although present in other areas, *Rhizobium* inoculants are not used by the small-scale common bean farmers in south-central Honduras, nor do they appear to be in the soil. *Rhizobium* inoculants have high potential to increase bean yields, especially in the absence of mineral fertilizers. *Research into the use of these inoculants should be done.*

Small-scale farmers are not using all of the low-input technologies available to them. *Low-cost techniques that take advantage of natural processes and changes to the physical growing environment should be tested and promoted to give farmers a "toolbox" of techniques* to use to increase production and profits. These include soil conservation techniques, organic fertilizers, cover crops, integrated pest management and other techniques used in low-input and organic agriculture.

APPENDICES

APPENDIX 1

Summary of Adopted Adjustment Measures

Exchange Rate Liberalization. The fixed exchange rate was abandoned, and a flexible mechanism to determine the rate of exchange was adopted. At the present time this rate is adjusted on the basis of differences between expected domestic inflation in Honduras and that its major trading partners, together with an auction system.

Liberalization of Internal Trade. Various price controls were eliminated for agricultural and non-agricultural products.

Interest Rate Liberalization. This was a gradual proves that ended in November 1992. This liberalization sought to achieve positive real interest rates that would help mobilize savings and provide a larger supply of loaned funds.

External Openness. The country achieve full membership in the General Agreement I Tariffs and Trade (GATT) and full entry into the World Trade Organization (WTO); non-tariff trade barriers were eliminated; tariffs were reduced from a maximum of 90% to a range of 5-20% and the process of regional tariff unification has advanced.

Fiscal Sector. Tax-revenue administration and restructuring and simplification of the tax system was initiated simultaneously with a search for better incentives to investment. Recent major changes (April 1998) are: 1) a reduction of the marginal tax rate from 42% to 25% and increased tax exemptions for individuals; 2) an increase in the sales tax from 7% to 12%; and 3) a significant reduction in export taxes. In 1997, a tax code was approved that establishes an integrated legal framework for the tax system, including general principles, administrative norms and sanctions that include prison.

[from (International Monetary Fund and International Development Fund, 2001).]

APPENDIX 2

Principal Constraints for Agricultural Development

Taking advantage of agricultural export markets can be one component in a healthy agricultural sector. In 2003, the World Bank identified constraints to economic development via the agricultural sector in Honduras, and stated that these must be overcome for the country to become competitive in the high value agricultural sector. These constraints were:

- Low productivity and diversification
- Low adaptation of technology
- Lack of skilled labor
- High costs of distribution
- Lack of integration between small farmers and distribution firms
- Trade restrictions in Central America
- High barriers to entry into the USA
- Lack of systems to certify food safety
- Lack of credit for small producers
- Lack of land tenure and titling
- Lack of general support for these changes

(World Bank, 2003)

APPENDIX 3

Survey in 2003 for Los Limones

No del Productor______

Parte 1: Primera 2003

I. CARACTARISTICAS DEL TERRENO

Primero me gustaría preguntarle acerca de cada uno de los lotes sembrados con frijol en la Primera 2003.

Cúal era:

- **el área?**
- **la unidad del área (e.g. metros cuadrados, tareas, manzanas)?**
- **la pendiente?**
- **la distancia de su casa (minutos o kilómetros)?**
- **la calidad del suelo?**
- **el tenencia del lote?**
- **Cuál es el área total de los terrenos que cultiva, frijoles y otros?** ______________________

Lote	Area	Unidad	Pendiente	Distancia	Calidad del Suelo	Tenencia
Lote más grande				___ minutos o ___ km		
Segundo lote más grande				___ minutos o ___ km		
Tercero lote más grande				___ minutos o ___ km		

Códigos:

Pendiente: *1=plano, 2=empinado, 3=muy empinado* ***Distancia:*** *minutos o km de la casa del productor*

Calidad del suelo: *1=bueno, 2=normal/típico de la región, 3=pobre* ***Tenencia:*** *1=propia, 2=prestado, 3=alquilado, 4=ocupado/sin consentimiento*

No del Productor______

II. INSUMOS Y RENDIMIENTO DE LOS LOTES DE FRIJOL

2.1 **Ahora me gustaría preguntarle acerca de la semilla que usó durante Primera 2003.**

- **Qué variedad de frijol sembró? Porque?** ______________________________
- **Lo sembró en relevo o asociado con otra cultivo?**
- **Cuánta área sembró con esta variedad?**
- **Cuál es la unidad de medida?**
- **De dónde obtuvo esta semilla?**
- **Encontramos algunos productores que hacen una prueba de germinación y otros que no lo hacen. Qué hace usted?**
  ____
- **Seleccionó las semillas? En qué momento?** ______________________________
- **Qué cantidad de semilla sembró en este área?**
- **Cuál fue el rendimiento de este lote?**
- **Cuál es la unidad del área (e.g. metros cuadrados, tareas, manzanas)?**
- **Qué destino se dará a la cosecha?**

Lote	**Variedad de frijol**	**Asociación**	**Area sembrado**	**Uni dad**	**Fuente de semilla**	**Cantidad de semilla**	**Rendi miento**	**Uni dad**	**Destino**
Lote más grande									
Segundo lote más grande									
Tercero lote más grande									

Códigos:

Fuente de semilla: *1=cosechas anteriores, 2=semilla de otro productor, 3=semilla de alguna ONG/Proyecto, 4=comprada en una agrocomercial, 5=otro (describa)*

No del Productor______

2.2 **Ahora me gustaría preguntarle acerca de su método de preparación del suelo y fertilización en sus lotes en Primera 2003.**

- **Cómo preparó el suelo?**
- **Utilizó fertilizantes?**
- **Cuáles fertilizantes utilizó? Porque estos y no otros?** ________________
- **Cuánto de cada fertilizante utilizó?**
- **Cuándo aplicó los fertilizantes? Porqué en este momento y no otro?**

____

- **Algunos productores usan un producto que se llama inoculante y otros no. Este producto ayuda a las raíces de las plantas de frijol a crecer mejor. Utilizó un inoculante de frijol durante la siembra?**

Lote	**Preparación de suelo**	**Uilizó fertilizante (indicar)**	**Tipo de fertilizante**	**Cantidad (kg)**	**Periodo de aplicación**		**Uso de inoculante (indicar)**
Lote más grande		no sí					no sí
Segundo lote más grande		no sí					no sí
Tercero lote más grande		no sí					no sí

<u>Códigos:</u>

Preparación del suelo: *1=preparación manual, 2=tracción animal, 3=tractor, 4=no preparó, 5=otro (especificar)*

Periodo de aplicación: *1=presiembra, 2=a la siembra, 3=después de germinar, 4=a la floración, 5=otro (especificar)*

No del Productor______

2.3 **Ahora me gustaría preguntarle acerca de su estrategia de control de malezas en Primera 2003.**

- **Cuántas veces desmalezó a mano?**
- **Cuántos días después de la siembra desmalezó?**
- **Aplicó herbicida? Porque no?** ____
- **Cuál herbicida aplicó? Porqué este y no otro?** ____
- **Cuándo aplicó el herbicida?**

