CONSTRAINTS TO AND OPPORTUNITIES FOR DEVELOPING A BEAN SEED PRODUCTION AND MARKETING SYSTEM IN HONDURAS

by

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ABSTRACT

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Recent studies have found that over 50% of bean farmers in the main bean-producing areas of Honduras planted modern varieties. However, many of the farmers planted varieties released up to 10 years ago and most farmers obtained seed from neighbors or farmer-saved seed. This indicates a need to increase physical supply and expand farmer access to modern bean varieties. One option for meeting this need is to establish a seed system in which small-scale farmers are contracted to multiply seed of modern varieties under the supervision of Zamorano and market seed through an input supply firm. This study looks at the feasibility of implementing such a scheme. A rapid appraisal was conducted to collect information from key informants to describe the bean seed subsector in Honduras and identify potential small-scale bean seed producers and marketing agents. In addition, 72 farmers in El Paraiso and Olancho were surveyed to assess the demand for improved bean seed. Amadeus 77 was the variety with the highest demand. Bean seed production budgets were constructed and used to determine if it was feasible to market improved bean seed at department capitals and smaller towns for L 12/lb (L 26.4/kg). At a price of L 12/lb (L 26.4/kg), the estimated seed demand for Amadeus 77 in El Paraiso and Olancho is of approximately 24 mt and 54 mt. At this price and demand level, the projected demand is sufficient to motivate input marketing firms to distribute the seed produced under contract by small-scale seed producers.

Dedication

I dedicate this thesis to my wife, Laila, for all her love, encouragement, and support. Thank you for being my motivation and simply for being who you are.

Also, I would like to dedicate it to my mother, Ilma, who has always supported me in my career and life.

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Chapter I

1. Introduction

Dry beans, the second most important grain in Honduras, accounts for an important part of the basic diet of most of the Honduran population. Currently, bean productivity is low. Many factors contribute to low productivity, including poor soils, climate-related factors like drought and hurricanes, farmers' low levels of input application, and their limited adoption of recommended agricultural practices, especially recently-released modern bean varieties which are a key technology that has the potential to increase farmers' yields.

There are several reasons why farmers purchase seed. Farmer demand for new seed can arise from their desire to replace retained seed of an existing variety that is no longer genetically pure or to obtain a new variety that is higher yielding or is more pest or disease resistance (Heisey and Brennan, 1991; Tripp, 1997). Also, farmers in developing countries are sometimes forced to search for seed outside their farm because, due to poverty, they are unable to harvest and save sufficient seed for the following season (Tripp, 1997).

Farmer demand for seed of modern varieties (MVs) depends on the performance of the varieties in farmers' fields (relative to traditional varieties, TVs), the acceptability of these varieties in the market, their local availability, and their affordability (Bernsten and Mainville, 1999). In Honduras, new varieties have been released with high yield potential and resistance to various diseases, especially Bean Golden Yellow Mosaic Virus (BGYMV). On-farm trials in Honduras indicated that recently-released MVs like Tio Canela produce higher yields than traditional varieties (Rodríguez and Viana, 1998).

A recent study found that over 50% of bean farmers in the main bean-producing areas of Honduras (El Paraiso, Olancho and Francisco Morazan) planted MVs, which indicates that they see advantages to planting MVs–primarily due to their higher yield potential and disease resistance (Mather *et. al.*, 2002). However, many of the farmers planted varieties that were released in 1990 and virtually all of the farmers obtained their seed from a neighbor or planted farmer-saved seed (Mather *et. al*, 2002).

Farmers' willingness to purchase an input such as certified seed depends on its price, their economic situation, and the availability of credit and government intervention such as subsidies. Given that few poor farmers in Honduras have access to credit, the relatively high cost of certified seed is a major constraint to its use. For example, in 2002 in Honduras, certified bean seed sold for approximately US$ 96/qq (quintal = 100 lbs) ($ 2.11/kg). In contrast, farmers can typically buy "saved" bean seed from their neighbors for only US$ 24 /qq ($ 0.53/kg) (*i.e.* 25% of the price of certified seed). Furthermore, compared to other countries in the region, certified seed is relatively expensive in Honduras. For example, the price of certified seed in Nicaragua (2002) was US$ 58/qq ($ 1.28/kg), while saved seed was valued at US$ 25/qq ($ 0.55/kg).

Utilizing Shaffer's (1973) characterization of activities governing a food sector, bean seed systems can be characterized by the agents involved and the coordinating mechanisms which bring modern varieties to the market. The agents involved in seed production may include private or public research agencies that develop modern varieties and produce foundation seed; private seed firms, agricultural schools, and NGOs which multiply foundation seed to produce certified or commercial seed; a public or private seed certification unit that verifies the quality of the seed; public or private input

marketing firms that distribute the seed; and other agents like banks and the government that facilitate bean seed trade by providing loans to farmers and establishing policies that support seed production and distribution.

As the consumer of the seed, farmers demand specific characteristics in the varieties that they plant. However, their varietal preferences are strongly influenced by bean traders, who take into account the preferences of consumers when setting the price that they will pay for the grain. Consequently, in order to recommend actions to increase the productivity of a seed system, it is necessary to take into account the varietal characteristics preferred by farmers, traders, and consumers.

1.1 Objective of Study

The general objective of the study is to assess the feasibility of both increasing the physical supply of modern bean seed varieties and expanding farmer access to these varieties. In the proposed seed system model, small farmers would be contracted to multiply seed of modern bean varieties, under the supervision of Zamorano. Rather than producing "certified' seed, the farmers' seed would be marketed as "Zamorano Supervised" seed. This seed would be sold at a price lower than "certified" seed, thereby making it more affordable to small farmers. Regarding marketing, the seed would be sold in small size bags (size to be determined) and distributed by one or more private sector firms that currently distributes farm inputs (e.g. fertilizer, pesticide) throughout Honduras.

The specific objectives of the study are to: a) document the characteristics of the existing "certified" bean seed system, including the activities of all actors (*i.e.*, foundation seed producer (Zamorano), "certified" seed sellers (Zamorano and Hondugenet), "certified"

seed multipliers (contracted farmers), DICTA (Directorate of Research, Science and Agricultural Technology), and government policies related to seed production); b) assess the farm-level demand for "Zamorano Supervised" seed; c) identify potential participants in a new bean seed system and the conditions under which each would be willing to participate; d) develop a prototype budget that estimates cost of producing "Zamorano Supervised" bean seed; and e) identify government policies and actions needed to create a sustainable private-sector based improved bean seed production and marketing system.

The increased production (multiplication) of seed of modern bean varieties that have characteristics acceptable to farmers and the market, promoting them widely, and marketing them to farmers in quantities and locations near their place of residence will contribute to increasing farmer adoption of these varieties. However, the feasibility of creating the proposed bean seed system will depend on the willingness of agricultural input firms, research agencies, farmers, and government to support such an initiative.

This study will analyze data and information required to document the characteristics of the existing bean seed subsector (including strengths and weaknesses) and draw on insights gained to propose a structure for a new bean seed system--including the possible actors, the activities that each would perform, and the conditions under which they would be willing to participate.

1.2 Research Questions

The sustainability of a commercial seed system requires that there exist a farm-level demand for improved seed and the continuous seed supply of these modern varieties. This study collected information/data to answer the following research questions.

1.2.1 Demand for Modern Bean Varieties

1.2.1.1 Farmer

1. Varietal Characteristics. What are the varieties' characteristics that farmers desire and are these being met by the available modern varieties?
2. Willingness to Pay. How much are farmers willing to pay for modern bean varieties?
3. Bag Size. What quantity of seed (*i.e.* bag size, lbs) do farmers prefer to purchase?
4. Seed Repurchasing. For how many years do farmers plant the same seed and how often are they willing to repurchase fresh seed from the formal market?

1.2.1.2 Bean Traders

3. Price Discounts. What is the relative price that traders pay to farmers for modern, compared to traditional (landrace) varieties?
4. Relative Volumes Traded. What percentage of bean sales are accounted for by modern versus traditional varieties?

1.2.2 Supply of Modern Bean Varieties

1.2.2.1 Research Agencies

1. Price of Foundation Seed. What is the price at which Zamorano would be willing to sell foundation seed to seed multipliers?

2. Necessary Resources and Conditions. What resources and conditions (e.g. contracts) do research agencies believe are necessary for seed multipliers to producegood quality seed?

3. Training and Supervision. How many seed farmer groups should be trained and supervised to grow commercial seed[1], who could provide the required training, and what should be the components of the training program?

4. Cost of Training and Supervision. How much would the institution providing training to the seed multiplier charge for training and supervision?

5. Institutional Arrangements. What requirements and arrangements would have to be negotiated in order for the training institution to agree to supervise the farmer seed multipliers?

1.2.2.2 Bean Seed Growers (Previous)

1. Production Costs. In the past, how much has it cost seed multipliers to produce improved bean seed?

2. Incentives to Produce Seed. What price did these farmers receive for producing commercial seed?

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[1]Commercial seed is a category of seed where field inspections are not needed and only purity and germination rates are checked.

3. Contract. Have seed multipliers been given contracts to multiply seed needed and if so, what were the terms of these contracts?

4. Necessary Resources and Conditions. What resources have seed multipliers required to produce good quality seed?

5. Inputs. What inputs have seed multipliers applied, where did they obtain them, and what were the purchasing terms?

6. Certification. What problems have multipliers encountered in obtaining government certification of their seed?

7. Participation in the New Scheme. Are previous multipliers interested in participating in the new scheme?

1.2.2.3 Bean Seed Growers (Potential)

1. Potential Bean Seed Growers. Which farmers or group of small-scale farmers have the necessary resources and conditions (e.g., expertise, accessible location) or with little investment, would be capable of producing commercial seed?

2. Production Advantages. What are the advantages and disadvantages (e.g., production costs, credibility,) of contracting small-scale versus commercial farmers to produce commercial seed?

3. Production Costs. What is the estimated production cost of contracting small-scale versus commercial farmers to multiply seed?

4. Incentives to Produce Seed. What is the minimum seed price that small-scale farmers would require to produce commercial bean seed?

5. Contract. Are contracts with small-scale seed multipliers required and, if so, what are the terms that they would require to participate in the proposed commercial bean seed production scheme?

1.2.2.4 Government Agencies

1. Volume. What is the annual quantity of bean seed produced by government agencies?

2. Contracts. What are the contract terms that government agencies offer to bean seed multipliers?

3. Characteristics of Bean Seed Growers. What resources and conditions (e.g. contract terms) do government agencies provide to its bean seed multipliers?

4. Seed Certification Requirements. What are the requirements that multipliers must meet for their seed to be certified by a government agency as certified seed versus commercial seed?

5. Agency Constraints. What problems do government seed certification agency encounters (e.g., understaffed, resources, cars, equipment, funding) that may constrain their ability to certify multipliers' seed?

6. Capacity. What is the government seed certification agencies' capacity (e.g., number of staff) to certify seed grown by seed multipliers?

1.2.2.5 Non-Government Organizations

1. Demand. What has been the magnitude of the NGOs' demand for certified bean seed?

2. Bag Size. What bag size do NGOs prefer for distributing/selling bean seed to farmers?

3. Beneficiary Terms. What are the terms under which NGOs provide bean seed to farmers?

4. Characteristics of bean seed growers. What resources have NGO artisan bean seed multipliers had to multiply seed and which resources were provided by the NGO?

5. Contracts. What contract terms have NGOs' offered to artisan bean seed multipliers?

6. Production Costs. What are NGOs' estimated production cost for producing commercial seed?

1.2.2.6 Private Sector Bean Seed Firms

1. Volume. What is the annual quantity of certified/commercial bean seed produced by private seed firms?

2. Bag Size. What is the current bag size, and would these firms consider marketing beans in other size bags?

3. Production Site. Where do these firms produce their certified/commercial bean seed?

4. Inputs. Do these firms provide inputs to their seed multipliers and what are the purchasing terms?

5. Contracts. Do these firms offer contracts to seed multipliers, and if yes, what are the contract terms?

6. Characteristics of Bean Seed Growers. What resources (e.g., irrigation) and conditions (e.g., provide inputs) do these firms provide to their seed multipliers?

7. Price. At what price do these firms sell certified and commercial seed and how do they determine the price?

8. Production Costs. What are these firms production costs for multiplying seed?

9. Marketing. How do these private firms market bean seed and at what location do they sell it?

10. Participation in Scheme. Would these firms be willing to participate in the proposed bean seed multiplication scheme and under what conditions and terms would they sell "Zamorano Supervised" seed?

11. Foundation Seed. From whom do these firms obtain foundation seed and do they sell it to their seed multipliers or provide it at no cost?

1.2.2.7 Input Marketing Firms

1. Inputs. What inputs do these private input marketing firms sell, and where and how do they distribute these inputs?

2. Bean Seed. What bean varieties do input marketing firms sell, in what amounts, and in which regions of Honduras do they sell these varieties?

3. Participation in Scheme. Would these firms be interested in participating in the proposed seed distribution scheme and what terms would they require to sell bean seed through their sales network (e.g., commercial seed, bag size, volume, exclusive seller, contract, markup)?

1.2.2.8 Bank Officials

1. History of Loans. Do commercial banks make loans to bean farmers, and if yes, what is the total number of loans, value, and average value of these loans?

2. Amount. What is the minimum/maximum amount of money that commercial banks will loan to a bean farmer?

3. Loan Terms. What terms (e.g., interest rate, collateral, amount, repayment time) do commercial banks offer to bean farmers and would they offer special terms to farmers participating in the proposed seed multiplication scheme?

1.3 Thesis Outline

This study is divided into seven chapters. Chapter I introduces the research problem and presents the research objectives and research questions. Chapter II presents the literature review and conceptual framework, which provide the rationale for the study objectives, research approach, and research questions. Chapter III describes the methodology used to collect data and methods of analysis, including the models used to test the hypotheses. Chapter IV reports the findings on the bean seed supply in Honduras and supporting related agents that supports the seed supply. Chapter V reports results on bean seed demand based on a farmer survey. Chapter VI proposes a new seed system framework and the mechanisms required to insure coordination among the agents in the system. Chapter VII summarizes the findings, discusses policy implications, and presents recommendations for future research.

Chapter II

2. Conceptual Framework

2.1 Overview

Chapter II presents an overview of the subsector approach, reviews the evolution of seed systems, and seed demand, supply, and transaction costs. The subsector approach includes the use of rapid appraisal methods to collect information and stages of seed development. The types of seed systems include formal and informal systems. The seed demand section discusses the structure of the random utility model that will be estimated using a double-hurdle analysis. The seed supply section presents a budget to determine the minimum price farmers will be willing to sell bean seed. Finally, Chapter II discusses the nature of transaction costs and the implications that they have on farmer seed demand and supply.

2.2 Subsector Analysis

Shaffer (1968) defines a subsector as "the vertical set of activities in the production and distribution of a closely related set of commodities". In bean seed production, several activities (*e.g.* breeding, multiplication, processing) are required to obtain the final product, seed. Staatz (1997) recommends using subsector analysis to analyze and evaluate how the productivity of production and distribution activities for a good or closely related goods can be increased.

In applying the subsector research approach, it is necessary to take into account the vertical coordination and competitive relationships in a food sector (Shaffer, 1973). All activities, from breeding to the actual sale of the seed, are governed by two systems: the physical transformation system and the coordinating system (Shaffer, 1973).

In the case of bean seed, physical transformation begins when the breeder combines the desired mix of genes, followed by multiplication, processing, and packaging of the improved seed, and ends with transportation to the place of sale. These activities are all controlled by the coordinating system, which include the administrative processes within the firm and the market processes, all governed by practices and institutions involved (Shaffer, 1973). Since there is dynamics in the way in which these systems interact, the rules and regulations that monitor the system must evolve as the system change in order to decrease transaction costs (Shaffer, 1973).

Data required to carry out a subsector analysis can be collected using rapid appraisal methods. Rapid appraisal, a methodology that falls within a continuum of informal and formal modes of data collection, leads to an objective reality (Kumar, 1993). Rapid appraisal relies heavily on key informant interviews with individuals who have expert knowledge about the subject of interest. During these interviews, the researcher solicits information from the expert on a series of themes and asks the expert to elaborate on his/her responses. Potential key informants in the food system include farmers, first handlers, wholesale traders, processors, storage and transport agents, and distributors (Holtzman, 1993).