Lote	**Veces desmalezó a mano**	**Días después de la germinación que desmalezó**		**Uso de herbicida (indicar)**	**Nombre de herbicida**	**Periodo de aplicación**	
Lote más grande				no sí			
Segundo lote más grande				no sí			
Tercero lote más grande				no sí			

Código:

Periodo de aplicación: *1=presiembra, 2=a la siembra, 3=después de germinar, 4=otro (describa)*

No del Productor______

2.4 **Ahora me gustaría preguntarle acerca de otros agroquímicos que usó en Primera 2003.**

- **Habían plagas en el lote de frijol? Cuáles eran?**
- **Aplicó algún plaguicida a causa de estas plagas?**
- **Cuáles plaguicidas eran? Porque este producto y no otros?**______________________________
- **Habían algunos ataques de enfermedades? Cuáles eran?**
- **Cuáles productos utilizó? Porque estos productos no otros?**______________________________
- **Cuándo aplicó estos productos?**

Lote	**Plagas**	**Uso de plaguicida (indicar)**	**Nombre de la plaguicida**	**Enfermedades**	**Uso de producto (indicar)**	**Nombre del producto**	**Periodo de aplicación**
Lote más grande		no sí			no sí		
		no sí			no sí		
Segundo lote más grande		no sí			no sí		
		no sí			no sí		
Tercero lote más grande		no sí			no sí		
		no sí			no sí		

Periodo de aplicación: *1=presiembra, 2=a la siembra, 3=después de germinar, 4=a la floración, 5=otro (especificar)*

No del Productor______

III. DATOS SOCIOECONOMICOS

3.1 **Ahora me gustaría preguntarle acerca de los miembros de la familia que ayudaron con los terrenos de frijol en Primera 2003.**

- **Cuántas personas tiene la familia? Qué edad tienen los niños? (Personas que tienen más que 15 años de edad se consideran adultos.)**
- **De estas personas, quien asistió en la preparación de terreno?**
- **Quién asistió en la siembra del terreno?**
- **Quién asistió en el deshierbe del terreno?**
- **Quién asistió en la cosecha del terreno?**

	Adultos	**Adultas**	**Niños**	**Niñas**
Total en la familia				
Preparación de suelo				
Siembra				
Deshierbe				
Cosecha				

No del Productor______

3.2 **Ahora me gustaría preguntarle acerca de la mano de obra que contrató en Primera 2003.**

- **Contrató mano de obra en Primera 2003?**
- **Para qué operaciones del producción contrató mano de obra?**

Lote	**Uso de mano de obra contratada (indicar)**	**Operación de producción (indicar)**
Lote más grande	no sí	PS S D C T
Segundo lote más grande	no sí	PS S D C T
Tercero lote más grande	no sí	PS S D C T

Código:

Operaciones de producción: *PS=Preparación de suelo, S=Siembra, D=Deshierbe, C=Cosecha, T=Trasporte*

IV. LIMITACIONES A LA PRODUCCION

En sus terrenos, cuáles son los factores más importantes que garantizan mayores rendimientos de frijol en primera? (Mostrar la hoja con los diferentes factores y dar 20 frijoles al productor para colocarlos donde hay más énfasis.)

Sequía		**Enfermedades**		**Fertilizante**	
Malezas		**Calidad de Semilla**		**Inundación**	
Insectos		**Calidad de Suelo**			

Parte 2: Postrera 2003

I. CARACTARISTICAS DEL TERRENO

Primero me gustaría preguntarle acerca de cada uno de los lotes sembrados con frijol en la Postrera 2003. Cuál era:

- **el área?**
- **la unidad del área (e.g. metros cuadrados, tareas, manzanas)?**
- **la pendiente?**
- **la distancia de su casa (minutos o kilómetros)?**
- **la calidad del suelo?**
- **el tenencia del lote?**
- **Cuál es el área total de los terrenos que cultiva, frijoles y otros?**___________________________

Lote	Area	Unidad	Pendiente	Distancia	Calidad del Suelo	Tenencia
Lote más grande				___ minutos o ___ km		
Segundo lote más grande				___ minutos o ___ km		
Tercero lote más grande				___ minutos o ___ km		

Códigos:

Pendiente: *1=plano, 2=empinado, 3=muy empinado* ***Distancia:*** *minutos o km de la casa del productor*

Calidad del suelo: *1=bueno, 2=normal/típico de la región, 3=pobre* ***Tenencia:*** *1=propia, 2=prestado, 3=alquilado, 4=ocupado/sin consentimiento*

No del Productor______

II. INSUMOS Y RENDIMIENTO DE LOS LOTES DE FRIJOL

2.1 **Ahora me gustaría preguntarle acerca de la semilla que usó durante Primera 2003.**

- **Qué variedad de frijol sembró? Porque?** ____________________
- **Lo sembró en relevo o asociado con otra cultivo?**
- **Cuánta área sembró con esta variedad?**
- **Cuál es la unidad de medida?**
- **De dónde obtuvo esta semilla?**
- **Encontramos algunos productores que hacen una prueba de germinación y otros que no lo hacen. Qué hace usted?** ____________________
- **Seleccionó las semillas? En qué momento?** ____________________
- **Qué cantidad de semilla sembró en este área?**
- **Cuál fue el rendimiento de este lote?**
- **Cuál es la unidad del área (e.g. metros cuadrados, tareas, manzanas)?**
- **Qué destino se dará a la cosecha?**
-

Lote	**Variedad de frijol**	**Area sembrado**	**Uni dad**	**Fuente de semilla**	**Prueba de germinación (indicar)**	**Cantidad de semilla**	**Rendim iento**	**Uni dad**	**Destino**
Lote más grande					no sí				
					no sí				
Segundo lote más grande					no sí				
					no sí				
Tercero lote más grande					no sí				
					no sí				

Códigos:

Fuente de semilla: *1=cosechas anteriores, 2=semilla de otro productor, 3=semilla de alguna ONG/Proyecto, 4=comprada en una agrocomercial, 5=otro (describa)*

No del Productor______

2.2 **Ahora me gustaría preguntarle acerca de su método de preparación del suelo y fertilización en sus lotes en Postrera 2003.**

- **Cómo preparó el suelo?**
- **Utilizó fertilizantes?**
- **Cuáles fertilizantes utilizó? Porque estos y no otros?** ______________________________
- **Cuánto de cada fertilizante utilizó?**
- **Cuándo aplicó los fertilizantes? Porqué en este momento y no otro?**
  ____
- **Algunos productores usan un producto que se llama inoculante y otros no. Este producto ayuda a las raíces de las plantas de frijol a crecer mejor. Utilizó un inoculante de frijol durante la siembra?**

Lote	**Preparación de suelo**	**Uilizó fertilizante (indicar)**	**Tipo de fertilizante**	**Cantidad (kg)**	**Periodo de aplicación**		**Uso de inoculante (indicar)**
Lote más grande		no sí					no sí
Segundo lote más grande		no sí					no sí
Tercero lote más grande		no sí					no sí

Códigos:

Preparación del suelo: *1=preparación manual, 2=tracción animal, 3=tractor, 4=no preparó, 5=otro (especificar)*

Periodo de aplicación: *1=presiembra, 2=a la siembra, 3=después de germinar, 4=a la floración, 5=otro (especificar)*

No del Productor______

2.3 **Ahora me gustaría preguntarle acerca de su estrategia de control de malezas en Postrera 2003.**

- **Cuántas veces desmalezó a mano?**
- **Cuántos días después de la siembra desmalezó?**
- **Aplicó herbicida? Porque no?** ____
- **Cuál herbicida aplicó? Porqué este y no otro?** ____
- **Cuándo aplicó el herbicida?**

Lote	**Veces desmalezó a mano**	**Días después de la germinación que desmalezó**		**Uso de herbicida (indicar)**	**Nombre de herbicida**	**Periodo de aplicación**	
Lote más grande				no sí			
Segundo lote más grande				no sí			
Tercero lote más grande				no sí			

Código:

Periodo de aplicación: *1=presiembra, 2=a la siembra, 3=después de germinar, 4=otro (describa)*

No del Productor______

2.4 Ahora me gustaría preguntarle acerca de otros agroquímicos que usó en Postrera 2003.

- **Habían plagas en el lote de frijol? Cuáles eran?**
- **Aplicó algún plaguicida a causa de estas plagas?**
- **Cuáles plaguicidas eran? Porque este producto y no otros?**________________________
- **Habían algunos ataques de enfermedades? Cuáles eran?**
- **Cuáles productos utilizó? Porque estos productos no otros?**________________________
- **Cuándo aplicó estos productos?**

Lote	**Plagas**	**Uso de plaguicida (indicar)**	**Nombre de la plaguicida**	**Enfermedades**	**Uso de producto (indicar)**	**Nombre del producto**	**Periodo de aplicación**
Lote más grande		no sí			no sí		
		no sí			no sí		
Segundo lote más grande		no sí			no sí		
		no sí			no sí		
Tercero lote más grande		no sí			no sí		
		no sí			no sí		

Periodo de aplicación: *1=presiembra, 2=a la siembra, 3=después de germinar, 4=a la floración, 5=otro (especificar)*

No del Productor______

III. DATOS SOCIOECONOMICOS

3.1 **Ahora me gustaría preguntarle acerca de los miembros de la familia que ayudaron con los terrenos de frijol en Postrera 2003.**

- **Cuántas personas tiene la familia? Qué edad tienen los niños? (Personas que tienen más que 15 años de edad se consideran adultos.)**
- **De estas personas, quien asistió en la preparación de terreno?**
- **Quién asistió en la siembra del terreno?**
- **Quién asistió en el deshierbe del terreno?**
- **Quién asistió en la cosecha del terreno?**

	Adultos	Adultas	Niños	Niñas
Total en la familia				
Preparación de suelo				
Siembra				
Deshierbe				
Cosecha				

No del Productor______

3.2 **Ahora me gustaría preguntarle acerca de la mano de obra que contrató en Postrera 2003.**

- **Contrató mano de obra en Postrera 2003?**
- **Para qué operaciones del producción contrató mano de obra?**

Lote	**Uso de mano de obra contratada (indicar)**	**Operación de producción (indicar)**
Lote más grande	no sí	PS S D C
Segundo lote más grande	no sí	PS S D C
Tercero lote más grande	no sí	PS S D C

Código:
Operaciones de producción: *PS=Preparación de suelo, S=Siembra, D=Deshierbe, C=Cosecha*

3.3 **Ahora me gustaría preguntarle sobre si mismo.**

- **Usted se considera un productor de tiempo completo? (indicar) no sí**
- **Usted tiene otro trabajo fuera de la finca durante Postrera? (indicar) no sí**
- **Cuántos años asistió en la escuela? ________ años.**

No del Productor______

IV. LIMITACIONES A LA PRODUCCION

En sus terrenos, cuáles son los factores más importantes que garantizan mayores rendimientos de frijol en postrera? (Mostrar la hoja con los diferentes factores y dar 20 frijoles al productor para colocarlos donde hay más énfasis.)

Sequía		**Enfermedades**		**Fertilizante**	
Malezas		**Calidad de Semilla**		**Inundación**	
Insectos		**Calidad de Suelo**		**Babosas**	

Usted tiene la intención de usar los mismos insumos con el cultivo de frijol en Primera 2004 que usó en Primera 2003? (indicar) no sí

Si la respuesta es no,

- **utilizará otra semilla? (indicar) no sí Si responde sí, describa:________________________**
- **utilizará otro fertilizante? (indicar) no sí Si responde sí, describa:________________________**
- **utilizará estrategia de manejo de malezas? (indicar) no sí Si responde sí, describa:________________________**
- **Hay otro factor que yo no mencioné? (indicar) no sí Si responde sí, describa:________________________**

GRACIAS POR SU PARTICIPACION

APPENDIX 4

Survey in 2004 for Los Limones

No del Productor______

Postrera 2004

I. CARACTARISTICAS DEL TERRENO

Primero me gustaría preguntarle acerca de cada uno de los lotes sembrados con frijol este año. Por favor hágame un dibujo de los lotes que siembró con frijol en Postrera este año. Cuál era:

- **el área? (incluir la unidad del área, e.g. tareas, manzanas)**
- **la pendiente?**
- **la distancia de su casa (minutos o kilómetros)?**
- **la calidad del suelo?**
- **la tenencia del lote?**
- **Cuál es el área total de los terrenos que cultiva, frijoles y otros? Dentro de estos terrenos, cuánto es su propio terreno?**
- **Se habla de una rotación de cultivos, es decir, una serie de cultivos sembrados juntos y de una manera seguida. Usted tiene rotaciones típicas? Si usted usa rotaciones de cultivos, explíqueme como son.**

Lote	**Area**	**Unidad**	**Pendiente**	**Distancia**	**Calidad del Suelo**	**Tenencia**
Lote más grande				___ min o ___ km		
Segundo lote más grande				___ min o ___ km		
Tercero lote más grande				___ min o ___ km		
Area total que cultiva			XXXXX	XXXXXXXXXXX	XXXXXXX	XXXXX
Area propia			XXXXX	XXXXXXXXXXX	XXXXXXX	XXXXX

Códigos:

Pendiente: *1=plano, 2=empinado, 3=muy empinado* ***Distancia:*** *minutos o km de la casa del productor*

Calidad del suelo: *1=bueno, 2=normal/típico de la región, 3=pobre* ***Tenencia:*** *1=propia, 2=prestado, 3=alquilado, 4=ocupado/sin consentimiento*

Rotaciones y asociaciones de cultivos:

No del Productor______

II. INSUMOS Y RENDIMIENTO DE LOS LOTES DE FRIJOL

2.1 Ahora me gustaría preguntarle acerca de la semilla que usó y el destino de la cosecha de este Postrera.

- **Qué variedad de frijol sembró?**
- **Lo sembró en relevo o asociado con otra cultivo?**
- **Cuánto de área sembró usted con esta variedad? (incluir la unidad del área)**
- **De dónde obtuvo esta semilla?**
- **Qué cantidad de semilla sembró en este área? (incluir la unidad de peso)**
- **Cuánto de frijol produjo este lote? (incluir la unidad de peso)**
- **Encontramos algunos productores que hacen una prueba de germinación y otros que no lo hacen. Qué hace usted?** ____________________
- **Algunos productores seleccionan las mejores semillas para la siguiente siembra, y otros siembran la semilla como es. Qué hace usted? Si selecciona semilla, en qué momento lo hace?** ____________________
- **En total, cuánto de frijol cosechó usted este año? (incluir unidades de peso)**__________________
- **De todo el frijol que usted cosechó este año, usted comercializó algo? Si fue así, cuánto se comercializó? (incluir unidades de peso)**__________________ **A qué precio?** ____________________
- **A quién se vendió los frijoles?**____________________ **Cuántas compradores hay en su comunidad?** ______
- **Usted vendió frijoles, y luego compró?** ____________________

Lote	Variedad de frijol	Asoc.	Area sembrado	Unidad	Fuente-semilla	Cantidad de semilla	Unidad	Rendimiento	Unidad	Comprador
Lote más grande										
Segundo lote más grande										
Tercero lote más grande										

Códigos: ***Fuente de semilla:*** *1=cosechas anteriores, 2=semilla de otro productor, 3=semilla de alguna ONG/Proyecto, 4=comprada en una agrocomercial, 5=otro (describa)* ***Comprador:*** *1=intermediario, 2=tienda en la ciudad, 3=otro granjero, 4=otro (describir)*

No del Productor______

2.2 Ahora me gustaría preguntarle acerca de su método de preparación del suelo y fertilización en sus lotes en este Postrera.

- **Cómo preparó el suelo?**
- **Utilizó fertilizantes?**
- **Cuáles fertilizantes utilizó?**
- **Cuánto de cada fertilizante utilizó? Cuánto costó?**
- **Cuándo aplicó los fertilizantes?**
- **Algunos productores usan un producto que se llama inoculante y otros no. Este es un polvo negro que ayuda a las raíces de las plantas de frijol a crecer mejor. Utilizó un inoculante de frijol durante la siembra?**
- **Cuando usted quiere saber más sobre las fertilizantes disponibles, dónde busque usted esta información?**

Lote	**Preparación de suelo**	**Uilizó fertilizante (indicar)**	**Tipo de fertilizante**	**Cantidad (kg)**	**Precio**	**Periodo de aplicación**		**Uso de inoc. (indicar)**	**Fuente de inform.**
Lote más grande		no sí						no sí	
Segundo lote más grande		no sí						no sí	
Tercero lote más grande		no sí						no sí	

Códigos:

Preparación del suelo: *1=preparación manual, 2=tracción animal, 3=tractor, 4=no preparó, 5=otro (especificar)*

Periodo de aplicación: *1=presiembra, 2=a la siembra, 3=después de germinar, 4=a la floración, 5=otro (especificar)*

Fuente de información: *1=amigo, 2=agropecuaria, 3=DICTA. 4=EAP, 5=otro (describir)*

No del Productor______

2.3 Ahora me gustaría preguntarle acerca de su estrategia de control de malezas en este Postrera.

- **Cuántas veces desmalezó a mano?**
- **Cuántas personas trabajaron para desmalezar todo el lote?**
- **Cuántos días trabajaron para terminar el desmalezar?**
- **Cuántos días después de la siembra desmalezó?**
- **Aplicó herbicida?**
- **Cuál herbicida aplicó?**
- **Cuándo aplicó el herbicida?**
- **Cuando usted quiere saber más sobre los herbicidas disponibles, dónde busque usted esta información?**

Lote	**Veces desmalezó a mano**	**Personas-días**	**Días después de la germinación que desmalezó**	**Uso de herbicida (indicar)**	**Nombre de herbicida**	**Periodo de aplicación**		**Precio**	**Fuente de inform.**
Lote más grande				no sí					
Segundo lote más grande				no sí					
Tercero lote más grande				no sí					

Código:

Periodo de aplicación: *1=presiembra, 2=a la siembra, 3=después de germinar, 4=otro (describa)*

Fuente de información: *1=amigo, 2=agropecuaria, 3=DICTA. 4=EAP, 5=otro (describir)*

No del Productor______

2.4 Ahora me gustaría preguntarle acerca de otros agroquímicos que usó en Postrera 2003.

- **Habían plagas en el lote de frijol? Cuáles eran?**
- **Aplicó algún plaguicida a causa de estas plagas?**
- **Cuáles plaguicidas eran? Cuánto costaron? Cuánto de la plaguicida usó en el cultivo?**
- **Cuando usted quiere saber más sobre los plaguicidas disponibles, dónde busque usted esta información?**

Lote	Plagas	Uso de plaguicida (indicar)	Nombre de la plaguicida	Precio por unidad	Cantidad de producto usado	Fuente de información
Lote más grande		no sí				
		no sí				
Segundo lote más grande		no sí				
		no sí				
Tercero lote más grande		no sí				
		no sí				

Fuente de información: *1=amigo, 2=agropecuaria, 3=DICTA. 4=EAP, 5=otro (describir)*

- **Habían algunos ataques de enfermedades? Cuáles eran?**
- **Cuáles productos utilizó?**
- **Cuándo aplicó estos productos?**
- **Cuando usted quiere saber más sobre los fungicidas disponibles, dónde busque usted esta información?**

Lote	Enfermedades	Uso de producto (indicar)	Nombre del producto	Periodo de aplicación	Precio por unidad	Cantidad de producto usado	Fuente de información
Lote más grande		no sí					
		no sí					
Segundo lote más grande		no sí					
		no sí					
Tercero lote más grande		no sí					
		no sí					

Periodo de aplicación: *1=presiembra, 2=a la siembra, 3=después de germinar, 4=a la floración, 5=otro (especificar)*
Fuente de información: *1=amigo, 2=agropecuaria, 3=DICTA. 4=EAP, 5=otro (describir)*

No del Productor______

III. DATOS SOCIOECONOMICOS

3.1 Ahora me gustaría preguntarle acerca de los miembros de la familia que ayudaron con los terrenos de frijol en Postrera 2003.