2.3 Seed Systems

2.3.1 Stages of Seed Development

Before proposing policies to enhance the productivity of a seed system, it is necessary to understand the current stage of seed development in a country. Seed industry development can be separated into four stages that transcends from the simple distribution of seed from farmer-to-farmer, which is regulated by customary law, to a

more complex system where private firms predominate and which is regulated by formal institutions (Douglas, 1980; Rusike and Eicher, 1997). Douglas defines these four stages as: 1) the traditional stage, 2) the emergence stage, 3) the growth stage, and 4) the maturity stage.

The "traditional stage" is characterized by production and exchange of seed among farmers (Rusike and Eicher, 1997). In addition, farmer organizations (Rusike and Eicher, 1997) or a plant breeding department (Douglas, 1980) may be involved in testing, selecting, and multiplying small quantities of seed. However, since regulatory organizations have not yet been established, informal habit and customary law prevail. Thus, seed quality is the principal problem (Rusike and Eicher, 1997).

In the "emerging stage", the government is formally involved in conducting research and ensuring seed quality. In this stage, the government delegates seed multiplication to selected farmers and establishes basic regulations for seed exchange (Rusike and Eicher, 1997). However, seed of modern varieties is not widely available (Douglas, 1980).

In the "growth stage", as the market grows, private firms become increasingly responsible for seed production. In response to the growth in seed demand, private firms create new generic technologies (Rusike and Eicher, 1997) and governments establish seed policies (Douglas, 1980). At this stage, private firms invest heavily in seed production and marketing. Thus, private firms are mainly concerned about farmer demand for seed and financial uncertainty if seed is not sold (Rusike and Eicher, 1997).

In the "maturity stage", variety proprietorship is recognized by the government. A main concern for private firms developing new varieties is obtaining patents (Rusike and

Eicher, 1997). Product labels become increasingly important (Rusike and Eicher, 1997) and seed firms put greater emphasis on marketing strategies because of the competitiveness among seed firms (Douglas, 1980).

2.3.2 Types of seed systems

Seed provision can be divided in formal and informal systems. Informal seed systems include farmer-saved seed, farmer-to-farmer exchange, farmers buying market grain for seed, and seed supplied by artisan seed projects. While artisan seed systems are more organized than the former, artisan seed is not labeled as "commercial" or "certified" seed by an authorized organization. In contrast, formal systems include commercial or certified seed, which is supplied by commercial input distributors.

While farmers in most developing countries rely primarily on saved seed (especially for self-pollinated crops), seed companies are playing an increasingly important role in seed provision. For example, while farmers in East Africa rely on saved seed as their primary source, in Kenya and Tanzania seed companies are very active (Remington *et. al.*, 2002). In the case of bean seed, some seed companies in Kenya contract seed production to farmers, and provide them with inputs on credit to grow seed under rainfed conditions. This seed is distributed through a cooperative union, wholesalers and through governmental selling centers, which some sell the seed on credit (Kamau, 1997). Kamau's (1997) research in Kenya identified several factors which limit the use of certified seed, including availability, quality, price of seed, and a lack of credit.

2.3.3 Informal Seed Systems in Central America

Bean farmers in Central America rely on saved seed as their main seed source. In recent past years, artisan seed projects have played an important role in supplying seed to Central American farmers. Nevertheless, these projects have not been sustainable. In the late 1980s and early 1990s, these projects sought to increase the supply of modern varieties by selecting and training farmers to produce seed (Viana, 1999). While the need to produce seed and make it accessible to farmers has been targeted by artisan seed programs, many improvements are needed for these projects to evolve into a sustainable seed system that most farmers will use. For example, Guatemala's artisan seed project ("Cooperativa Integral Agrícola Santa Gertrudis") collapsed because of poor seed quality (Ordóñez, 1999). To insure that seed produced by artisan seed projects is of good quality, Chacón *et. al.* (1999) recommended that the seed should at least be graded as commercial or certified seed --depending on the quality of seed produced. Another problem with artisan seed programs is that they are funded by projects. When the project ends, the program struggles until a new project is initiated. For example a FINNIDA-funded project which started at the beginning of the 1990s, and was implemented together with the Ministry of Agriculture in Nicaragua until 1995, struggled to survive until the National bean Program (UNISEM) (part of the National Institute of Technology Transfer (INTA)) was established in 1996 to replace the project (García, 1999). Finally, since artisan seed programs have failed to involve the private sector, they have not contributed to the development of a sustainable seed system.

2.3.4 Informal Seed Systems in Honduras

Honduras' informal seed system has similar characteristics as the informal systems described above, including the widespread planting of farmer-saved seed, farmer-to-farmer exchange, farmers buying market grain for seed, and seed supplied by artisan seed projects.

In Honduras, the artisan seed program started in 1989 with two objectives: 1) to accelerate the diffusion of modern varieties and 2) to train technicians and farmers in artisan seed production (Rodríguez and Viana, 1998). The activities of the program included motivational meetings with technicians and farmers, farmer selection, technician selection and assignment of activities, farmer and technician training in variety selection and crop growth, harvesting, and commercialization (marketing). The foundation seed, which was provided by the "Programa Nacional de Frijol", was produced with leader farmers and then sold to participants in the artisan seed project. Farmers participating sold the seed they produced to input firms and to the Directorate of Research, Science and Agricultural Technology (DICTA), who then sold the seed to farmers on credit (Rodríguez and Viana, 1998). According to Bernsten and Mainville (1999), while artisan seed programs have successfully produced seed, they have failed to develop a strategy for marketing their seed to farmers in neighboring villages.

In the past few years, NGOs and development projects have distributed certified seed to farmers, especially after natural disasters. NGOs and projects give the seed to farmers for free or ask farmers to repay in kind after the harvest. Consequently, after natural disasters input dealers accumulate a large stock of seed which they cannot sell. In

addition, seed firms reported that even in normal years, NGOs free seed distribution initiatives reduced commercial seed sales.

Recognizing the need to avoid undermining the development of a private seed sector, several projects in Africa have provided seed vouchers (*i.e.* coupons or certificates issued by the NGOs or projects) to farmers that guarantees a cash value for the exchange of seed from approved sellers (Remington *et. al.*, 2002). In addition, Remington *et.al.* (2002), describes the success of seed fairs in several countries in Africa; where commercial seed companies, input dealers, and market grain traders offer their seed to farmers under the supervision of a fair committee that recommends a sale price and buys the vouchers back from the sellers. While provision of free seed to farmers undermines the development of a commercial seed system, the voucher approach actively involves the seed supplying agents and helps to increase the likelihood that farmers will seek to purchase seed from those agents in the future.

2.4 Function of Seed

Tripp (1997) states that seed has two functions. First, as an input and second, as a source of germ plasm. Tripp emphasizes that farmer demand for seed will differ, depending on which need he/she wants to satisfy (Tripp, 1997).

Farmers need seed as an input when natural disasters occur (*e.g.* hurricanes) and the farmer is left without seed to plant. In this case, the farmer will purchase any available seed, without regard to his/her variety preferences. In addition, due to poverty, farmers in developing countries are often forced to obtain seed from outside their farm because they are unable to harvest and save sufficient seed for the following season (Tripp, 1997). Alternatively, a farmer who wants a specific variety might purchase a

small quantity and multiply it himself to obtain seed with the characteristics that he/she desires. However, this is only possible for self-pollinating crops (because of the slow rate of genetic degradation) and crops multiplied via asexual reproduction.

On the other hand, there are two reasons why a farmer may demand germplasm. First, farmers may wish to obtain seed of a new variety that is higher yielding and or more pest/disease resistant than the farmer's current variety. Second, farmers may wish to obtain germplasm of the same variety to replace retained seed because its production potential has deteriorated due to a breakdown of its pest or disease resistance (Heisey and Brennan, 1991; Tripp, 1997).

In order to develop new varieties that meet farmers'preferences, researchers should observe the varieties that farmers plant to determine if they have been adopted because of farmers' preferences or because farmers desire seed just as an input. However, farmer demand for modern varieties also depends on the performance of the varieties in farmers' fields (relative to traditional varieties (TVs)), the acceptability of these varieties in the market, their local availability, and their affordability (Bernsten and Mainville, 1999).

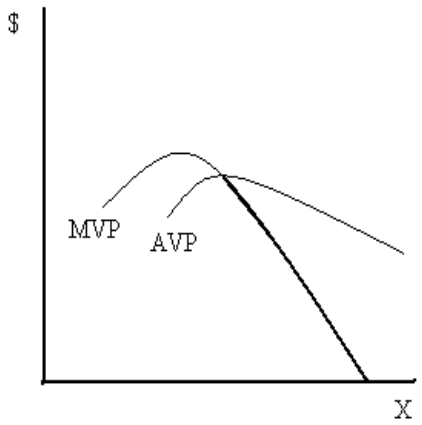
2.5 Seed Demand

Farmer demand for seed depends on several factors including seed rate (planting density), area planted, and varietal choice.

2.5.1 Seed Rate

In a competitive market for a single factor the neoclassic input demand (e.g. seed rate) function is the inverse of the marginal value productivity function, from the input level of maximum average value product to higher levels (Beatie and Taylor, 1993) (Figure 1). The optimal seed rate per hectare is found at the point where the marginal change in yield, due to an increase in planting rate, is equal to the seed-to-grain price ratio. The optimal seed rate is determined by testing several planting densities by varying the distances between plants and rows. However, farmers in Honduras usually plant the same amount of seed per unit area regardless of variety, as long as there is no big difference in bean grain size[2]-- although farmers in Honduras use a lower seed rate in the Primera than in the Postrera, due to higher rainfall in the Primera.

Figure1. Factor demand function for single-variable factor.



* MVP = marginal value product
AVP = average value product

[2] Farmers in Honduras usually use the same seed rate for bush-like plants. This could be attributed to custom or feeling secure of the planting practice because of past experience.

2.5.2 Area Planted

Farmers in Honduras usually plant the same hectarage to beans every year. This is because of limitations in land and access to credit. Thus, the total quantity of seed a farmer plants does not vary greatly from year-to-year.

2.5.3 Varietal Choice

Farmers often plant different varieties from year-to-year. In such instances, farmers face the decision of choosing between two inputs (varieties) with different prices that yield two products with different attributes and prices. The farmers' decision regarding which variety to plant can be reduced to a breakeven price analysis. In business management analysis, the breakeven point is the point where total costs are equal to total revenues (Gardner, 1948). In the context of comparing two varieties, the breakeven price of seed is the maximum seed price that makes the profits of using either variety equal. In other words, the breakeven price is the highest price a farmer would pay for seed of a variety, given the output prices, seed price of the compared variety, and yields of both varieties. Thus, a farmer would only be willing to buy a new variety if the net revenue from that variety is equal to or greater than his/her existing variety.

2.5.4 Hedonic Price Model

Hedonic pricing can be used to estimate the price that farmers would be willing to pay for a product that is yet to be introduced in the market. The hedonic pricing method is based on the idea that price is a function of a product's attributes (Jimenez and Oppen, 1999). In the case of seed, farmers will be willing to pay a high price for a variety if he/she likes the cryptic and noncryptic characteristics that it possess. Cryptic characteristics are the inner properties of the variety, which are invisible (*e.g.* nutritional

and productive properties). In contrast, a varieties non-cryptic characteristics are properties that can be assessed by touch and sight (*e.g.* weight, color and shape). A model representing this idea is shown in Eq. 1

$$r_{mv} = f(c, n) \qquad \text{(Eq 1)}$$

where r_{mv} = price of the modern variety

c = cryptic characteristics

n = non-cryptic characteristics

Hedonic pricing does not contradict the concept that price is a function of supply and demand. However, it does assume a competitive equilibrium in a plane of several dimensions, where buyers and sellers are located (Jimenez and Oppen, 1999). In this equilibrium, farmers' characteristics like capital (e.g. land), human capital, labor, and infrastructure are held constant, which in reality may not be true. In an attempt to explain that variability, variables that measure farmer (i.e. seed buyer) characteristics can be included.

While breakeven analysis only takes into account yields, seed prices, and grain prices, hedonic pricing analysis also incorporates varietal seed characteristics as explanatory variables. If the model is used to compare only two varieties, these varieties can be thought to be a modern and a currently used variety. Using hedonic price analysis, the highest price a farmer will pay for a variety can be expressed as a function of the attributes of the variety itself, and the attributes of other varieties, as follows:

$$r_{mv} = f(c_{cv}, c_{mv}, n_{cv}, n_{mv}) \qquad \text{Eq. 2}$$

where r_{mv} = price of the modern variety

c_{cv} = cryptic characteristics of current variety

c_{mv} = cryptic characteristics of modern variety

n_{cv} = non-cryptic characteristics of current variety

n_{mv} = non-cryptic characteristics of modern variety

In this hedonistic price model, cryptic characteristics include yield and other nonobservable characteristics of the modern and the farmers' current variety. Farmers assessment of the non-cryptic attributes (e.g. size, color, shape) are reflected in farmers' expectations regarding the price that they think the variety would sell for in the market. In other words, rather than incorporating output prices as explanatory variables, price is reflected in the farmers' valuation of each characteristic. Furthermore, if factors that are held constant in the Eq. 2 (*e.g.* capital, human capital and labor–since they do not appear in the model) are introduced into the model, the price of a modern variety is a function of the attributes of the modern variety, attributes of the farmers' variety and socio-economic characteristics of the farmers. Thus, the new model may be represented as:

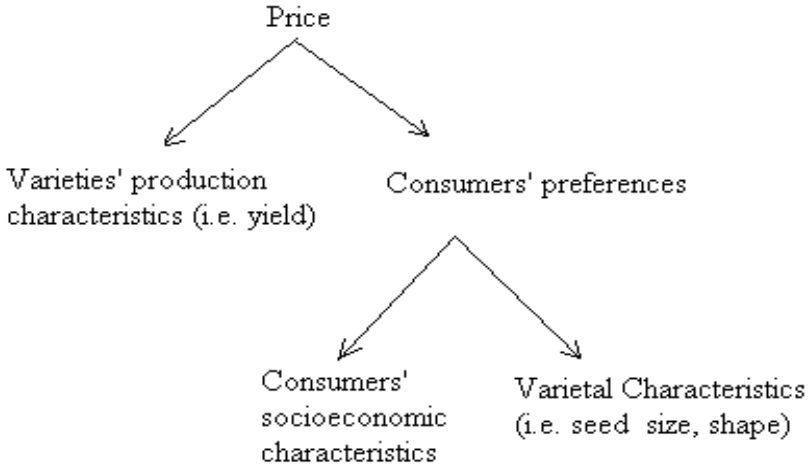
$$r_{mv} = f(c_{cv}, c_{mv}, n_{cv}, n_{mv,} fr) \qquad \text{Eq. 3}$$

where "fr" takes into account the farmer's management and socioeconomic characteristics and the other variables are the same as shown in Eq 2.

In summary, the price of bean seed is a function of its yield, farmers' varietal preferences (e.g. seed size, shape, color, cooking time, and palatable characteristics of the grain), and farmers' socioeconomic characteristics[3] (Figure 2).

Limited–dependent variable models are typically used to determine the influence of factors (variables) that explain purchasing decisions (i.e. willingness to pay). These models may include truncated variables (i.e. values above or below some threshold level are not observed due to either research design or naturally). According to Roosen *et.al.*(1998), a double hurdle model is appropriate for evaluating data with truncated dependent variables such as willingness to pay (WTP) data sets.

Figure 2. Bean price factor dependence.



[3] The farmer's characteristics include education (Heisey and Brennan, 1991), management practices they use, capital and age.

A double-hurdle model is estimated in two stages. First, bivariate probit analysis is used to estimate the first hurdle and then truncated regression analysis is used to estimate the second hurdle (Cragg, 1971; Baek, 2004).

2.5.5 Willingness to Pay

Myrick (1993) defines willingness to pay as the maximum amount of money an individual is willing to pay, instead of doing without the increase in the quantity of some good. While willingness to pay is most frequently associated with nonmarket valuation techniques like contingent valuation (Hanley *et. al.,* 1998), it can also be used with observed data of marketed goods, where WTP is a limited dependent variable (Roosen *et.al.*,1998). The demand curve provides information on the marginal willingness to pay (Perman *et. al.*, 1999).

One way[4] to structure the deterministic part of a random utility model (e.g. double hurdle model) is by specifying the utility of an individual as a function of a combination of that individual's characteristics and attributes of an alternative good (i.e. improved bean seed) (Kennedy, 1998). Thus, a random utility model can be used to estimate the farmers' highest price that a farmer would pay for seed of modern varieties, given certain information about the traits of the modern varieties, farmers information about traditional varieties (i.e. yield, cooking characteristics, and grain color, size and shape), and information about the farmer per se (i.e. capital, labor). In a random utility model, the farmer's latent value (i.e. breakeven price or highest price that a farmer

[4] The two other ways to structure the deterministic part of the random utility model is by 1) specifying the utility of the individual as a linear function of that individual's characteristics or 2)as a linear function of the attributes of the alternative.

would pay for seed of modern varieties) is not estimated and average yields of farmer's landrace varieties are not observed as they are in a break even price analysis. Instead, we collect data of farmers' affirmative or negative response to the purchase decision and WTP. By specifying the latent value (i.e. breakeven price) as a function of attributes of the product and characteristics of a farmer, it is possible to observe how an attribute or a characteristic increases or decreases the probability to purchase and WTP.

A farmer's buying decision has two dimensions--the decision to purchase and willingness to pay a given price. An advantage of the double hurdle model, as opposed to the Tobit model, is that it allows for the possibility of separating these two decisions (Burton *et. al.*, 1994). The double-hurdle model assumes that the farmer makes these two decisions separately–a farmer first decides to purchase a new variety to replace retained seed of an old variety and later decides on the maximum price that he/she would be willing to pay, depending on his assessment of the benefits of planting the improved seed. The farmer replaces his/her retained seed because he/she is convinced that modern varieties have superior characteristics over the retained seed, or just to try a new variety to observe how it responds.

2.6 Seed Supply

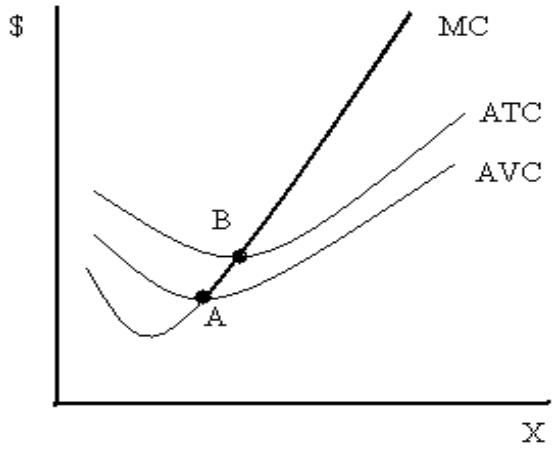
Seed supply information is important because it enables to understand the price determination and to assess the possibility of new firms entering the bean seed subsector.

2.6.1 Supply function

The neoclassic supply function specifies a schedule of prices and quantities of product that a firm will supply when investments have already been made. In a competitive product and input market, the supply function is the inverse of the marginal

cost function from the minimum average variable cost point to higher values (Beatie and Taylor, 1993)(Figure 3). In the short run, the minimum price that the firm will be willing to sell its product is at the point where minimum average variable cost is minimized (Point A in figure 3). In the long run, a firm will be willing to sell its products at the point where minimum average total cost is minimized (Point B in figure 3). However, to decide on the minimum price that a firm is willing to sell the product before the required investments have been made, budgeting techniques can be used.

Figure 3. Short-run firms' supply curve in a competitive market.



* MC = Marginal cost
ATC = Average total cost
AVC =Average variable cost

2.6.2 Budgeting

Three major types of budgets are used to analyze farm operations. These are the whole farm budget, enterprise budget, and partial budget. The enterprise budget is used when we need to analyze the profitability of a production system or activity. The

enterprise budget consists of a list of revenues and expenses incurred in the production of a product (Doye, 2005). In particular, for bean seed production, an enterprise budget consists of list of expenses like land preparation, inputs, labor expenses for applying inputs, and processing of the seed. The enterprise budget will provide the cost of seed.

2.7 Transaction Costs

2.7.1 The Nature of Transaction Costs

North (1990) defines transaction costs as the costs involved in an exchange, including the costs of information, protecting rights, policing, and enforcing agreements. On the demand side (e.g. seed buyer), Rusike and Eicher (1997) stated that "the transaction costs are caused by imperfect information, as well as transportation, negotiation, motivation, monitoring and supervision, and contract enforcement". On the supply side (e.g. seed grower), transaction costs include the costs of gathering demand information (North,1990), asset specificity[5] (Williamson, 1985), principal agency problems[6] (HayamiY., and Otsuka K., 1993) , and uncertainty in the market (Nicholson, 1998). With respect to seed, the incremental revenues expected from a modern variety, either by supplying it (firm) or adopting it (farmer), must exceed the incremental costs of supplying or obtaining the modern variety, including transaction costs.

[5] Difference between assets value in its optimal use and its second best alternative.

[6] Problems in contracting due to information asymmetry like moral hazard and adverse selection

2.7.2 .Farmers' Transaction Costs

On the demand side, farmers' information costs include the costs searching for the characteristics that he/she values in a bean variety. Seed characteristics include noncryptic (visible) characteristics and performance characteristics of the variety. To assess performance, farmers need to observe the variety, either in their field or in a demonstration plot of a promoting organization, the former being most trusted by farmers. Because it is difficult for farmers to measure all of these characteristics for several varieties at a time, government agencies and NGOs establish demonstration plots in farmers fields for farmers to assess these attributes. Nevertheless, the final test of a variety is when a farmer plants it in their own field using his/her technology and consumes the grain to measure its edible characteristics. Finally, transportation costs from the farmgate to the seed retail store play a role in the farmer's decision to buy seed, specially for farmers living in remote areas.

The transaction costs associated with protecting rights (e.g. writing the contract), policing (e.g. monitoring), and enforcing (e.g. legal fees) agreements also affect a farmer's decision to buy seed. In the first stages of seed system development, farmers save their own seed or obtain it seed from another farmer. Thus, seed inspection is easy and the trust among farmers is high. However, when farmers buy seed from a commercial seed distributor, they are not able to inspect the seed. Rather, they must rely on the government's seed certification unit to guarantee seed quality (Rusike and Eicher, 1997). Furthermore, if the seed fails to meet the required quality characteristics (e.g. purity, germination rate), the farmers' power to enforce an agreement (*i.e.*, obtain compensation) is low because they usually do not have the means to hire a lawyer to

protect his/her rights. And even if a farmer made a claim to the seed retailer, the retailer would only replace the purchased seed; which would not fully compensate the farmer, since he/she would have lost other inputs previously applied and possibly would have missed the proper time to plant his/her crop. Consequently, to minimize these transaction costs the government must establish a reliable seed certification system, as well as the other institutions required to protect rights, police and enforce agreements in order to insure seed quality.

Thus, for a farmer to adopt a modern bean variety, the benefits (e.g. higher yields, higher prices) must be greater than the incremental cost due to the higher seed price and the transaction costs aforementioned.

2.7.3 Seed Firms' Transaction Costs

On the supply side, firms face three problems: gathering demand information, recovering costs, principal-agent problems, and uncertainty in the market. The cost of gathering demand information could be very costly for a small seed firm especially in the first stages of seed development. This information is important to make decisions on the amount of capital to set for research and development. According to Rusike and Eicher (1997), in the first development stages, private firms-- which must invest in asset-specific equipment, research and promotion-- usually do not recover their investments. To reduce these risks, a firm might, for example, rely on the government to conduct varietal research and only multiply and seed these public varieties.

The principal-agency problems could also arise in a bean supply scheme in which the contractor (principal) or the entity in charge of selling a category of seed (e.g. foundation, certified, commercial) contracts a farmer (agent) for seed multiplication and

the agent tries to minimize its costs by using fewer inputs, thus, producing lower quality seed. This problem is complicated by the fact that sometimes, it is not possible to assess seed quality until after the crop is planted (i.e. seed-borne diseases).

Uncertainty in the market (e.g. bean prices, demand for beans) leads to inefficient allocation of resources (Nicholson, 1998). That is because a bean multiplier decides on courses of action (e.g. input use, investment) based on the probability of events to occur and not on the precise event. This leads to lower profits and even bankruptcy, as depicted in the example of Rusike and Eicher (1997).

2.7.4 Government's Role in Reducing Transaction Costs

Because transaction costs plays an integral role in the farmers' decision to adopt a variety and a firms decision to supply a variety, the government or a foreign organization often play a facilitating role to help support the evolution of the seed systems stages (Douglas, 1980; Rusike and Eicher, 1997). According to Fafchamps, Janvry and Sadoulet (1995), the government needs to establish policies to promote technological change, reduce transaction costs, lower credit costs, and relax credit constraints that farmers face in order to enhance competitiveness and thereby seed system development.

2.8 Summary

The subsector approach gives a useful frame to explain the vertical set of activities in the production and distribution of closely related set of commodities. Rapid appraisal methods are used to collect data to carry out subsector analysis. The diagnostic of the subsector analysis on the bean subsector should identify the stage of seed development for later proposing of policies to enhance the productivity of the bean system.

Developing countries in Africa and Latin America have used the informal seed systems as the primary source of obtaining seed. This informal seed system gives a poor quality seed since the seed is coming from farmer-to-farmer and farmer-saved seed, or are of good quality but not sustainable like the artisan seed projects have been. The failure of artisan seed projects has been the inability to develop a strategy for marketing their seed.

The breakeven analysis is used in farmers' decision on which variety to plant when the demand for seed is static, as when the farmer plants same area and does not vary the quantity of seed per area. Instead of including the output price of a product, which encapsulates the characteristics of a product, as a explanatory variable, hedonic pricing includes the characteristics of the product as explanatory variables to capture the value of each characteristic. Factors that are held constant in hedonic pricing like capital, labor, and infrastructure, and consumer (farmers) characteristics can be included in a random utility model to explain purchase decision and willingness to pay. A random utility model is analyzed with a double-hurdle approach. The first hurdle with a probit model to analyze the purchase decision and the second with a truncated regression to analyze willingness to pay.

A bean seed budget is used to determine the minimum price farmers will be willing to sell bean seed.

Transaction costs or costs involved in an exchange include costs of information, protecting rights, policing, and enforcing agreements. Information is needed by farmers of the varieties they are offered, and by firms of farmers preferences. Protection of rights, policing and enforcing agreements are an important part of the decision of the

farmer since if there is no system that could ensure these rights, the transaction costs could deter farmers' purchase decision. On the supply side, these rights are also important when dealing with contractees where principal-agency problems arise, with competitors when intellectual property rights are not in place and with customers.

Chapter III.

3. Research Methods

A rapid appraisal was conducted to collect information about the bean seed subsector in Honduras. During the rapid appraisal, key informant interviews were conducted and secondary data were collected. In addition, a sample of bean farmers were surveyed to collect data required to assess farmer demand for modern bean varieties. Also, a budgeting model was used to estimate the farm level profitability of producing commercial seed. Finally, a willingness to pay analysis, using a double-hurdle model, was used to assess farmer demand for modern varieties.

3.1 Data Collection

3.1.1 Rapid Appraisal

The rapid appraisal method was used to collect data needed to characterize the bean seed subsector. Key informant interviews were conducted with staff of input dealers, seed firms, NGOs and projects, banks, research agencies, government offices; and farmer groups and seed growers.

3.1.1.1 Input Dealers

Many firms in Honduras market agricultural inputs (*e.g.* seed, fertilizer, insecticide). However, only three dealers were contacted–DUWEST, FERTICA and CADELGA-- because these firms own or do business with many retail stores around the country. Thus, they could possibly be utilized in the future to market bean seed. Initial attempts to contact CADELGA and FERTICA revealed that they were not interested in participating in the bean seed scheme. However, staff of DUWEST agreed to be interviewed. During the meeting, information was obtained regarding the type of inputs

they sold and where they distributed inputs. After explaining the proposed bean scheme, DUWEST staff were asked under what conditions they would be willing to participate and sell bean seed through their sales network.

3.1.1.2 Seed Firms

Only two private firms produce bean seed in Honduras, Zamorano and Hondugenet. Zamorano is a private agricultural college. Hondugenet is a private company, which was a parastatal before it was privatized in the early 1990s under the Law of Agricultural Modernization. Staff of Zamorano and Hondugenet agreed to be interviewed and provide information about their bean seed production strategies, varieties produced, problems encountered, bean seed production contracts, seed production locations, inputs used, and marketing strategies.

3.1.1.3 NGOs and Projects

In recent years, several NGOs and projects have been involved in the bean seed production and distribution, especially following Hurricane Mitch (1998). In 2000, USAID funded a major project (Post Mitch Revitalization of the Agricultural Sector) to produce and distribute bean seed. Staff of two NGOs --World Neighbors (WN) and the Catholic Relief Services (CRS)– and two projects --the Development Project of the Mideast (PRODERCO) and the International Center of Tropical Agrigulture's (CIAT) seed project-- were interviewed because of their extensive participation in seed distribution schemes. In 2000, CIAT, in collaboration with Food and Agricultural Organization (FAO) and Movimento Liberazione e Sviluppo (MOVIMONDO) organized the "Production and Commercialization of Improved Artisan Seed" project, which worked with seven NGOs, including World Neighbors. Under the Post-Mitch project,

World Neighbors, CRS, and PRODERCO worked in collaboration with Zamorano to distribute seed to small farmers in the Departments of El Paraiso, Francisco Morazan, and Olancho. These NGOs were contacted to collect information about their bean seed production and commercialization/distribution activities, the demand for improved seed, their distribution strategies, and their interest in participating in the proposed bean seed production scheme.

3.1.1.4 Banks

Key informant interviews were conducted at four banks: Banco de Occidente, BGA, BAMER, and the National Agricultural Development Bank (BANADESA). Banco de Occidente, BGA, and BAMER were contacted because they are major participants in the capital market and have branches throughout Honduras. BANADESA was contacted because it was established by the government to support farmers. Bank staff were interviewed to collect information about their loan terms, volume of past loans to bean producers, loan services available to bean farmers, their interest in lending to bean seed producers, and the conditions under which they would extend loans to bean seed farmers.

3.1.1.5 Research Agencies

Two research agencies were contacted: the Bean Research Program (PIF) at the Panamerican Agricultural School and The Directorate of Research in Science and Agricultural Technology (DICTA), which are both responsible for developing modern bean varieties in Honduras. Staff from these agencies were interviewed to collect information about their bean seed production capacity, varieties released, prices of modern varieties, resources and conditions that farmers must follow to produce high

quality bean seed, the structure of the existing bean seed production system, and the ability of these agencies to train farmers in bean seed production.

3.1.1.6 Seed Certification Agency

CERTISEM, the agency in charge of certifying seed, dictates and enforces grain quality standards for seed marketing. CERTISEM staff were interviewed to collect information about the quality requirements for seed certification, the methodology used to measure these requirements, the legal requirements that must be followed to initiate the proposed bean seed scheme, and to determine the requirements for marketing bean seed.

3.1.1.7 Farmer Groups

Two groups of farmers and an individual bean seed contractee were interviewed: farmers in Yaruca, Atlantida; farmers and managers of the Regional Association of Agrarian Services in the Orient (ARSAGRO); and a Zamorano bean seed contractee. The Yaruca farmers were interviewed because they have a potential to grow bean seed in the Apante rainy season (December to February) and have access to technical support from the Atlantic Littoral University Center. The ARSAGRO farmers and managers were interviewed because they had previously participated in a CIAT-managed artisan bean seed production scheme. The bean seed contractee was interviewed because of his experience in bean seed production and knowledge of the typical problems encountered in growing bean seed. During these interviews, data were collected about their costs of seed production, incentives and constraints to producing seed, and the conditions under which they would be interested in participating in the proposed bean seed production scheme. The two farmer groups were interviewed to assess their willingness to

participate in the proposed bean seed scheme, to learn about their bean and bean seed production practices, and to collect data for a budget analysis.

3.1.1.8 Traders

Market traders in "Las Americas" market in Tegucigalpa were interviewed to obtain information on the prices they would pay farmers for several modern varieties and assess the price discounts that they impose on those varieties.