- **Cuántas personas tiene la familia? Qué edad tienen los niños? (Personas que tienen más que 15 años de edad se consideran adultos.)**
- **De estas personas, quien asistió en la preparación de terreno?**
- **Quién asistió en la siembra del terreno?**
- **Quién asistió en el deshierbe del terreno?**
- **Quién asistió en la cosecha del terreno?**

	Adultos	Adultas	Niños	Niñas
Total en la familia				
Preparación de suelo				
Siembra				
Deshierbe				
Cosecha				

3.2 Ahora me gustaría preguntarle acerca de la mano de obra que contrató en Postrera 2003.

- **Contrató mano de obra en Postrera 2003?**
- **Para qué operaciones del producción contrató mano de obra? A qué precio?**
- **Cuántas personas trabajaron para cada actividad? Cuántos días trabajaron en cada actividad?**

Lote	**Uso de mano de obra contratada (indicar)**	**Operación de producción (indicar)**	**Precio**
Lote más grande	no sí	PS S D C Personas-días:	
Segundo lote más grande	no sí	PS S D C Personas-días:	
Tercero lote más grande	no sí	PS S D C Personas-días:	

Código:

Operaciones de producción: *PS=Preparación de suelo, S=Siembra, D=Deshierbe, C=Cosecha*

No del Productor_____

3.3 Si usted quiere prestar dinero para su cultivo de frijol, cuáles son sus opciones? Cuál es la condición bajo que usted prestara el dinero?

Manera de prestar	**Condición del préstamo**
Prestar de un amigo	
Prestar del intermediario	
Prestar de una caja local	
Prestar de un banco	
Otro (describir)	

Códigos:

Condición del préstamo: *1=sin condición, 2=con taza de interés (indicar porcentaje) 3=otro (describir)*

3.4 Ahora me gustaría preguntarle sobre sus otras actividades que le permitan ingresos. Cuales son las actividades que resultan en la ganancia de dinero, tan de usted como de las otras personas que componen su familia?

1.______________________________ 2.______________________________

3.______________________________ 4.______________________________

5.______________________________ 6.______________________________

3.5 Ahora me gustaría preguntarle sobre si mismo.

- **En qué año nació usted?**
- **Cuántos años asistió en la escuela? _______ años.**

No del Productor______

IV. LIMITACIONES A LA PRODUCCION
Ahora quisiera preguntarle sobre los factores que reducen un buen rendimiento de frijol en postrera. Responde a las preguntas con MUY IMPORTANTE, POCO IMPORTANTE, o NO IMPORTANTE.

Sequía		Enfermedades		Falta de Fertilizante	
Malezas		Mala Calidad de Semilla		Inundación	
Insectos		Mala Calidad de Suelo		Babosos	

Código:
1= Muy importante, 2= Poco importante, 3= No importante.

V. CONFIANZA A LAS FUENTES DE INFORMACION SOBRE PRODUCCION
Ahora quisiera preguntarle cuanta confianza tiene usted en los consejos de la producción de frijol que le dan las siguientes instituciones o personas. Responde a las preguntas con MUCHA CONFIANZA, ALGO DE CONFIANZA, o POCA CONFIANZA.

Vecino		Zamorano	
Agropecuaria		(otro)	
DICTA		(otro)	

Código:
1= Mucha confianza, 2= Algo de confianza, 3= Poca confianza.

VI. BENEFICIOS DE LAS COMITES DE INVESTIGACION AGRICOLA LOCAL
(Solo para miembros del CIAL) Cuáles son los beneficios que usted percibe de ser miembro de su CIAL?

GRACIAS POR SU PARTICIPACION

APPENDIX 5

Survey in 2004 for communities other than Los Limones

No del Productor______

Postrera 2003

I. CARACTARISTICAS DEL TERRENO

Primero me gustaría preguntarle acerca de cada uno de los lotes sembrados con frijol en la Postrera 2003. Por favor hágame un dibujo de los lotes que siembra con frijol en esta hoja en Postrera del año 2003. Cuál era:

- **el área? (incluir la unidad del área, e.g. tareas, manzanas)**
- **la pendiente?**
- **la distancia de su casa (minutos o kilómetros)?**
- **la calidad del suelo?**
- **la tenencia del lote?**
- **Cuál es el área total de los terrenos que cultiva, frijoles y otros? Cuál es el área total de su propiedad?**

Lote	Area	Unidad	Pendiente	Distancia	Calidad del Suelo	Tenencia
Lote más grande				___ min o ___ km		
Segundo lote más grande				___ min o ___ km		
Tercero lote más grande				___ min o ___ km		
Area total que cultiva			XXXXX	XXXXXXXXXXX	XXXXXXX	XXXXX
Area propia			XXXXX	XXXXXXXXXXX	XXXXXXX	XXXXX

Códigos:

Pendiente: *1=parejo, 2=inclinado, 3=muy inclinado* ***Distancia:*** *minutos o km de la casa del productor*

Calidad del suelo: *1=bueno, 2=normal/típico de la región, 3=pobre* ***Tenencia:*** *1=propia, 2=prestado, 3=alquilado, 4=ocupado/sin consentimiento*

No del Productor_____

II. INSUMOS Y RENDIMIENTO DE LOS LOTES DE FRIJOL

2.1 Ahora me gustaría preguntarle acerca de la semilla que usó y el destino de la cosecha durante Postrera 2003.

- **Qué variedad de frijol sembró?**
- **Lo sembró asociado con otra cultivo? Cuántos surcos de frijol y cuántos del otro cultivo?**
- **Cuánto de área sembró usted con esta variedad? (incluir la unidad del área)**
- **De dónde obtuvo esta semilla? Si compró la semilla, a qué precio la compró?**
- **Qué cantidad de semilla sembró en este área? (incluir la unidad de peso)**
- **Cuál fue el rendimiento de este lote? (incluir la unidad de peso)**
- **Algunos productores seleccionan las mejores semillas para la siguiente siembra, y otros siembran la semilla como es. Qué hace usted? Si selecciona semilla, en qué momento lo hace?** ____________________
- **En total, cuánto de frijol cosechó usted este año, primera y postrera? (incluir unidades de peso)**____________
- **De todo el frijol que usted cosechó este año, usted comercializó algo? Si fue así, cuánto se comercializó? (incluir unidades de peso) Qué precio recibió?** ____________________
- **A quién se vendió los frijoles (intermediario, pulpería, bodega)?**____________________
- **Pasó alguna vez que vendió frijoles y luego tenía que comprarlos?**____________

Lote	**Variedad de frijol**	**Asoc.**	**Area sembrado**	**Uni dad**	**Fuente-semilla**	**Precio semilla**	**Cantidad de semilla**	**Uni dad**	**Rendim iento**	**Uni dad**
Lote más grande										
Segundo lote más grande										
Tercero lote más grande										

Códigos:

Fuente de semilla: *1=cosechas anteriores, 2=semilla de otro productor, 3=semilla de alguna ONG/Proyecto, 4=comprada en una agrocomercial, 5=otro (describa)*

No del Productor______

2.2 Ahora me gustaría preguntarle acerca de su método de preparación del suelo y el use de fertilizantes en sus lotes en Postrera 2003.