3.1.1.9 Budget Data Collection

Data required to construct a seed production budget were collected from several key informants. Key informants interviews were conducted with three small-scale bean seed producers in El Paraiso Department, who are members of the farmer association ARSAGRO[7], which jointly with CIAT, produces and sells bean seed of modern varieties to farmers in the region. Data collected from the three farmers included costs of land preparation, inputs, labor, and seed processing. In addition, bean seed cost of production data were obtained from World Neighbors, an NGO working in collaboration with CIAT in the aforementioned seed production initiative. These data were extracted from the records of ten participating farmers, including the cost of inputs, labor, seed processing, and tool investments. Finally, training investment costs were collected through interviews with experts (i.e. Professor Juan Carlos Rosas (Zamorano) and Rodolfo Pacheco (CIAT)) in bean seed production; and data on the cost of land registration and legal fees were collected from the government seed certification unit.

[7] ARSAGRO was participating in a CIAT seed scheme with the NGO ICADE.

3.1.2 Farmer Survey

A farmers survey was conducted to assess the demand for modern bean varieties. A total of 72 farmers were surveyed in El Paraiso and Olancho, the two departments in Honduras (Figure 4.) which have the largest bean hectarage (i.e. El Paraiso 13% and Olancho 15%, of the total area planted in Honduras (Agricultural census, 1993)). In El Paraiso (Figure 5.), the 24 most important bean-producing villages[8] in the Department were listed and divided into two regions: the plateau and the valley region. Each region included twelve villages. The twelve plateau villages were Arauli, Pescadero, Linaca, San Matias, San Geronimo, Jacaleapa, El Barro, El Tablon, Las Animas, Teupasenti, El Arenal, and Moroceli. The twelve valley villages were Jutiapa, Coyolar, El Obraje, Apali, Chirinas, Sartenejas, Chichicaste, Poteca, Montañita, Quebrada Larga, Zamorano, Zapotillo, and Matazano.

In Olancho (Figure 6), the 13 most important bean-producing villages in the Department were listed and divided in two regions--the North West mountain region with a total of six villages and North Central and Central valley region with 7 villages. The six mountain villages were Yocon, La Union, Salama, Silca, Talgua, and El Rosario. The seven valley villages were Manto, Guarizama, San Francisco de la Paz, Jimazque, Jutiquile, Catacamas, and Boqueron.

[8] Most important bean producing villages" refers to villages where small-scale farmers are known to grow beans, as opposed to villages where a few big farmers produce most of the beans.

Figure 4. The map of Honduras.

Figure 5. Department of El Paraiso, Honduras.

Figure 6. Department of Olancho, Honduras.

Finally a sample of 13 villages, from the total of 37 villages in both Departments, were selected; three in the plateau region of El Paraiso, four in the valley region of El Paraiso, three in the North West mountain region of Olancho, and three in the North Central and Central Valley Region of Olancho. Six farmers were selected in each village, except for two villages in El Paraiso because of the proximity of two villages (i.e., Poteca and Montañita; 3 farmers per village). In each village (except as noted above), the sample of six bean farmers was selected at random from lists that included 19 to 58 farmers--developed *in situ* with the help of two to three farmers in each village. Information about the selected departments, villages, and farmers is summarized in Table1.

Table 1. Number of farmers surveyed by department, region, and village in Honduras, Bean Survey, 2002.

Department	Topography/Region	Village Name	Village Population[a]
El Paraiso	Plateau	Linaca	39
	Plateau	San Jeronimo	22
	Plateau	El Tablon	27
	Valley	El Coyolar	26
	Valley	Chirinas	36
	Valley	Poteca[b]	19
	Valley	Montañita	26
Olancho	North West	Salama	52
	North West	Silca	41
	North West	El Rosario	58
	North Central	Manto	42
	Central	San Francisco de la	57
	Central	El Boqueron	44

[a] Estimated village population developed from a farmer aided *in situ* village farmer list.
[b] Six farmers selected in each village except for Poteca and Montañita, where three farmers were selected in each.

3.1.2.1 Questionnaire

The questionnaire focused on soliciting information from farmers about their preferences for and their willingness to pay for improved bean seed. Farmers' varietal preferences were first identified by asking them which bean varieties they had planted and sold during the past two years. Additional questions designed to measure farmers' preferences and demand focused on determining their awareness and assessment of widely available modern varieties, their assessment of new modern bean varieties (i.e. farmers were shown samples of six recently or soon to be released varieties), and their demand (i.e. willingness to pay) for improved bean seed.

Farmers' awareness of widely-available modern varieties was measured by asking them if they had planted or heard of the most recently released bean varieties, Dorado and Tio Canela. Farmers' assessment of these modern varieties was solicited through an open-ended question that asked farmers to identify the good and bad qualifications of Tio Canela and Dorado. Farmers' assessment of the traits (i.e. grain size, shape, weight, and color) of new modern varieties--which included already released and soon to be released varieties--was evaluated using a likert scale (1 = excellent , 5 = poor). Farmers' demand for each new variety was measured by their willingness to pay. To measure their ratings and willingness to pay, the farmers were shown six modern varieties in resealable transparent plastic bags. Each variety was labeled with a number instead of its name, so farmers would not respond based on his or her prior knowledge about the specific variety. Farmers were allowed to take the bean seeds out of the bags so they could examine them better. The six bean varieties shown to farmers were: Catrachita, Dorado, Tio Canela 75, Milenio, Amadeus 77 and Carrizalito--labeled from one to six,

respectively. The latter three have not yet been released to the market. In addition, farmers were asked to estimate the price that they thought traders would pay for each variety. Finally, farmers were asked about their recent bean production history (e.g., area planted, yields) and socioeconomic characteristics (e.g., age, education).

The draft questionnaire was pretested with farmers in the Zamorano Valley, revised to clarify ambiguous questions, and finally implemented in the aforementioned regions.

3.2 Empirical Methods

3.2.1 Empirical Model for Demand

A double-hurdle model was used to determine farmers' interest in purchasing MVs and their willingness to pay for these MVs. The double-hurdle approach, as the name indicates, divides the analysis into two parts: first a probit regression and then a truncated regression. The probit model is used to determine the degree and direction of influence that farmers' personal characteristics and varietal traits have on his/her purchase decision (i.e. marginal probability of each characteristic); and the truncated regression is used to determine the degree and direction of influence that farmers' personal characteristics and varietal traits have on how much a farmer is willing to spend on each variety (i.e. marginal willingness to pay).

The following double hurdle model was used to assess farmers' purchasing decisions and WTP:

$$\mathbf{Y}_i = B_o + \mathbf{X}_{ik}\,\boldsymbol{\beta}_k + \mathbf{v}_i \qquad \text{(Probit)} \quad \text{for i= 1,..,72, k=1,...,10}$$

where $\mathbf{v}_i$ is the error term.

$$WTP_i = B_o + \mathbf{X}_{ik}\,\boldsymbol{\gamma}_k + \mathbf{e}_i \qquad \text{(Truncated) for i= 1,..,72, k=1,...,10}$$

where $\mathbf{e}_{it}$ is the error term.

$\mathbf{Y}_i$ = desirability to purchase modern variety at a price between L 9 and L 17 (1=yes, 0=otherwise)

WTP = the highest price (between L9 and L17) willing to spend on a purchase. (willingness to pay)

$\mathbf{X}_{ik}$= set of explanatory variables determining the desirability to buy

$\boldsymbol{\beta}_k$ and $\boldsymbol{\gamma}_k$ are the parameter vectors to be estimated.

Separately from the double-hurdle model, an enterprise budget was used to estimate the cost of bean seed and to analyze the price at which bean seed can be sold.

3.3 Empirical Model for Seed Supply

A budget was used to estimate the minimum price of seed at which bean farmers would be willing to produce bean seed. The general objective of using this model was to determine the feasibility of producing bean seed of modern varieties at a price lower than L 30.8 /kg (i.e., the current price of certified bean seed). Sensibility analysis was conducted on the budget to estimate the risk borne by the farmer for producing bean seed.

3.4 Summary

The rapid appraisal methodology was used to collect information from key informants required to describe the bean seed subsector in Honduras. In addition, a sample of bean farmers were surveyed to collect data about their bean variety preferences, including their assessment of six modern varieties and their willingness to pay for these varieties. To assess farmer demand for modern bean varieties, a double hurdle model was used to determine the degree and direction of influence that farmers' and varietal characteristics have on farmers' purchase decision and willingness to pay. To assess the feasibility of supplying improved bean seed, a budgeting model was used to estimate the farm level profitability of producing commercial seed and the minimum price that the farmers need to have an incentive to produce bean seed.

Chapter IV.

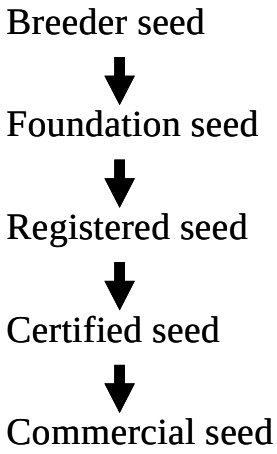
4. Bean Seed Supply in Honduras

This chapter describes the activities required to develop, multiply, and distribute seed of modern bean varieties and the agencies responsible for carrying out these activities. It also describes the participants in the Honduran seed subsector (i.e. governmental agencies, Zamorano university, NGOs and projects, private seed firms, input distributors, and banks).

4.1 Seed Production Stages

New seed varieties are developed through a sequence of stages (Figure 7). First, plant breeders produce breeders' seed by crossing various lines, multiply the breeder seed to produce foundation seed, and multiply the foundation seed to produce registered seed. Seed for sale to farmers is then produced by multiplying registered seed to produce certified seed. Finally, certified seed may be multiplied to produce commercial seed. As discussed below, each of these seed classes must meet specific quality standards.

Figure 7. Bean seed development stages.



4.2 Seed Supply Agents

4.2.1 Seed Certification Service

In Honduras, certified and commercial seed production[9] and distribution is regulated by a government entity, CERTISEM (Seed Certification), which is under the National Service of Farming Health of the Ministry of Agriculture in Honduras. Prior to 2002, a committee was in charge of creating and revising policies regarding the production, distribution, and importation of seed. However, the committee was dissolved in summer 2002.

Seed producers are required to follow a set of rules to be able to sell their product as commercial or certified seed. Table 2 summarizes the steps that seed growers must follow to meet the seed certification requirements and the cost of meeting each requirement.

Who bears these costs depends on the arrangement between the seed producers and the sellers. While a vertically integrated firm bears all the costs associated with the seed certification process, a processor[10] (who only sells certified seed) may negotiate a contract with a producer under which the processor pays all of those costs.

[9] Foundation and registered seed are mainly produced by licensed producers (DICTA, PIF), which are not required to have their seed inspected.

[10] Processors include firms or individuals that cleans and sorts seed using a machine.

Table 2. Steps seed industry producers and processors must follow to obtain seed certification from CERTISEM, Honduras, 2002.

Step	Cost	Characteristics
1. Register as: Individual merchant Producer Processor Importer	 L 500 a) L 1,000 b) L 500 L 1,000 L 1,500	 Every 2 years a) First time b) Every 2 years Every 2 years Every 2 years
2. Plot registration	L 50/mz[a] (L 71/ha)	Each cycle/cropping season
3. Plot supervision[b]	L 2/km	Outside urban area
4. Seed sampling	L 2/km L 0.50/sampled bag	- Outside urban areas - 45 kg bag
5. Seed label	Equal to the sale price of 1 kg of seed	*i.e.* If seed sells for L 1,500/qq (100 lbs), the label will cost L 33/qq.

[a] 1mz = 0.7ha
[b] Only required for certified seed, but not for commercial seed.
Exchange rate (2002): US $ 1.00 = L 16.44
Source: CERTICEM

Seed merchants (individuals or businesses) must purchase their supplies from a certified or a commercial seed producer[11]. With respect to seed certification regulations, a major difference between these two types of seed is that while certified seed must be inspected both in the field and in a laboratory, commercial seed is only inspected in a laboratory after the producer gives CERTICEM a sample of the harvested seed. In addition, certified seed must meet higher quality standards, as specified in Table 3. CERTISEM has established specific field specifications for growing certified seed: 1) no more than two varieties may be grown per farm and both varieties must have

[11] While individuals or business may import seed, bean seed has only been imported once in the past seven years. In 1998, seed was imported from Nicaragua following Hurricane Mitch, which reduced the seed supply.

characteristics that are easy to differentiate by sight; 2) fields are not eligible in which different bean varieties or soybeans have been grown in the prior six months; 3) a field where bean varieties have been planted in the prior six months must be planted to the same variety with the same or lower category of seed (e.g. cannot grow certified seed if commercial seed was previously grown in the field); 4) all plants infected with bacterial or fungal diseases must be removed; and 5) fields planted to different bean varieties must be separated at least 10 meters.

Table 3. Quality standards for certified and commercial seed, Honduras, 2002.

Category	Certified Seed	Commercial Seed
Seed purity [a] $	98 %	97 %
Seed of other varieties #	3 seeds/kg	10 seeds/kg
Seed of other crops #	2 seeds/kg	4 seeds/kg
Seed of weeds #	2 seeds/kg	4 seeds/kg
Inert material #	3%	3%
Germination $	80%	80%
Humidity #	14%	14%
Seed with holes	0%	3%

[a] The percent of seed that has a cover even if the seed is rotten, wrinkled and has holes.
Source: CERTISEM

In addition to the field specifications, the bean seed crop must meet specific field tolerance standards. The field tolerances for each seed category[12] are shown in Table 4.

[12] CERTISEM does not specify seed tolerances for breeders seed, since the breeder is responsible for insuring its quality.

Table 4. Field tolerances for different categories of bean seed, Honduras, 2002.

Presence of:	Foundation Seed	Registered Seed	Certified Seed
Other varieties	0%	0.1%	0.2%
Other crops	0%	0%	0%
BGYMV[a]	0.5%	1%	1.5%
Antrachnose	0.5%	1%	1.5%
Bacterial blight	0.1%	0.3%	0.5%

[a] Bean Golden Yellow Mosaic Virus
Source: CERTISEM

CERTISEM reported that plots are most commonly rejected because of variety impurity, which is detected by CERTISEM staff when they visit the fields during the development and flowering stage. On very few occasions, plots are rejected due to the presence of diseases.

According to key informants, CERTISEM staff face two main problems. First, its trained technicians periodically leave the institution following a change in the government. Second, the agency has too few vehicles and personnel to inspect seed plots. Thus, when there is a high demand for seed inspections, staff have to make arrangements with the producers to pick up the technicians and drive them to the seed plots. Consequently due to staff shortages, sometimes it takes CERTISEM more than 14 days to carry out seed germination tests and return the results to their clients.

While Honduras has not yet approved intellectual property rights protocols for seed, a draft law has been submitted to Congress for its approval. Thus, presently, anyone can multiply any variety without paying royalties.

4.2.2 Breeder, Foundation, and Registered Bean Seed Producers

Interviews with key informants revealed that Zamorano and "The Directorate of Research in Science and Agricultural Technology" (DICTA) are the only organizations that produce breeder seed, foundation, registered, and certified seed. The following sections describe information collected from key informants interviewed at Zamorano and DICTA.

4.2.2.1 Zamorano/PIF

Zamorano has two distinct units involved in bean seed production. "El Proyecto de Investigaciones en Frijol" (PIF), a research unit that produces breeder, foundation and registered seed, and the Zamoempresa de Cultivos Extensivos (ZCE), a unit of Zamorano that produces certified seed.

4.2.2.1.1 Production

PIF produces breeder, foundation, and registered seed (small red and small black beans) for the Central American and Caribbean region on its own plots (i.e. does not contract with farmers). While PIF has contributed most of the germplasm (50%) in varieties it has released for use in Central America and the Caribbean region, material from CIAT (20%), University of Puerto Rico (20%), and DICTA (10%) have also been used in making these crosses (Rosas, J.C., 2002, personal communication).

PIF maintains a seed bank which includes landraces breeding lines and varieties released in Honduras (i.e. Tio Canela, Dorado, Catrachita, Danli 46, DICTA 113, DICTA 122, Don Silvio, Acacias 4, Esperanza 4, Zamorano, Desarrural). In addition, PIF maintains unreleased germplasm (i.e. Milenio, Yeguare, and Don Victor), which were not

released due to some problems (e.g. discoloration of the grain from excessive water).

4.2.2.1.2 Quality Control

PIF's is responsible for insuring the quality of its seed. No government agency inspects its seed because they have that license to produce their own seed and maintaining its reputation provides sufficient incentive to insure good quality seed.

4.2.2.1.3 Distribution and Sales

In recent years, PIF has produced about 1.8 mt of foundation/registered seed per year. PIF sells registered seed to ZCE and various agricultural related projects. In addition, PIF assists projects to which it provide seed to establish demonstration plots so farmers can observe and compare different varieties. In the future, PIF plans to expand its collaboration with the national program, DICTA (Rosas, J.C., 2002, personal communication).

4.2.2.1.4 Prices

The price at which PIF sells its foundation seed is for L 2,000 per bag of 45 kg. (Rosas J.C., 2002, personal communication).

4.2.2.2. DICTA

4.2.2.2.1 Production

DICTA produce breeder seed[13] of its own varieties and has permission from Zamorano to produce foundation, registered, and certified seed of the same small red varieties that PIF produces. DICTA produces foundation seed on its fields in Comayagua (i.e. they do not contract), although it sometimes obtains foundation seed from PIF. In

[13] CIAT has collaborated with the National Bean Program from 1989 to 1993 and with DICTA since its creation in 1993.

recent years, DICTA has released several varieties (e.g. DICTA 113 and DICTA 122) and has multiplied varieties bred by PIF (e.g. Tio Canela, Don Silvio and Dorado).

4.2.2.2.2 Quality Control

DICTA staff are responsible for insuring the quality of its foundation seed. However, for registered and certified seed, DICTA must register the plot with CERTISEM and pay for the seed label. Although not a major problem, the most common reason that DICTA's seed is rejected is due to weeds in the field.

According to DICTA personnel, because DICTA is understaffed, it is only able to manage up to 7 has of seed of all types in its production fields during each growing season.

4.2.2.2.3 Distribution and Sales

In the past, DICTA has sold registered seed to Hondugenet –a private seed company. However, in recent years (2000-2002) DICTA only sold seed to Hondugenet once, since after 2002 Hondugenet began to produce commercial seed instead of certified seed. In addition, DICTA occasionally sells foundation seed to NGOs . While DICTA sells seed of all types to farmers, NGOs, and agricultural related projects, DICTA is a relatively minor actor in the seed market, as selling only 181 kg, 1.6 mt, and 2.3 mt of foundation, registered, and certified seed combined in 1999, 2000, and 2001, respectively. All sales were in Danli. The price at which DICTA sells seed varies by seed category. In 2002, DICTA sold the 45 kg bags of foundation, registered, and certified seed for L 2,000, L 1,800, and L 1,500, respectively (Escoto, 2002, personal communication).

4.2.3 Certified and Commercial Bean Seed Producers

Key informants reported that Zamorano (ZCE) and Hondugenet are the major certified and commercial bean seed producers and sellers in Honduras. Zamorano only sells certified seed and Hondugenet sells both certified and commercial seed. Additional minor seed producers include DICTA[14] (certified seed), as well as some NGOs (commercial seed). The following sections describe information collected from key informants from ZCE, bean seed contractees, and Hondugenet.

4.2.3.1 Zamorano/Zamoempresa de Cultivos Extensivos

ZCE is in charge of producing and marketing certified seed. It obtains registered seed from PIF (70%) and DICTA (30%, mostly Dorado).

4.2.3.1.1 Production

ZCE produces about 45,455kg to 54,545 kg of certified seed per year. About 50% of the seed is produced by ZCE staff at Zamorano and about 50% is produced by contractors at San Juan de Flores. In 2001, Tio Canela (75%) and Dorado(25%) were the varieties produced by ZCE. In the future, ZCE speculates they will produce mostly Amadeus 77, due to its desired light red color.

4.2.3.1.2 Quality

To insure that contractees produce high quality seed, ZCE requires its contractees to produce seed under irrigation during the dry season (Jan-Apr), which reduces uncertainty and disease problems. In addition, ZCE requires its contractees to follow its

[14] Currently DICTA sells small amounts of certified seed to NGO's (e.g. CRS, Movimundo, and World Neighbors), institutions (e.g. FAO, ICADE, and Zamorano), and farmers.

recommendation regarding plant spacing, weeding, disease and insect control, and roguing. Furthermore, ZCE staff visit the farmers to select the production fields, monitor land preparation, planting, crop development, flowering and harvest.

4.2.3.1.3 Sales

Before 2002, ZCE sold seed mainly in 50 pound bags (22.7 kg) and in a few cases in 10 (4.54 kg) and 25 (11.36 kg) pound bags . However, starting in 2002, ZCE began to sell seed in 44 lb (20 kg) bags.

In 2001 ZCE distributed all seed it produced from its office at Zamorano. While ZCE made DUWEST (a national distributor of Dupont's agricultural chemicals) an authorized distributor of its certified seed by early 2002, by the 2002 primera planting season, ZCE had not yet started to distribute seed through DUWEST. DUWEST distributes agricultural inputs throughout Honduras.

Key informants at ZCE reported that they have not had any problems getting its seed inspected or certified, although sometimes CERTISEM employees did not carry out all of the scheduled visits.

ZCE sold certified seed for L 14/lb (L 30.8/kg) in 2001 and plans to sell for L 15.9/lb (L 35.0/kg) in 2002. ZCE staff would not give the price at which they plan to sell certified seed to DUWEST because they said it was classified information.

4.2.3.1.4 Contract Terms

ZCE started contracting farmers to produce certified seed after Hurricane Mitch (1999), when the demand for seed increased dramatically. In selecting contractees, ZCE looks for educated and trustful farmers --farmers who they already know by reputation. In addition, they look for contractees who are located near Zamorano and have access to

capital and irrigation. Since 1999, ZCE has used contractees located in San Juan de Flores, Francisco Morazan (38 km from Zamorano).

ZCE makes a verbal contract with farmers which specify the area to be planted, an expected yield, and delivery place and date. ZCE agrees to pay the land registration fee[15] (which prohibits farmers from legally selling the seed to anyone except ZCE) and provides the contractee with registered seed. The contractee agree to pay for all inputs, except seed, and agrees to host regular inspections by ZCE and the required inspections by CERTISEM staff. At harvest, ZCE collects the seed at the farm where it is grown, pays the transport costs from the farm to Zamorano and returns rejected grain to the farmer, unless the farmer agrees to accept a lower price (i.e. grain price) for the rejected seed. ZCE pays contractees L 1.5/lb (L 3.3/kg) above the SIMPAH[16] bean price, although the price premium can be renegotiated if the grain price increase to a high level.

The ZCE has not had any problems with its contractees (e.g. rejection of bean seed fields, legal disputes). However, some farmers expressed concern about the amount of grain that ZCE accepts as seed. Rather than having their seed rejected, contractees would prefer to receive a price decrease (i.e. from L 650/qq to L 550/qq, but not lower (1 qq = 100 lbs)), as long as all grain is accepted.

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[15] Along with the land inscription, ZCE pays for all visits by CERTISEM.

[16] SIMPAH is a government organization that monitors and reports the prices of major agricultural commodities grown in Honduras.

4.2.3.1.5 Contractee's concerns

While the contractees were generally satisfied with the above described contract, some contractees are unhappy with the percentage of their production that was rejected as seed (Table 5). The contractee reported that while Hondugenet paid farmers only L 5.5/lb (L 12.1/kg) of seed in 2002, it did not reject any seed. So the farmer argued that it was more attractive to sell to Hondugenet than to ZCE which paid a higher price but also had a higher rejection rate. However, ZCE need to maintain high quality standards to protect against moral hazard, since it markets certified seed while Hondugenet only markets commercial seed.

Table 5. Percentage of seed rejection of seed delivered to the Zamoempresa de Cultivos Extensivos by a representative contractee, Honduras, 2002.

Year	Delivered (qq)[a]	Amount of Sales as:		
		Seed	grain	percent sold as seed
2001-2002	208	158	50	75.96%
2000-2001	105	72	33	68.57%
1999-2000	230	150	80	65.22%
Mean	181	126.66	54.33	69.92

[a] 1qq = 100 lbs.
Source: Key informant interview, 2002.

Second, contractees expressed concern about the lack of transparency in ZCE's seed evaluation process. After transporting the seed to Zamorano, as part of processing, ZCE uses a screen to select out small size kernels. However, the contract does not specify the criteria for rejecting seed (e.g. grain size, foreign matter, germination rate). Thus, to avoid future problems with contractees, ZCE should specify in the contract, the size of the screen that it uses to select seed and other criteria for rejecting seed.

Third, some contractees expressed concern that the price that ZCE paid for seed has declined. In 1999, contractees received a price of L 7/lb (L 15.4/kg). This high price was paid because ZCE was certain that it would sell a large quantity of seed at a high price to the Post-Mitch alleviation projects. However, in 2001 and 2002, ZCE paid its contractees L 5.5/lb (L 12.1/kg) and L 6.5/lb (L 14.3/kg), respectively.

In addition, contractees expressed concern about the difficulty of obtaining loans from banks. Typically banks require borrowers to provide urban collateral as a guarantee against default. In addition, the banks value these assets at 50% of their market value and then issue a loan for 50% of that value.

Finally the contractee reported that to successfully produce bean seed, farmers must have access to an irrigation system because the seed crop must be grown during the dry season.

4.2.3.2 Hondugenet

In the past, Hondugenet obtained its foundation seed from DICTA. However, the firm had not purchased seed from DICTA[17] since 1998. Currently rather than buying foundation or registered seed, Hondugenet produces seed from its own seed stocks. Thus, although Hondugenet can only sell commercial seed, it is able to sell its commercial seed at the same price as certified seed due to its good reputation.

4.2.3.2.1 Seed Production

Hondugenet produces seed in Francisco Morazan and El Paraiso because those are the country's most productive bean areas and Hondugenet has a long relationship with its

[17] Hondugenet has also bought certified seed from Zamorano to produce their commercial seed.

contractees in these areas. About 70% of Hondugenet's seed is produced by contractees (6-7 farmers), and the firm produces 30% in leased fields.

4.2.3.2.2 Contract terms

According to key informants at Hondugenet, good contractees are farmers who do not place the crop at risk for trying to cut costs, and who work on a fixed schedule. Hondugenet selects farmers who have farms on which beans can be grown isolated from other crops, are easy to access, have an irrigation system and flat fields, own or can rent a tractor, have sufficient labor, are trained in crop management (e.g. herbicides, insecticides), and have fields close to the processing plant. Also, to insure the contractees produce high quality seed, Hondugenet staff makes 8-10 inspections to contractees' fields.

Even though there is no written contract, Hondugenet's requires that the contractees' seed meet the standards required by law to be considered commercial seed. The informal contract specifies the area to be planted, that the contractee delivers[18] the seed to the processing plant in "Ojo de Agua", and that Hondugenet will pay for the grain at delivery (14% humidity). All input costs are incurred by the contractee, except for seed which is provided by Hondugenet. Similar to ZCE, Hondugenet pays a given percentage (not given, confidential) above the grain market price given by SIMPAH.

Key informants at Hondugenet reported no problems with their contractees and rejected almost no seed. Also, CERTISEM has not rejected any seed produced by Hondugenet's contractees and CERTISEM staff have inspected the seed in a timely manner.

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[18] Hondugenet pays CERTISEM just for sampling and for the label (i.e. field inspections are not done), because they only sell commercial seed.

4.2.3.2.3 Sales

Hondugenet sold approximately 18 mt of commercial bean seed in 1997 and 1998, and 136 mt in 1999, 2000, and 2001. Hondugenet sells its bean seed to large-scale farmers, distributors, NGOs, and projects (e.g. CARITAS, CRS, CARE, FAO, GTZ, Movimundo, PNUD, and the Red Cross)–mostly in Tegucigalpa (80%) but also in San Pedro Sula (20%). Hondugenet produces several varieties. However in 2001, it mainly sold Tio Canela (68 mt), Dorado (45 mt), and Dicta 113 (14 mt).

Hondugenet does not have any authorized distributors. Rather, it sells seed primarily to 8-10 customers who buy large quantities which they redistribute. These buyers receive a discount of L 1/lb (L 2.2/kg) below the retail selling price. In 2001, Hondugenet sold its seed in Tegucigalpa and San Pedro Sula for L 14/lb (L 30.8/kg) and planned to sell commercial seed in 2002 for L 15/lb (L 33/kg). Also, Hondugenet does not sell seed on consignment because returned seed might have a low germination rate.

Hondugenet primarily sells its seed in 50 lb (22.7 kg) bags because this size is easy to handle and it is the amount needed to plant one manzana (0.7 Ha). However, they will sell seed in a 20 lb (9 kg) bag to a farmer who asks for it.

4.2.3.2.4 Hondugenet Bean Seed Production Role

Hondugenet staff reported that bean seed sales is a side business, rather a primary part of their seed business (i.e. produce bean seed just to give a service, not interested in participating in seed scheme). In addition, they commented that the bean seed business is tied to development of a new variety–demand is greatest after a new variety is released and then declines. Furthermore, they only sell bean seed in Tegucigalpa and San Pedro Sula

because farmers in other areas/departments have low purchasing power and typically buy seed from their neighbors.

Finally, Hondugenet staff were pessimistic about the sustainability of artisan seed projects and providing seed vouchers to NGO-beneficiary farmers. They asserted that farmers sell artisan seed at grain prices out of necessity (i.e. they sell the seed at the grain price because local farmers are not willing to pay a premium for seed) and using vouchers to sell seed to farmers will not work because of corruption.

4.2.4 NGOs and Artisan Seed Producers

4.2.4.1 NGOs

Over the past 20 years, artisan seed production has been promoted by the Ministry of Agriculture and NGOs with support from Zamorano and CIAT. Key informants at CIAT, reported that under the project "Production and Commercialization of Improved Artisan Seed"(PCIAS[19]), 10 NGOs (i.e. APS, CCD, World Neighbors, CONSULUPE, Grupo Guia, MOVIMONDO, ICADE, and CISP) are assisting small-scale farmers to produce commercial seed of beans, maize, sorghum, soybean, rice, and peanuts. The project covered the departments of Colon, Santa Barbara, Ocotepeque, El Paraiso, and Francisco Morazan.

The NGOs purchased registered seed from either Zamorano or DICTA and then distributed it to their farmers. In the first year, the NGOs gave the inputs to the farmers, but in the second year the farmers had to pay for the inputs. The NGOs do not use contracts,

[19] PCIAS is very similar as other artisan seed schemes and to the scheme proposed in this research. The major differences between PCIAS and the proposed seed scheme are that under PCIAS farmers sell their seed in the region where it is produced, while the goal of the proposed is to contract a private input supplier (DUWEST) and market the seed through its distribution network.

since the farmers were considered to be beneficiaries. In 2001, farmers from World Neighbors sold bean seed in 25 lb (11.36 kg) bags at L 8/lb (L 17.6/kg). According to CIAT staff bean seed production costs averaged around L 6/lb (L 13.2/kg).

World Neighbors (WN) and Catholic Relief Services (CRS) are two active bean seed distributing NGOs. Also, some projects like PRODERCO, were involved in bean seed distribution. These NGOs and PRODERCO distributed seed mainly in 25 lb (11.36 kg) bags. These project and NGOs gave the bean seed at highly subsidized rates. However, CRS was willing to use a voucher system.

4.2.4.2 Role of CIAT

CIAT has played a major role in supporting PCIAS, including selecting leader farmers in each village to help manage the seed production scheme, training the farmers in seed production, and assisting the farmers to sell the seed that they produce.

CIAT's staff reported that farmers in some regions had low yields or the crop failed due to low rainfall, since the farmers do not have irrigation systems.

4.2.4.3 ARSAGRO

ICADE, one of the NGOs that promotes artisan seed production under PCIAS, works with several farmer groups including ARSAGRO--farmers association that offers agricultural services to its members. ARSAGRO staff and farmers were interviewed to gain insights from participants regarding how artisan schemes function. To become a member, farmers must pay a fee, agree to participate in meetings, and own land. The farmers selected to produce commercial seed had previously taken seed production training[20]. Farmers

[20] From 1990-1992, The Ministry of Natural Resources trained farmers in artisan seed production.

reported that the advantages of being associated with ARSAGRO is that membership gives them access to inputs, services (i.e. plowing), and credit.