- **Cómo preparó el suelo?**
- **Si ocupó bueyes en el arado y el surqueo del lote, cuánto costó por día, y cuántas días ocupó?**
- **Si ocupó mozos en la preparación del lote, cuántos mozos ocupó durante cuántas días? A que precio pagó los mozos?**
- **Utilizó gramoxone u otro herbicida en la preparación del suelo? Cuánto utilizó, y a que precio por unidad?**
- **Ocupó mozos en la aplicación del herbicida? Cuántas días? A que precio pagó los mozos?**

Lote	Preparación de suelo	Uso bueyes		Uso de mozos			Herbicida	Cantidad (unidad)	Precio/ unidad	Uso mozos	
		días	precio	no.	días	precio				días	precio
Lote más grande											
Segundo lote más grande											
Tercero lote más grande											

Códigos:

Preparación del suelo: *1=preparación manual, 2=tracción animal, 3=tractor, 4=no preparó, 5=otro (especificar)*

- **Cuáles fertilizantes fórmulas utilizó?**
- **Cuánto de cada fertilizante fórmula utilizó? A qué precio compró la fórmula? Cuándo aplicó los fertilizantes?**
- **Utilizó algún abono foliar? Cuál? Cuánto de abono foliar utilizó? A qué precio compró? En qué momento lo aplicó?**
- **Ocupó mozo en la aplicación de abono foliar? Cuántas días? A que precio pagó los mozos?**

Lote	**Uilizó fertilizante (indicar)**	**Tipo de fertilizante**	**Cantidad/ unidad**	**Precio/ unidad**	**Periodo de aplicación**	**Uso de mozos**	
						días	**precio**
Lote más grande	no sí						
Segundo lote más grande	no sí						
Tercero lote más grande	no sí						

Periodo de aplicación: *1=presiembra, 2=a la siembra, 3=poco después de germinar, 4=al aporque, 5=otro (especificar)*

No del Productor______

2.4 Ahora me gustaría preguntarle acerca de su estrategia de control de monte en Postrera 2003.

- **Cuántas veces limpió el lote a mano?**
- **Cuántas personas trabajaron para limpiar todo el lote?**
- **Cuántos días trabajaron para terminar a limpiar?**
- **De estas personas que limpiaron el lote, cuántas eran mozos?**
- **Cuántos días después de haber nacido el frijol limpió?**
- **Aplicó gramoxone u otro herbicida después de haber nacido el frijol para controlar el monte?**
- **Cuál herbicida aplicó?**
- **En qué momento aplicó el herbicida? Cuánto utilizó, y a que precio por unidad?**
- **Ocupó mozo en la aplicación de herbicida? Cuántas días? A que precio pagó los mozos?**

Lote	Veces limpió a mano	Tiempo para limpiar pers.	días	mozos	Días post germ.	Nombre de herbicida	Periodo de aplicación	Cantidad (unidad)	Precio (unidad)	Uso de mozos días	prec.
Lote más grande											
Segundo lote más grande											
Tercero lote más grande											

No del Productor_____

2.5 Ahora me gustaría preguntarle acerca de otros agroquímicos que usó en Postrera 2003.

- **Habían plagas en el lote de frijol? Cuáles eran?**
- **Aplicó algún plaguicida a causa de estas plagas?**
- **Cuál plaguicida era?**
- **Ocupó mozo en la aplicación de plaguicidas? Cuántas días? A que precio pagó los mozos?**

Lote	**Plagas**	**Uso de plaguicida (indicar)**	**Nombre de la plaguicida**	**Cantidad (unidad)**	**Precio (unidad)**	**Uso de mozos** días	precio
Lote más grande		no sí					
		no sí					
Segundo lote más grande		no sí					
		no sí					
Tercero lote más grande		no sí					
		no sí					

- **Habían algunos ataques de enfermedades? Cuáles eran?**
- **Utilizó algún producto para prevenir o curar una enfermedad?**
- **Cuándo aplicó este producto?**
- **Ocupó mozo en la aplicación de este producto? Cuántas días? A que precio pagó los mozos?**

Lote	**Enfermedades**	**Uso de producto (indicar)**	**Nombre del producto**	**Cantidad (unidad)**	**Precio (unidad)**	**Uso de mozos**	
						días	**precio**
Lote más grande		no sí					
		no sí					
Segundo lote más grande		no sí					
		no sí					
Tercero lote más grande		no sí					
		no sí					

No del Productor_____

Postrera 2004

III. CARACTARISTICAS DEL TERRENO

Primero me gustaría preguntarle acerca de cada uno de los lotes sembrados con frijol en la Postrera 2004. Por favor hágame un dibujo de los lotes que siembra con frijol en esta hoja en Postrera del 2004. Cuál era:

- **el área? (incluir la unidad del área, e.g. tareas, manzanas)**
- **la pendiente?**
- **la distancia de su casa (minutos o kilómetros)?**
- **la calidad del suelo?**
- **la tenencia del lote?**
- **Cuál es el área total de los terrenos que cultiva, frijoles y otros? Cuál es el área total de su propiedad?**

Lote	Area	Unidad	Pendiente	Distancia	Calidad del Suelo	Tenencia
Lote más grande				___ min o ___ km		
Segundo lote más grande				___ min o ___ km		
Tercero lote más grande				___ min o ___ km		
Area total que cultiva			XXXXX	XXXXXXXXXXX	XXXXXXX	XXXXX
Area propia			XXXXX	XXXXXXXXXXX	XXXXXXX	XXXXX

Códigos:

Pendiente: *1=parejo, 2=inclinado, 3=muy inclinado* ***Distancia:*** *minutos o km de la casa del productor*

Calidad del suelo: *1=bueno, 2=normal/típico de la región, 3=pobre* ***Tenencia:*** *1=propia, 2=prestado, 3=alquilado, 4=ocupado/sin consentimiento*

No del Productor______

IV. INSUMOS Y RENDIMIENTO DE LOS LOTES DE FRIJOL

4.1 Ahora me gustaría preguntarle acerca de la semilla que usó y el destino de la cosecha durante Postrera 2004.

- **Qué variedad de frijol sembró?**
- **Lo sembró asociado con otra cultivo? Cuántos surcos de frijol y cuántos del otro cultivo?**
- **Cuánto de área sembró usted con esta variedad? (incluir la unidad del área)**
- **De dónde obtuvo esta semilla? Si compró la semilla, a qué precio la compró?**
- **Qué cantidad de semilla sembró en este área? (incluir la unidad de peso)**
- **Cuál fue el rendimiento de este lote? (incluir la unidad de peso)**
- **Algunos productores seleccionan las mejores semillas para la siguiente siembra, y otros siembran la semilla como es. Qué hace usted? Si selecciona semilla, en qué momento lo hace?** ____________________
- **En total, cuánto de frijol cosechó usted este año, primera y postrera? (incluir unidades de peso)**____________________
- **De todo el frijol que usted cosechó este año, usted comercializó algo? Si fue así, cuánto se comercializó? (incluir unidades de peso) Qué precio recibió?** ____________________
- **A quién se vendió los frijoles (intermediario, pulpería, bodega)?**____________________

Lote	Variedad de frijol	Asoc.	Area sembrado	Uni dad	Fuente-semilla	Precio semilla	Cantidad de semilla	Uni dad	Rendim iento	Uni dad
Lote más grande										
Segundo lote más grande										
Tercero lote más grande										

Códigos:

Fuente de semilla: *1=cosechas anteriores, 2=semilla de otro productor, 3=semilla de alguna ONG/Proyecto, 4=comprada en una agrocomercial, 5=otro (describa)*

No del Productor______

4.2 Ahora me gustaría preguntarle acerca de su método de preparación del suelo y el use de fertilizantes en sus lotes en Postrera 2004.