ARSAGRO's members produces seed in the municipalities (department subdivisions) of Danli, El Barro, Arauli, and San Matias. In 2001, ARSAGRO farmers produced commercial seed of Dorado, Tio Canela, DICTA 113, Amadeus-77, and Carrizalito (Amadeus and Carrizalito just as trials since they were not released yet). While ARSAGRO does not require its seed growers to sign written contracts, farmers must agree to grow seed in a field that is acceptable to ARSAGRO and deliver it to ARSAGRO at harvest. In 2001, ARSAGRO paid farmers L 5/lb (L 11/kg) for dry (14% humidity) unselected seed in bags, delivered to ARSAGRO's office in Danli. In 2002, farmers were negotiating to receive L 6/lb (L 13.2/kg) of dry and selected seed. ARSAGRO markets its seed in the 25 lb (11.36 kg) bags (provided by CIAT) to farmers in the region, since it does not have distributors to market the seed.

A summary of the agents and functions of seed suppliers in Honduras is presented in Table 6.

Table 6. Seed Production and marketing in Honduras, 2002.

Activity / Participants	**Description**
Breeding	
Zamorano/PIF	makes crosses
DICTA	makes crosses
Seed Multiplication	
Zamorano	
PIF	multiplies breeder seed up to registered seed
ZCE	multiplies registered seed to produce certified seed
ZCE's contractees	multiply registered seed to produce certified seed
DICTA	multiplies breeder seed up to certified seed
Hondugenet	
Firm	Hondugenet multiplies certified seed to produce commercial seed
Hondugenet's contractees	Hondugenet's contractees multiply certified seed to produce commercial seed
NGOs[a]	
NGOs central office	collaborate with CIAT in its seed multiplication scheme; NGOs multiply certified seed to produce commercial seed
NGO Farmers	participate with NGOs (i.e. ARSAGRO farmers) to multiply certified seed to produce commercial seed
Seed Inspection	
CERTISEM	inspects all fields used to produce certified seed and all certified and commercial seed
Seed sales/Distribution[b]	
Zamorano/ZCE	sells seed at Zamorano's campus
Hondugenet	sells its own seed in Tegucigalpa and San Pedro Sula
NGOs	helps farmers sell their seed in neighboring towns

[a] NGOs (i.e. APS, CCD, World Neighbors, Consulupe, Grupo Guia, Movimundo, Icade, CISP).
[b] DUWEST made a contract to distribute ZCE's seed but had not started by June 2002.
Source: Key informants, 2002.

4.2.4.4 Potential Bean Seed Producers

In addition to the ARSAGRO farmers**,** a group of farmers from the north coast were interviewed to see if they were interested in participating in the proposed bean seed production scheme. This farmer group were contacted because they were experienced bean farmers and had access to extension services through the National University of Honduras. In addition, the north coast farmers can grow beans during December to February. Thus, they can produce bean seed for sale in the primera season without irrigation. Although they had never produced bean seed, this farmer group were interested in learning how to produce seed and participate in the proposed scheme.

4.2.5 Input Distributor

4.2.5.1 DUWEST

While several firms (e.g. CADELGA, FERTICA, BAYER) distribute agricultural inputs in Honduras, DUWEST was the only firm that expressed an interest in distributing bean seed. DUWEST has exclusive and non-exclusive distributors/agents who are based in the main department cities of Olancho, Yoro, El Paraiso. Also, in addition to department capitals, DUWEST sells in fairly big cities. DUWEST markets its products through subdistributors (e.g. REISA and PROTECNO). For example, DUWEST has around 10-15 subdistributors/agents in Danli, El Paraiso, including Alagro and Agropecuaria Rodas. DUWEST sells its inputs on a cash basis. These agents markup products 10-15% above the price they paid to DUWEST.

In 2002, DUWEST planned to sell bean seed to subdistributors in El Paraiso and Olancho for the postrera season at L 17.27/lb (L 38/kg). DUWEST expected to obtain its seed from ZCE for L 13.82/lb (L 30.4/kg) of bean seed. The price of L 17.27/lb (L 38/kg)

in Danli, includes the 20-25% markup (2-3% is to cover transportation costs) from the price DUWEST paid to ZCE. Transportation costs (calculated as 17.27*0.02-17.27*0.03) are L 0.35 - L 0.52 per lb (L 0.76-L 1.14 per kg). The final price to the farmer would be around a range of L 19/lb (L 41.8/kg) and L 19.86/lb (L 43.7/kg) with the markup of 10-15% from the subdistributor.

4.2.6 Agricultural Banks

Staff of four banks were interviewed: Banco de Occidente (BO), BANADESA, BGA, and BAMER. Banco de Occidente (BO), BANADESA, and BAMER have given loans to bean farmers for up to three years before 2002.

After hurricane Mitch, BGA reduced the amount of their direct loans to agriculture and restructured its loans. In 2000, BGA stopped making loans to most bean farmers because of the risk involved in agriculture. In addition, the bank shifted their lending to more profitable crops and lengthened the repayment time of their late loans.

On the other hand, Banco de Occidente has directed more funds to small farmers, using both its own funds and discounted funds (i.e., subsidized interest rate) that is obtained from the government.

BAMER and BANADESA continue to extend loans to bean farmers, except that now they are also extending low interest rate loans with discounted funds recently made available by the government.

4.2.6.1 Recent Lending Activities

The value of loans to bean farmers accounts for 2-3% of the agricultural account in some banks like BO but less than 1% in BGA. As Table 7 shows, the value of loans extended to farmers by each bank ranges from L300,000 to L7,000,000.

Table 7. Value of loans extended to bean farmers by several banks in Honduras, 2002.

	Total Value of Loans (In Lempiras)			
Year	**2002**	**2001**	**2000**	**1999**
Bank				
BAMER	NA	7,000,000	4,500,000	3,000,000
BANADESA	3,100,000	3,900,000	4,300,000	6,000,000
Banco de Occidente	NA	300,000,000[a]	NA	NA
BGA	300,000	NA	NA	NA
Source: Key informant interviews, 2002.				
NA= Not available [a] Total amount in the agricultural account for that year. $1 = L 16.44				

Banco de Occidente, BANADESA, and BAMER extends minimum loans of L5,000, L 3,000, and L10,000, respectively. BGA lends 75% of production costs to clients with annual sales greater than $120,000, which eliminates small scale farmers.

4.2.6.2 Banking Operations

In the interest of reducing transaction costs, staff from the banks were asked if they had agreements with rural cashiers[21]. BAMER and BGA have no agreements with rural cashiers. On the other hand, Banco de Occidente and BANADESA manages accounts with rural cashiers and extends loans to them. This not only reduces transaction costs to the bank,

[21] Rural cashiers are entities that work in collaboration with banks to facilitate loans to farmers in the rural areas.

but also to the farmer which can make it easier to farmers to invest in bean seed production. In addition to having agreements with rural cashiers, BANADESA uses government funds to make loans to farmers who do not have collaterals.

While BGA made it clear that it is not willing to extend loans to bean seed farmers because of the risk involved and late payments, BANADESA and Banco de Occidente are interested in working with small-scale bean farmers.

4.2.6.3 Loan Conditions

4.2.6.3.1 Interest Rate

BGA charges an interest rate of 26-32% depending on the client. When BGA uses FONAPROVI[22] funds, it changes 10 %. However, BGA has not extended any loan to bean farmers with FONAPROVI funds because the bank bears the risk. BAMER used to charge a 19% interest rate, but with FONAPROVI funds they lend at 10%. Banco de Occidente used to charge an interest rate of 22-28% with their funds and 17.22% with FONAPROVI funds. However in 2002, it charged 10% after legislation lowered the FONAPROVI funds interest rate. BANADESA charges 10% interest rate on FONAPROVI funds, and 24% on its own funds.

4.2.6.3.2 Time Horizon

BGA requires farmers to repay their loans in six to nine months. BAMER requires farmers to repay their loans in nine months, but allows farmers 18 months for FONAPROVI funds. Farmers can opt to repay their loans in two payments instead of one. BO requires

[22] FONAPROVI is a financial institution that provides loans for production of goods and housing for lower income groups.

farmers to repay their working capital loan in nine months and fixed asset loans in five years. BANADESA requires farmers to repay any kind of loan in six months.

4.2.6.3.3 Collateral

BGA requires farmers to have a collateral, usually an urban mortgage. It allows farmers to borrow up to 60% of the bank's appraised value of the mortgage, or if it's a pledge, farmers can borrow up to 40% of the appraised value and the pledge has to be insured and turned over to the bank. BAMER accepts both mortgage collaterals and pledges. It allows farmers to borrow up to 60% of the bank's appraised value of the mortgage. Banco de Occidente accepts fiduciary (up to L 25,000 and two guarantors), mortgage (up to L3,000,000, 60% of the appraised value) or a pledge (40-50 % of appraised value). BANADESA accepts fiduciary (with guarantors), mortgage (60% of the appraised value) or pledge (40-50 % of land registry appraised value) as a collateral.

4.2.6.3.4 Group Loans

BGA is willing to extend loans to individual farmers or to groups of farmers if a recognized institution agrees to serve as a collateral and provides technical assistance to these farmers. BAMER is willing to extend loans to individual farmers or to groups of farmers. If its in a group, they would deal only with the president of the group. Banco de Occidente prefers to extend loans to individual farmers. If loans were made to a group of farmers, the group would all be responsible for repaying the loan. BANADESA is willing to give loans to individuals or to groups of farmers. BANADESA is willing to work with bean farmers, as long they meet the following requirements: photocopy of ID, municipal solvency, complete ownership of collateral, up to date with taxes, 2-3 bank references; for a group: authorized act, legal status and CNC and COCOCH proof (legal registration).

4.2.6.3.5 Interest in Loaning to Scheme Farmers

Banco de Occidente, BAMER and BANADESA were willing to provide credit to small farmers. Nevertheless**,** BAMER's minimum loan is two to three times larger than BO's and BANADESA's loan. Thus, many small-scale farmers might not be interested in obtaining a loan from BAMER, if they only wanted working capital to cover the cost of inputs like seed, fertilizer and pesticides which would only cost approximately L 5000/ha. Even though BANADESA and Banco de Occidente are willing to lend to small-scale farmers, small scale farmers may not be willing to ask for a loan. Given the production risks involved (i.e. rainfall) farmers might be hesitant to take a loan because they fear losing the land or other collateral. In addition, small-scale farmers might be hesitant to take a loan due to transaction costs involved (i.e. paperwork).

Finally, BGA is not willing to work with small-scale farmers because they frequently do not repay loans on schedule and due to the risk involved in lending to small-scale farmers.

4.3 Summary

Bean seed supply is characterized by a series of seed production stages up to the distribution of seed through a marketing network. The seed production stages are the development of breeder seed and then a series of multiplications from breeder seed to foundation seed to registered seed to certified seed and finally commercial seed. This process is supervised by a governmental agency, CERTISEM.

PIF and DICTA are the only two entities that produce breeder, foundation, and registered seed. PIF sells its registered seed to ZCE and assists NGO and agricultural related projects with bean seed to establish demonstration plots for farmers.

ZCE is the major certified bean seed producer in Honduras and Hondugenet is the major commercial bean seed producer. While ZCE produces only certified seed, Hondugenet produces both certified and commercial seed, the former being produced erratically. Another minor participant that produce certified seed is DICTA and some NGOs produce commercial seed.

ZCE contracts with farmers to produce certified seed. Although not a major problem, some contractees have expressed concern on the lack of transparency of the contract, specifically the screen size used to reject grain and the seed price paid to them. Hondugenet also, contracts with farmers to produce its commercial seed. The major differences between the contracts is the delivery place and the rejection rate of the grain. The formula price is unknown for both contracts .

In 2001 and 2002, some NGOs together with CIAT, trained small-scale farmers to produce commercial seed in several regions of Honduras. The main differences between CIAT's scheme and the one proposed in this study is the larger scope of the distribution and the inclusion of a private company to do the distribution.

DUWEST was the only major agricultural input distributor in Honduras interested in distributing bean seed as part of the proposed scheme. The final retail price in Danli of ZCE-produced and DUWEST-distributed in 2002 was around L 19/lb (L 41.8/kg) - L 19.86/lb (L 43.7/kg).

Even though banks have played a minor role in small-scale farmers bean production, Banco de Occidente and BANADESA seem promising for small-scale farmers acquiring capital to invest for the bean seed production scheme, mainly because of their disposition towards small-scale farmers.

Chapter V.

5. Bean Seed Demand In Honduras

To assess the demand for improved bean seed, farmers were surveyed in two bean-producing regions of Honduras to characterize their farming system and seed use. These data are used to assess the potential demand for seed of recently-released modern bean varieties and implications for the proposed seed scheme.

5.1. Farmer's Characteristics, Seed Use, Production, and Sales

The survey was carried out in El Paraiso (N=36) and Olancho (N=36).

5.1.1. Socioeconomic Characteristics of the Farmers

The sampled farmers owned an average of 5.37 ha of land. However, this does not mean that they all had a title for the land, but that they had been farming the land for several years and no one had challenged their use of the land. Almost half of the farmers (47%) reported having land with poor to normal soil quality. The average age of the farmers was 51 years, ranging from 22 years to 82 years. The farmers had few years of formal education. On average, the farmers had completed the fourth grade, but their education level ranged from no school to university (16 years).

5.1.2. Bean Area

Corn is the most important staple grain in Honduras, followed by beans. Results from the survey indicates that 86% and 57% of bean farmers grew corn in the primera (2002) and postrera (2001) seasons, respectively. In addition, 35% of bean farmers grew corn in one season, 54% grew it in both seasons, and 11% did not grow corn at all. The average area planted to beans in El Paraiso and Olancho were similar in the postrera

(2.12 ha and 2.02 ha, respectively), but El Paraiso planted more in the primera (1.37ha and 0.76 ha, respectively)(Table 8).

Table 8. Average area and average of farmers planting corn and bean in postrera (2001) and primera (2002), by department, Honduras.

	Average area (ha)				Average of farmers planting crop (ha)			
Department	El Paraiso		Olancho		El Paraiso		Olancho	
Season	Bean	Corn	Bean	Corn	Bean	Corn	Bean	Corn
Postrera	2.12	1.16	2.02	1.81	2.12	2.45	2.02	2.72
N	36	36	36	36	36	17	36	24
Primera	1.37	2.37	0.76	2.93	1.70	2.59	1.04	3.63
N	36	36	36	36	29	33	26	29
Source: Farmer survey, 2002.								

5.1.3. Source of Bean Seed

Farmers obtained bean seed from several different sources (Table 9), which are predominantly associated to the "traditional stage" of seed development. In both departments, the two most important seed sources were saved seed from the previous harvests and seed obtained from another farmer. In El Paraiso and Olancho, most of the bean area was planted with saved seed (73%, 63%) or seed obtained from another farmer (20%, 26%). Farmers reported that they usually traded or bought seed from another farmer when they ran out of seed, wanted to replace their stock with fresh seed, or wanted to change varieties. When farmers purchased seed from another farmer, they paid a price close to the price of grain.

Table 9. Hectares farmers planted (percentage) to bean by seed sources and department, during four seasons (postrera 2000 to primera 2002), Honduras.

Department (percentage)			Total[a]
Seed Source	El Paraiso[b] (Ha = 246.35)	Olancho[c] (Ha = 245.78)	
Saved from previous harvest	73.4	63.0	68.2%
Another farmer	20.0	25.9	22.9%
NGO/Project	4.0	7.8	5.9%
Purchased in grain market	1.7	1.6	1.7%
Certified seed dealer	0.9	1.7	1.3%

[a] Approximation. Exact percentage can be obtained by using percentages in each department and their total hectares.
[b] N=36 [c] N=36
Source: Farmer survey, 2002.

In recent years, NGOs and Projects have been an important source of seed for small farmers who have faced a seed shortage due to droughts and hurricanes. Two examples were the Zamorano Post-Mitch projects in 1999 and 2000-2001. While only 4% and 8% of the area in El Paraiso and Olancho, respectively, was planted with seed obtained from an NGO or Project, 21% of the farmers reported previously receiving a modern variety from an NGO or Project. Finally, only a small percentage of the bean area in El Paraiso (1%) and Olancho (2%) was planted with seed obtained from a certified dealer. Furthermore, although 28% of the farmers had purchased improved seed from a certified dealer at least once, 72% of the farmers had never purchased improved seed from a certified dealer.

5.1.3.1 Reasons

Farmers gave several different reasons for not buying certified seed (Table 10). The most common reason was that certified seed is too expensive (El Paraiso, 52.4% and Olancho, 72%). This reason can be interpreted in several ways, including that the farmer did not have the capital available to buy the seed, or that he/she did not believe that improved seed was worth the extra investment, given the extra revenue that it will generate. The second most important reason farmers gave for not buying improved seed was that they can produce their own seed. While the seed that farmers produce is of lower quality than certified seed, it is a good substitute when farmers cannot afford to purchase certified seed. The third most important reason that farmers reported was that certified seed was not available in the towns where they live (El Paraiso,14% and Olancho, 6%). Because certified seed dealers usually only sell seed in major cities, farmers must travel to a city to purchase it, which increases the cost of improved seed. Contrary to expectation, very few farmers reported bag size as a reason for not purchasing certified seed.

Table 10. Percentage of farmers quoting different reasons for not ever buying certified seed, by department, Honduras, 2002.

Department	Reasons					
	Too expensive	Not available	Bag size	Produces own seed	Custom	Likes landraces
El Paraiso (N = 21)	52.4	14.3	4.8	23.8	0.0	4.8
Olancho (N=18)	72.2	5.6	1.0	11.1	11.1	0.0
Total	62	10	3	18	5	3
13 missing (nonresponces). Source: Farmer survey, 2002.						

5.1.3.2 Prices Paid

Compared to certified seed, seed that farmers purchase from another farmer is relatively inexpensive. Farmers reported hypothetical prices based on what they think they would pay when buying seed of traditional and recycled modern varieties from a neighbor. The average of these reported hypothetical prices are shown in Table 11.

Table 11. Average hypothetical prices (Lempiras/Kg) for bean seed[a] purchases among neighboring farmers, by department and type of seed, primera 2002, Honduras.

Variety	Department	
	El Paraiso[b] (N = 46)	Olancho (N = 41)
Traditional (N = 57)	L 9.6	L 8.5
Modern (N = 30)	L 8.6	L 7.7

[a] These are prices of traditional and recycled modern varieties and not resale price from seed purchased from a certified dealer.
[b] Traditional N=33, Modern N=13
Source: Farmer survey, 2002.

Bean seed was slightly more expensive in El Paraiso than in Olancho. Farmers in El Paraiso reported that they would have to pay L 9.6/kg (L 4.36/lb) to a neighbor for seed of a traditional variety and L 8.6/kg (L 3.91/lb) for a modern variety. In contrast, farmers in Olancho paid L 8.5/kg (L 3.86/lb) and L 7.7/kg (L 3.5/lb) for TVs and MVs, respectively. The small difference in the prices between modern and traditional varieties is due to the price discount for MV (*i.e.* darker red color). As expected, seed prices in Olancho were lower than prices in El Paraiso because the surveyed villages in El Paraiso were nearer to the department capital. Given that certified bean seed sold for L 35/kg (L 15.90/lb)(at Zamorano), it is clear why farmers with limited resources saved their seed or bought seed from a neighbor instead of from a certified seed dealer. While the prices

farmers paid for seed obtained from another farmer was usually equal to the price of grain, 36% of the farmers in El Paraiso and 9% of the farmers in Olancho reported that they paid a higher price for seed than for grain.

5.1.4. Varieties Planted

Farmers planted both traditional and modern varieties. Farmers in the study area planted a total of 22 different varieties over the four seasons (246 ha) from the postrera of 2000 to the primera of 2002. In El Paraiso, the farmers planted four different modern varieties and in Olancho they planted five different modern varieties (Table 12). In the other hand, in El Paraiso, the farmers planted six different traditional varieties and in Olancho they planted 13 different traditional varieties.

In El Paraiso, Paraisito was the most widely planted variety in terms of area and number of farmers planting it. On the other hand, in Olancho, Jutiquile was the most widely planted variety in terms of area. Dorado and Tio Canela were the most widely planted varieties in terms of number of farmers planting them.

Table 12. Area planted (ha) and number of farmers who planted the variety during any of four seasons, (postrera 2000 to primera 2002), Honduras.

	Department				
	El Paraiso		Olancho		
Variety Name	Area	Farmers	Area	Farmer	Type
Dorado	58.5	14	60.2	14	Modern
Tio Canela	8.9	6	53.1	14	Modern
Zamorano	8.6	5	1.3	2	Modern
Catracho	0	0	1.4	1	Modern
Seda	0	0	0.7	1	Modern
Esteli 90	0.5	1	0	0	Modern
Danli 46	1.4	1	1.2	2	Modern
Paraisito	150.1	32	0.4	1	Traditional
Jutiquile	0	0	80.7	7	Traditional
Cuarenteño	1.9	2	11.3	9	Traditional
Chimino	0	0	9.1	4	Traditional
Payomo	8.1	3	0	0	Traditional
Vaina Blanca	0	0	7.5	6	Traditional
Cincuenteño	0	0	6.7	5	Traditional
Retinton	6.3	1	0	0	Traditional
Sangre de Toro	0	0	3.3	3	Traditional
Arbolito	0	0	2.8	1	Traditional
Nogue	0	0	2.7	2	Traditional
Marciano	2.1	2	0	0	Traditional
Chapin	0	0	1.8	1	Traditional
Tegucigalpa	0	0	0.9	1	Traditional
Rosita	0	0	0.8	3	Traditional
Total	246.4	67	245.9	77	
Source: Farmer survey, 2002.					

5.1.5. Traditional Varieties v.s. Modern Varieties

During the four seasons, farmers in El Paraiso planted a larger percent of their bean area to traditional varieties (68%), compared to the Olancho farmers (52%).

Of the farmers who planted modern varieties from 2000 to 2002, some used varieties released as early as 1984. However, most farmers had heard of the most

recently-released varieties-- Dorado (1990) and Tio Canela (1996). In El Paraiso, all of the farmers had heard of Tio Canela, but only 44% had planted it. On the other hand, 97% of the farmers had heard of Dorado and 85% had planted it. In Olancho, there was less difference between farmers who had heard of each modern variety and who had actually planted it. Almost all of the farmers (97%) had heard of both Tio Canela and Dorado, 71% had planted Tio Canela, and 65% had planted Dorado. Dorado was planted by more farmers because it was released six years before Tio Canela and therefore in a later stage of adoption.

Although only a few farmers planted both a MV and a TV in the same season, the farmers reported that they liked to try different types of varieties. For example, during the period from postrera 2000 to primera 2002, a majority of the farmers in both departments planted both a TV and a MV (Table 13).

Table 13. Percentage of farmers who planted modern varieties, traditional varieties, and both traditional and modern varieties (not necessarily in the same season) during four seasons (postrera 2000 to primera 2002), by department, Honduras.

Type of Variety	Department	
	El Paraiso (N = 36)	Olancho (N = 36)
Traditional only	30.6	30.6
Modern only	5.6	16.7
Traditional and Modern	63.9	52.8
Source: Farmer survey, 2002.		

5.1.6. Total Production

The farmers were asked to estimate the area that they planted to each variety and the total harvest for each variety during four seasons (postrera 2000 to postrera 2001)

(Table 14). In El Paraiso, a larger percentage of the area was planted to traditional varieties (65%) compared to Olancho (53%). Nevertheless, the total combined area planted to traditional and modern varieties in Olancho is larger than in El Paraiso. In the other hand, El Paraiso farmers had higher yields for both TVs (767 kg/ha) (1181 lb/mz) and MVs (855 kg/ha) (1317 lb/mz) than farmers in Olancho (713 kg/ha (1098 lb/mz), and 441 kg/ha (679 lb/mz), for traditional and modern varieties, respectively). In El Paraiso, MVs yielded higher than TVs. In contrast, in Olancho, MVs yielded lower than TVs. A possible explanation to this unexpected result is what Mather (2003) found when comparing yields of modern and traditional varieties, modern varieties were most widely grown in areas where Bean Golden Yellow Mosaic Virus pressure was high and thus traditional varieties could not be grown.

Table 14. Farmers total production and area by type of variety, postrera 2000 to postrera 2001, by department, Honduras.

Department	N	Type of Variety	Production mt	ha	yield [a] kg/ha
El Paraiso	87	Traditional	91	128	767
	39	Modern	65	68	855
Olancho	72	Traditional	93	117	713
	54	Modern	54	102	441

[a] This estimate gives equal weight to each farmer's mean yield (i.e. it is not the division of the production over the area in this table).
Source: Farmer survey, 2002.

5.1.7. Bean Sales

Farmers grew beans for both home consumption and to sell. Therefore, farmers can plant a specific variety for consumption only, for sales only or for both consumption

and to sell (Table 15). Results from the survey indicated that 100% of the farmers in El Paraiso and 77% of farmers in Olancho sold part of their harvest.

The most common practice is for farmers to both consume and sell the variety that he/she grows, as reported by 86% of the farmers in El Paraiso and 78% of farmers in Olancho. Nevertheless, some farmers in both departments grew a specific variety (or varieties) only for consumption (El Paraiso, 14%, Olancho, 22%) or only for sales (El Paraiso, 17%, Olancho, 22%).

Table 15. Farmers (percentage[a]) preferred use of a variety (or varieties), postrera 2000 to primera 2002, by department, Honduras.

Variety Use	Department	
	El Paraiso (N = 76)	Olancho (N = 75)
Consumption only	13.9	22.2
Sale only	16.7	22.2
Consumption and sale	86.1	77.8

[a] Percentages do not add to one hundred percent because farmers used several varieties, each for different reasons, so a farmer can count twice for one variety use.
Source: Farmer survey, 2002.

Farmers in El Paraiso sold almost twice as much of their 2001 harvest (57%), as did farmers in Olancho (26%) (Table 16). This can be explained by Olancho farmers' lower yields in 2001 (652.7Kg/ha, (1005 lb/mz)), compared to El Paraiso (860.4Kg/ha (1048 lb/mz)). Thus, farmers in Olancho had less grain for sale, after setting aside grain to meet their consumption needs.

Table 16. Farmers' sales (percentage) of the 2001 postrera harvest, by type of variety and department, Honduras.

Variety	Department	
	El Paraiso[a] (N = 46)	Olancho[b] (N = 41)
Traditional	75.2 (N = 32)	27.2 (N = 24)
Modern	36.3 (N = 14)	23.6 (N = 17)

[a] Total Harvest = traditional =34,484 kg, modern=28,996 kg
[b] Total Harvest = traditional =29,727 kg, modern=16,386 kg
Source: Farmer survey, 2002.

In Postrera, in El Paraiso 75% of the harvest of traditional varieties was sold, compared to 36% of the modern varieties. However, this does not indicate that traditional varieties are preferred for sale over modern varieties. Some key informants in Honduras said that farmers plant both modern and traditional varieties, so they can consume their preferred traditional variety and sell the modern variety, while others say that farmers sell their traditional varieties because they command a higher price and consume the modern varieties. However, the farmers surveyed showed no preference for selling either TVs or MVs. In postrera of 2001, of the 28% of the farmers in El Paraiso who planted both types of varieties, they sold 73% of their TVs harvest and 67% of their MVs harvest. In Olancho, only 13.9% of the farmers planted both TVs and MVs in the same season and they sold 15% of their TVs harvest and 25% of their MVs harvest.

5.1.8. Prices Received

Sales price data collected from the farmers (Table 17) confirms the conventional wisdom that traders pay a higher price for grain of traditional varieties than for modern varieties due to the former's lighter red color, ranging from 5.6% more in El Paraiso to 14.4% more in Olancho.

Table 17. Price (Lempiras/Kg) at which farmers sold their postrera 2001 harvest, by type of variety and department, Honduras.

Variety	Department	
	El Paraiso[a] (N = 41)	Olancho[b] (N = 21)
Traditional (N = 44)	8.67	8.12
Modern (N = 18)	8.21	7.10

[a] Traditional N=29, [b]Modern N=12
Source: Farmer survey, 2002.

Up to this point, several prices have been reported. Table 18 makes it summarizes some grain and seed prices at various places that have been mentioned since Chapter 4.

Table 18. Summary of bean prices (in Lempiras /kg), Honduras, 2002.

Type of grain\ Place sold	**El Paraiso**	**Olancho**	**Tegucigalpa**	**Zamorano**
Grain (2001 harvest[a])				
Traditional	8.67	8.12	NA[b]	NA
Recycled modern	8.21	7.10	NA	NA
Seed				
Farmer[c]				
Traditional	9.6	8.5	NA	NA
Recycled modern	8.6	7.7	NA	NA
Commercial				
Hondugenet	NA	NA	33	NA
Certified				
ZCE	NA	NA	NA	35
DUWEST	38	38	36.5	NA

[a] Grain sold following the postrera 2001 harvest.
[b] Not available
[c] Price farmers expected to pay for seed bought from a neighbor.
Source: Farmer survey 2002 and key informant interviews.

5.2 Demand for Modern Varieties

5.2.1 Preferred Bag Size

In 2002, certified and commercial seed of modern bean varieties were sold in 50 lb bags (22.7kg bags) and 44 lb bags (20 kg bags). It was hypothesized that farmers would prefer to purchase seed in a smaller bag. To assess the importance of bag size as a constraint to purchasing seed, farmers were asked what bag size they preferred (i.e. 5 lbs, 10 lbs, 15 lbs, 20 lbs, 44 lbs, and 50 lbs (2.27 kg, 4.54 kg, 6.81 kg, 9.09 kg, 20 kg, and 22.7 kg, respectively)). While most farmers (57%) preferred a 50 lb bag, 26% preferred a 20 lb bag. In spite of the fact that farmers did not report bag size as a reason not to purchase seed, once it is presented as an option, some farmers stated the preference of a 20 lb bag (26%). This low percentage of farmers stating a preference for a 20 lb bag but who also would buy a 50 lb bag (35%) suggests that seed should be sold in 50 lb bags.

5.2.2 Purchase Frequency

To estimate the annual demand for improved seed and also to obtain an estimate of how often farmers like to renew their seed stock, farmers were asked how long after they have purchased improved seed would they buy again. The average time between purchases of seed was of 1.7 years for those who were willing to buy.

5.2.3 Price Discounts for Modern Varieties

To assess the market acceptability of the both existing and yet-to-be-released modern varieties, traders in Tegucigalpa were asked what price they would pay for each of six MVs. The six modern varieties were Catrachita, Dorado, Tio Canela 75, Milenio (not yet released in July 2002), Amadeus 77 (not yet released in July 2002), and

Carrizalito (not yet released in July 2002). Catrachita, a MV with market qualities similar to TVs was used as a control.

The prices that traders in "Mercado Las Americas" estimated that they would pay for these six varieties are listed in Table 19.

Table 19. Traders (N = 5) procurement prices of modern varieties in Mercado Las Americas, July 2002, Tegucigalpa, Honduras.

Variety	Price (L./kg)	Price Index	Color
Catrachita (control)	9.0	100	Light red
Dorado	8.2	91	Reddish black
Tio Canela 75	8.5	94	Dark red
Milenio	9.4	104	Light red
Amadeus 77	9.4	104	Red
Carrizalito	8.3	92	Light dark red
Source: Key informant, 2002.			

As expected, traders were willing to pay a higher price for lighter red color grain. However, in addition traders take into account freshness and cleanliness of the grain. Traders were willing to pay higher prices for Milenio and Amadeus 77. They have high prices due to their lighter color–compared to Dorado and Carrizalito. Since Amadeus was a soon-to-be-released variety, these data suggest that this variety will be highly acceptable to farmers.

5.2.4 Farmers Preferences for Recent Modern Varieties

To assess farmers' preferences for the six recently-released varieties, the farmers were shown an unlabeled sample of the varieties and asked to rank each variety. The farmers' rankings were used to create a global ranking score for each variety (Table 20).

This was done by assigning a value of six to the variety that farmers ranked highest, five for the second highest ranked variety, etc. The 72 farmers rankings of each variety were summed to obtain an overall ranking score for each variety.

Table 20. Ranking of six recently released varieties, by department, July 2002, Honduras.