- **Cómo preparó el suelo?**
- **Si ocupó bueyes en el arado y el surqueo del lote, cuánto costó por día, y cuántas días ocupó?**
- **Si ocupó mozos en la preparación del lote, cuántos mozos ocupó durante cuántas días? A que precio pagó los mozos?**
- **Utilizó gramoxone u otro herbicida en la preparación del suelo? Cuánto utilizó, y a que precio por unidad?**
- **Ocupó mozos en la aplicación del herbicida? Cuántas días? A que precio pagó los mozos?**

Lote	**Preparación de suelo**	**Uso bueyes**		**Uso de mozos**			**Herbicida**	**Cantidad (unidad)**	**Precio/ unidad**	**Uso mozos**	
		días	**precio**	**no.**	**días**	**precio**				**días**	**precio**
Lote más grande											
Segundo lote más grande											
Tercero lote más grande											

Códigos:
Preparación del suelo: *1=preparación manual, 2=tracción animal, 3=tractor, 4=no preparó, 5=otro (especificar)*

- **Cuáles fertilizantes fórmulas utilizó?**
- **Cuánto de cada fertilizante fórmula utilizó? A qué precio compró la fórmula? Cuándo aplicó los fertilizantes?**
- **Utilizó algún abono foliar? Cuál? Cuánto de abono foliar utilizó? A qué precio compró? En qué momento lo aplicó?**
- **Ocupó mozo en la aplicación de abono foliar? Cuántas días? A que precio pagó los mozos?**

Lote	**Uilizó fertilizante (indicar)**	**Tipo de fertilizante**	**Cantidad/ unidad**	**Precio/ unidad**	**Periodo de aplicación**	**Uso de mozos**	
						días	**precio**
Lote más grande	no sí						
Segundo lote más grande	no sí						
Tercero lote más grande	no sí						

Periodo de aplicación: *1=presiembra, 2=a la siembra, 3=poco después de germinar, 4=al aporque, 5=otro (especificar)*

No del Productor______

4.4 Ahora me gustaría preguntarle acerca de su estrategia de control de monte en Postrera 2004.

- **Cuántas veces limpió el lote a mano?**
- **Cuántas personas trabajaron para limpiar todo el lote?**
- **Cuántos días trabajaron para terminar a limpiar?**
- **De estas personas que limpiaron el lote, cuántas eran mozos?**
- **Cuántos días después de haber nacido el frijol limpió?**
- **Aplicó gramoxone u otro herbicida después de haber nacido el frijol para controlar el monte?**
- **Cuál herbicida aplicó?**
- **En qué momento aplicó el herbicida? Cuánto utilizó, y a que precio por unidad?**
- **Ocupó mozo en la aplicación de herbicida? Cuántas días? A que precio pagó los mozos?**

Lote	Veces limpió a mano	Tiempo para limpiar			Días post germ.	Nombre de herbicida	Periodo de aplicación	Cantidad (unidad)	Precio (unidad)	Uso de mozos	
		pers.	días	mozos						Días	prec.
Lote más grande											
Segundo lote más grande											
Tercero lote más grande											

No del Productor______

4.5 Ahora me gustaría preguntarle acerca de otros agroquímicos que usó en Postrera 2004.

- **Habían plagas en el lote de frijol? Cuáles eran?**
- **Aplicó algún plaguicida a causa de estas plagas?**
- **Cuál plaguicida era?**
- **Ocupó mozo en la aplicación de plaguicidas? Cuántas días? A que precio pagó los mozos?**

Lote	**Plagas**	**Uso de plaguicida (indicar)**	**Nombre de la plaguicida**	**Cantidad (unidad)**	**Precio (unidad)**	**Uso de mozos**	
						días	**precio**
Lote más grande		no sí					
		no sí					
Segundo lote más grande		no sí					
		no sí					
Tercero lote más grande		no sí					
		no sí					

- **Habían algunos ataques de enfermedades? Cuáles eran?**
- **Utilizó algún producto para prevenir o curar una enfermedad?**
- **Cuándo aplicó este producto?**
- **Ocupó mozo en la aplicación de este producto? Cuántas días? A que precio pagó los mozos?**

Lote	**Enfermedades**	**Uso de producto (indicar)**	**Nombre del producto**	**Cantidad (unidad)**	**Precio (unidad)**	**Uso de mozos**	
						días	**precio**
Lote más grande		no sí					
		no sí					
Segundo lote más grande		no sí					
		no sí					
Tercero lote más grande		no sí					
		no sí					

No del Productor______

V. DATOS SOCIOECONOMICOS

5.1 Ahora me gustaría preguntarle acerca de los miembros de la familia que ayudaron con los terrenos de frijol en Postrera 2004.

- **Cuántas personas tiene la familia? Qué edad tienen los niños? (Personas que tienen más que 15 años de edad se consideran adultos.)**
- **De estas personas, quien asistió en la preparación de terreno?**
- **Quién asistió en la siembra del terreno?**
- **Quién asistió en el deshierbe del terreno?**
- **Quién asistió en la cosecha del terreno?**

	Adultos	Adultas	Niños	Niñas
Total en la familia				
Preparación de suelo				
Siembra				
Deshierbe				
Cosecha				

5.2 Ahora me gustaría preguntarle sobre si mismo.

- **En qué año nació usted?**
- **Cuántos años asistió en la escuela? ________ años.**

5.3 Ahora me gustaría preguntarle sobre sus otras actividades que le permitan ingresos. Cuales son las actividades que resultan en la ganancia de dinero, tan de usted como de las otras personas que componen su familia?

1.______________________ 2.______________________

3.______________________ 4.______________________

5.______________________ 6.______________________

VI. LIMITACIONES A LA PRODUCCION

6.1 Ahora quisiera preguntarle sobre los factores que reducen un buen rendimiento de frijol en postrera. Responde a las preguntas con MUY IMPORTANTE, POCO IMPORTANTE, o NO IMPORTANTE.

Sequía		**Enfermedades**		**Falta de Fertilizante**	
Malezas/Monte		**Mala Calidad de Semilla**		**Inundación**	
Insectos		**Mala Calidad de Suelo**		**Babosos**	

Código:
1= Muy importante, 2= Poco importante, 3= No importante.

6.2 Si usted quiere prestar dinero para su cultivo de frijol, cuáles son sus opciones? Cuál es la condición bajo que usted prestara el dinero?

Manera de prestar	**Condición del préstamo**
Prestar de un amigo	
Prestar del intermediario	
Prestar de una caja local	
Prestar de un banco	
Otro (describir)	

Códigos:
Condición del préstamo: *1=sin condición, 2=con taza de interés (indicar porcentaje) 3=otro (describir)*

No del Productor______

VII. CONFIANZA A LAS FUENTES DE INFORMACION SOBRE PRODUCCION

7.1 Cuando usted tiene un problema en su frijolar, quien busca para recibir un consejo para solucionar el problema?

____

7.2 Ahora quisiera preguntarle cuanta confianza tiene usted en los consejos de la producción de frijol que le dan las siguientes instituciones o personas. Responde a las preguntas con MUCHA CONFIANZA, ALGO DE CONFIANZA, o POCA CONFIANZA.

Compañeros	
Agropecuaria	
Zamorano	
(otro)	

Código:

1= Mucha confianza, 2= Algo de confianza, 3= Poca confianza.

VIII. BENEFICIOS DE LAS COMITES DE INVESTIGACION AGRICOLA LOCAL

(Solo para miembros del CIAL) Cuáles son los beneficios que usted percibe de ser miembro de su CIAL?

GRACIAS POR SU PARTICIPACION

APPENDIX 6

Agronomic results from factorial trials in 2003 in Los Limones

Farmer 1 bean yield in kilograms per hectare (Tukey's mean separation, beans at 13.5% moisture).

Amadeus + urea + paraquat 1740 kg/ha	Amadeus + urea - paraquat 1760 kg/ha	Amadeus - urea + paraquat 1490 kg/ha	Amadeus - urea - paraquat 1410 kg/ha
Seda + urea + paraquat 1640 kg/ha	Seda + urea - paraquat 1700 kg/ha	Seda - urea + paraquat 1340 kg/ha	Seda - urea - paraquat 1290 kg/ha
Amadeus total: 1600 kg/ha (P =0.35) Seda total: 1490 kg/ha With urea total: 1700 kg/ha (P =0.01) Without urea total: 1390 kg/ha With paraquat: 1540 kg/ha (P =0.93) Without paraquat: 1540 kg/ha			

Farmer 2 bean yield in kilograms per hectare (Tukey's mean separation, beans at 13.5% moisture).

Amadeus + urea + paraquat 1240 kg/ha	Amadeus + urea - paraquat 1830 kg/ha	Amadeus - urea + paraquat 1430 kg/ha	Amadeus - urea - paraquat 1490 kg/ha
Seda + urea + paraquat 1570 kg/ha	Seda + urea - paraquat 1790 kg/ha	Seda - urea + paraquat 1170 kg/ha	Seda - urea - paraquat 1490 kg/ha
Amadeus total: 1500 kg/ha (P =0.81) Seda total: 1500 kg/ha With urea total: 1610 kg/ha (P =0.36) Without urea total: 1400 kg/ha With paraquat: 1360 kg/ha (P =0.18) Without paraquat: 1660 kg/ha			

Farmer 3 bean yield in kilograms per hectare (Tukey's mean separation, beans at 13.5% moisture).

Amadeus + urea + paraquat 1660 kg/ha	Amadeus + urea - paraquat 2440 kg/ha	Amadeus - urea + paraquat 2040 kg/ha	Amadeus - urea - paraquat 2110 kg/ha
Seda + urea + paraquat 2500 kg/ha	Seda + urea - paraquat 2230 kg/ha	Seda - urea + paraquat 2170 kg/ha	Seda - urea - paraquat 2160 kg/ha
Amadeus total: 2070 kg/ha (P=0.33) Seda total: 2260 kg/ha With urea total: 2210 kg/ha (P =0.67) Without urea total: 2110 kg/ha With paraquat: 2100 kg/ha (P =0.50) Without paraquat: 2230 kg/ha			

Farmer 4 bean yield in kilograms per hectare (Tukey's mean separation, beans at 13.5% moisture).

Amadeus + urea + paraquat 1070 kg/ha	Amadeus + urea - paraquat 730 kg/ha	Amadeus - urea + paraquat 560 kg/ha	Amadeus - urea - paraquat 640 kg/ha
Seda + urea + paraquat 870 kg/ha	Seda + urea - paraquat 940 kg/ha	Seda - urea + paraquat 460 kg/ha	Seda - urea - paraquat 710 kg/ha
Amadeus total: 760 kg/ha (P =0.87) Seda total: 760 kg/ha With urea total: 900 kg/ha (P =0.04) Without urea total: 600 kg/ha With paraquat: 740 kg/ha (P =0.86) Without paraquat: 760 kg/ha			

APPENDIX 7

Field Day Questions for Farmers in Los Limones in 2004

Field analysis
1. What are the qualities of this soil?
2. What is the highest yield from this field in the past?
3. What do you think are the reasons that this piece of land produced so much?
Treatment comparison
4. Which treatment will produce the best this year? Why?
5. Which treatment will do the worst this year? Why?
6. Based on your experiences in the past, which bean variety would you use to maximize your bean production?

APPENDIX 8

Common Local (Spanish), Scientific and Common English Names for Farmer-Identified Insects

Local name	**Latin name**	**English name**
Picudo de la Vaina	*Apion godmani*	Bean Pod Weevil
Pulgón	*Systena blanda* and others	Flea beetle
Mosca Blanca	*Bemesia tabaci*	Whitefly
Tortuguilla	*Diabrotica* spp., *Cerotoma* spp.	Chrysomelids
Crisomelido	*Diabrotica* spp., *Cerotoma* spp.	Chrysomelids
Lorito Verde	*Empoasca* spp.	Leafhoppers
Gusano Desfoliador	Order: Lepidoptera	Defoliating insect larvae
Gusano Alambrique	Family: *Elateridae*	Wireworms
Gallina Ciega	*Phyllophaga* spp.	White grubs

APPENDIX 9

Common Local (Spanish), Scientific and Common English Names for Farmer-Identified Diseases

Local name	**Latin name**	**English name**
Mustia Hilachosa	*Thanatephorus cucumeris*	Web blight
Hielo Negro	*Colletotrichum lindemuthianum*	usually Anthracnose
Bacteriosis	*Xanthomonas campestris* pv. *phaseoli*	Common Bacterial Blight
Mancha Angular	*Phaeoisariopsis griseola*	Angular leaf spot
Antracnose	*Colletotrichum lindemuthianum*	Anthracnose
Roya	*Uromyces appendiculatus*	Rust
Sclerotinia	*Sclerotinia sclerotium*	Sclerotinia
Mal de Talluelo	*Rhizoctonia* spp. or *Pythium* spp.	Damping Off
Rhizoctonia	*Rhizoctonia solani*	Rhizoctonia Root Rot
Mosaico		Bean Common Mosaic Virus or Bean Golden Yellow Mosaic Virus
Hielo Amarillo		usually Bean Golden Yellow Mosaic Virus

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