Place in ranking	El Paraiso		Olancho	
	Variety	Score	Variety	Score
First	Amadeus 77	172	Amadeus 77	184
Second	Catrachita	140	Catrachita	144
Third	Milenio	123	Carrizalito	131
Fourth	Carrizalito	118	Tio Canela 75	119
Fifth	Dorado	108	Milenio	109
Sixth	Tio Canela 75	95	Dorado	69
Source: Farmer Survey, 2002.				

In both departments, the farmers assigned the highest ranking to Amadeus 77 and Catrachita and the lowest ranking to Tio Canela and Dorado in El Paraiso and Olancho, respectively.

As noted earlier, many farmers prefer TVs because they command a higher market price. The results in the table above indicate that the farmers assess Amadeus 77's quality characteristics (i.e., color) as superior to all other modern varieties–including Catrachita, which is similar in color to TVs.

In addition, farmers were asked to state the price that they would be willing to pay for seed of each variety. These data were used to estimate the percent of farmers who would be willing to pay a price ranging from L 9/lb (L 19.8/kg)(minimum price thought that a bean seed farmer would be willing to sell) to L 17/lb (L 37.4/kg)(expected certified

seed price) for each of the six varieties, by department (Figure 8 and 9). For each variety, each positive response of a farmer to a price for an specific variety was added to the percentage of farmers willingness to pay. For prices lower than L 17/lb, the reported percentage includes the accumulated positive responses up to that price, since if someone is willing to pay L 17/lb they would also be willing to pay a lower price.

In both departments, Amadeus 77 is the variety with the highest demand. Figure 8 and 9 show that 70% and 81% of the farmers in El Paraiso and Olancho, respectively, are willing to pay L 9/lb of seed of the variety Amadeus 77. In El Paraiso, Dorado follows Amadeus 77 with the second highest demand where 39% of farmers are willing to pay L 9/lb of seed. On the other hand, in Olancho, Carrizalito and Tio Canela 75 follow Amadeus 77 with the second highest demand where also 39% of farmers are willing to pay L 9/lb of seed for each variety. These shows the farmers' preference for Amadeus 77. Farmers' preferences for Amadeus 77 makes it a variety with high potential demand. DUWEST and small-scale farmers participating in the seed scheme would be more certain that its seed would sell. This high demand can be attributed to a lower than usual price for commercial seed (L 15/lb), and to the light red color of the seed.

Figure 8. Farmers' willingness to pay for bean varieties in El Paraiso, 2002, Honduras.

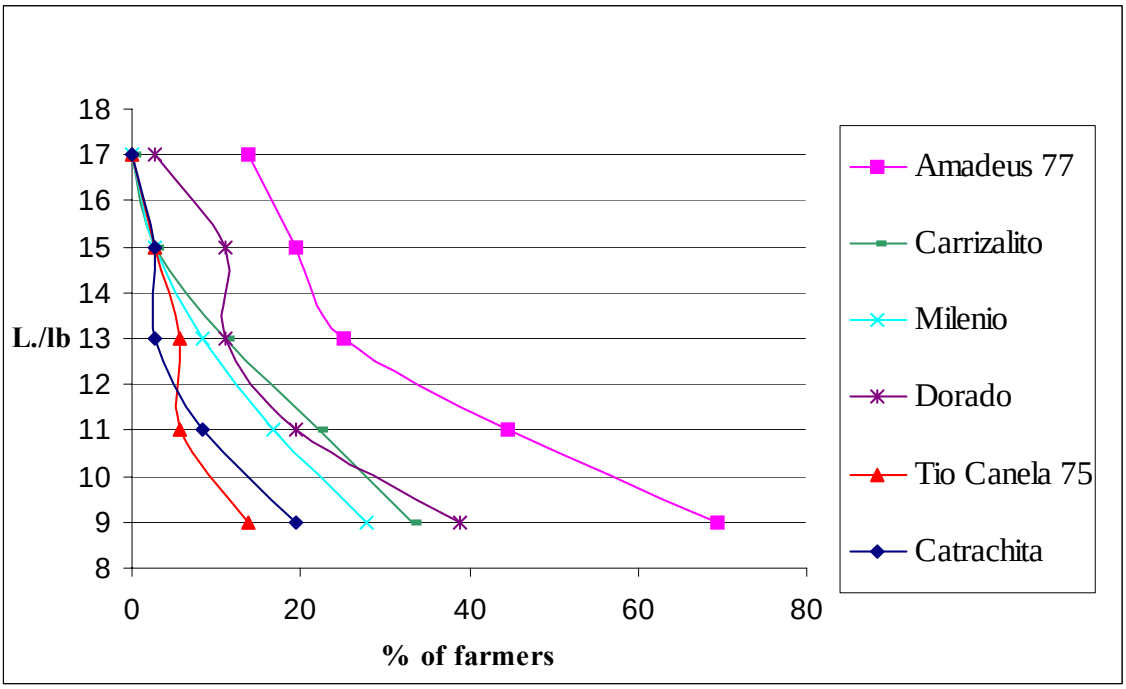
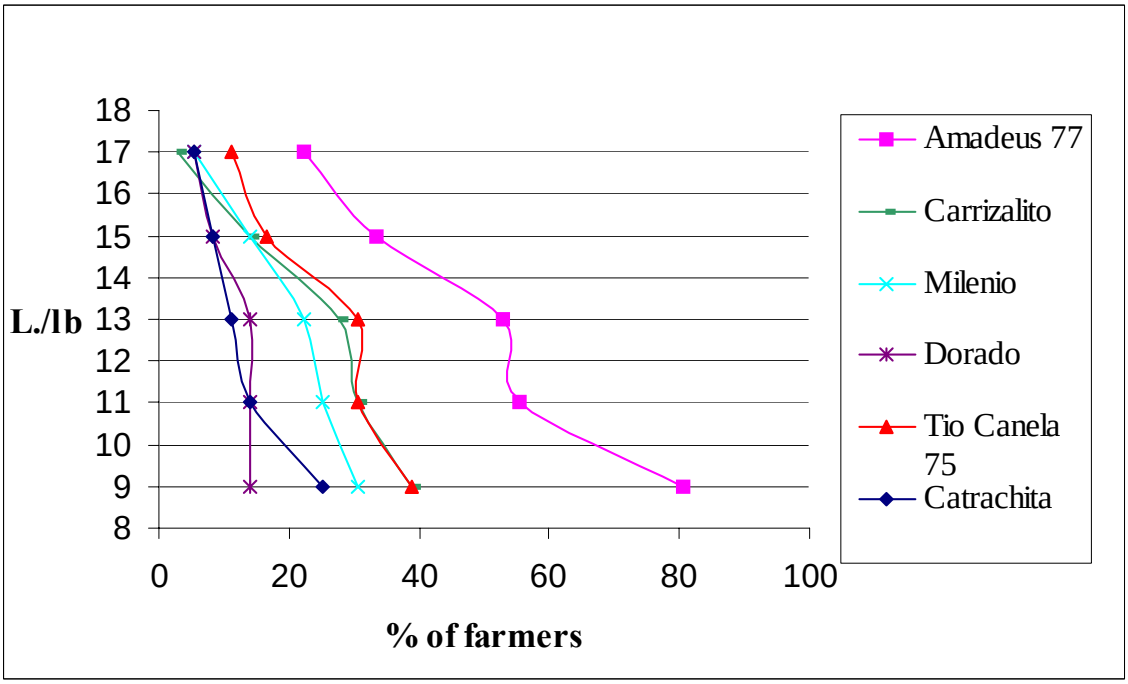


Figure 9. Farmers' willingness to pay for bean varieties in Olancho, 2002, Honduras.



To estimate an annual demand curve for each variety (Figures 10 and 11), farmers responses regarding their preferred bag size and frequence of bean seed purchase were combined with their willingness to pay. So for example, if a farmer responded that he/she was willing to pay L 15/lb, his/her preferred bag size was 44 lbs, and his/her frequency of bean seed purchase is once every two years, then his/her demand is of 22 lbs of seed per year at a price of L 15/lb (44lb*1/2 purchases/year). Analogous to the demand percentage, for prices lower than L 17/lb, the reported demand includes the accumulated demand up to that price.

While farmers in both departments preferred Amadeus 77 above all other varieties, the demand curve is more elastic in El Paraiso than in Olancho. Since farmers would likely only purchase seed of a single new variety, these curves represent an "either or" demand for the varieties (e.g. farmers would not demand all of them at the same time). Results from the farmer ranking of the varieties and the willingness to pay analysis are generally consistent, except for Catrachita. While farmers ranked Catrachita as the second most preferred variety, the demand for Catrachita was low and inelastic. However, willingness to pay (rather than rank) better reflects farmers preferences because it forces farmers to assign a price to each variety.

Assuming a seed rate of 32 kg/ha, the sampled farmers in El Paraiso and Olancho annually require approximately 4,020[23] kg (8,844 lbs) and 3,203[24] kg (7,046 lbs) of seed,

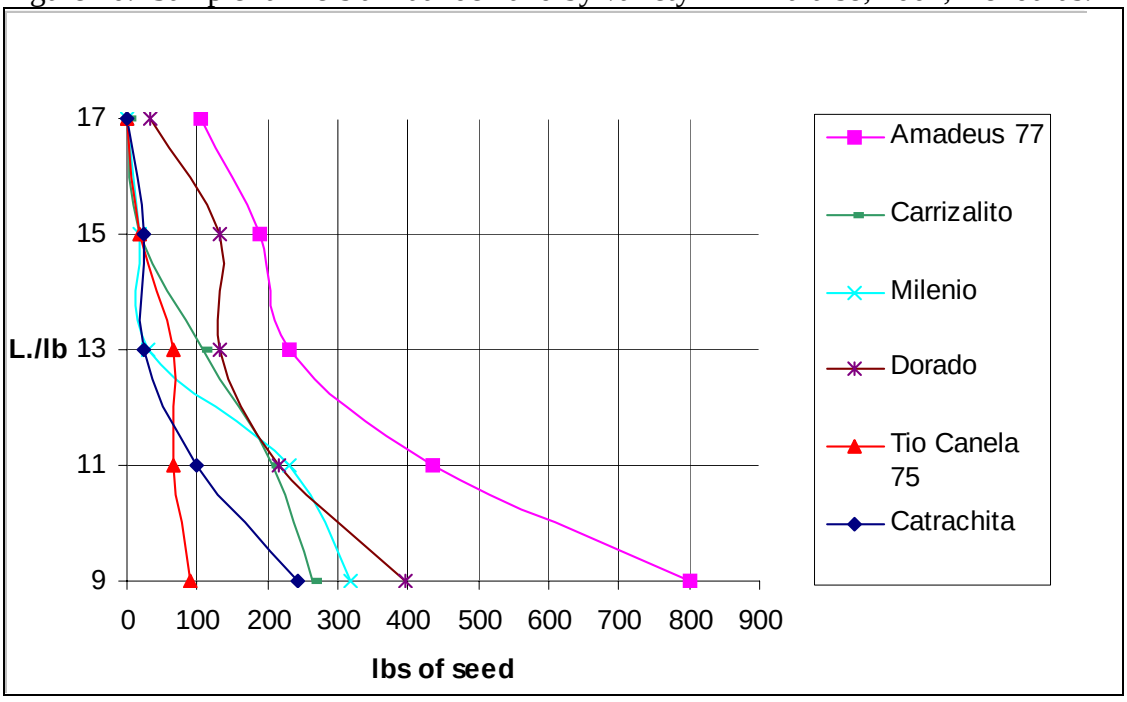
---

[23] (2.12+1.37)*36*32 = 4020.48 where (2.12+1.37) is the average area planted by each farmer (Table 8), 36 is the number of farmers in the department and 32 kg/ha is the seed rate.

[24] (2.02+0.76)*36*32 = 3,202.56 where (2.2+0.76) is the average area planted by each farmer (Table 8), 36 is the number of farmers in the department and 32 kg/ha is the seed

respectively. These figures are calculated by multiplying the sampled farmers average bean planting area per year (sum of primera and postrera areas (Table 8)) by the assumed seeding rate of 32 kg/ha times the number of farmers in the department (i.e. 36). So the total seed requirements for the sampled bean farmers in El Paraiso the estimation and estimate would be the following: (2.12 ha in postrera+1.37 ha in primera)*36 farmers*32 kg/ha (seeding rate) = 4020.48 kg of seed.

Figure 10. Sample farmers annual demand by variety in El Paraiso, 2002, Honduras.



rate.

Figure 11. Sample farmers annual demand by variety in Olancho, 2002, Honduras.

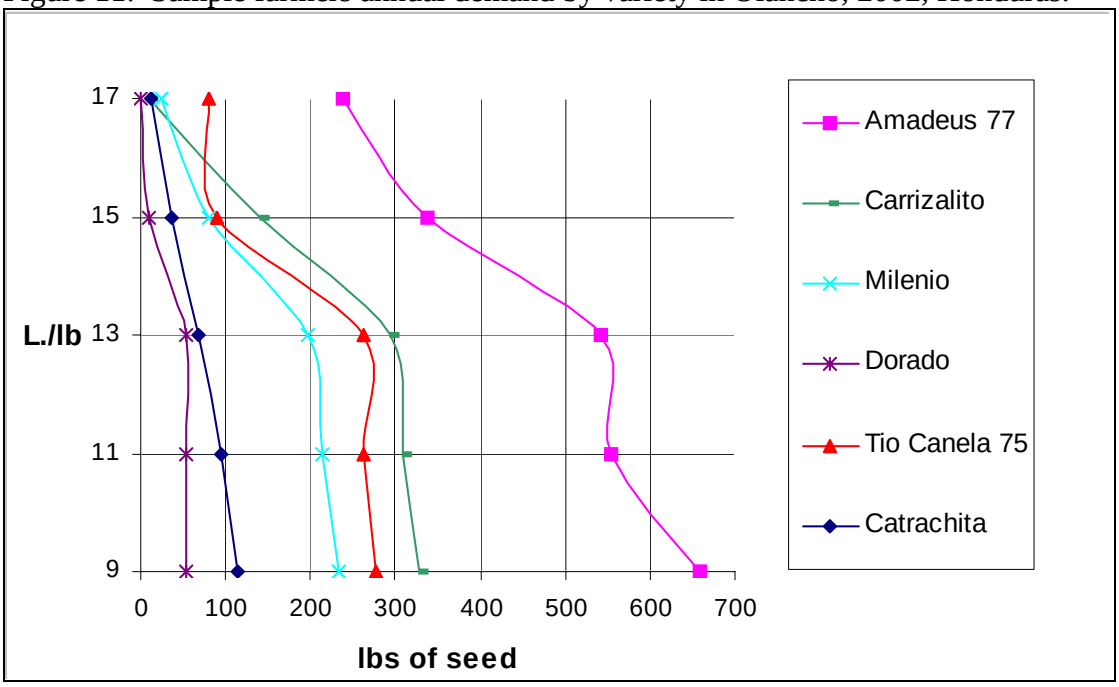


Table 21 shows the estimated amount of seed that the sampled farmers were willing to purchase at various prices and the departments demand. Farmer demand per ha is estimated by dividing the seed demand at each price obtained from Figures 10 and 11 by the number of farmers in each department (i.e. 36). For example in El Paraiso, the total demand of Amadeus seed of the sampled farmers at L 17/lb is of 48 lbs. This estimate of 48 lbs is then divided by 36 (number of farmers sampled in El Paraiso) to obtain 1.33 lbs/farmer. This latter estimate, average individual farmer demand, is then divided by the sample farmer average annual bean area obtained by a summation from Table 8, 3.49 (ha in El Paraiso (2.12 ha in postrera + 1.37 ha in primera)) to consequently obtain demand per ha. Finally, demand for the department is estimated by multiplying demand/ha times the number of hectares planted in postrera 2001 and

primera 2002 in each department (seasons where average area was calculated from) as reported in the National Statistics Institute of Honduras (INE).

Table 21. Estimated annual demand (kg) for seed of Amadeus 77 at various prices, by department, Honduras, 2002.

Department ---------- Price per pound	El Paraiso[a]		Olancho[b]		Total (kg)
	Sample (kg/farmer/ha)	Demand in department	Sample (kg/farmer/ha)	Demand in department	
17	0.38	7,566	1.08	23,518	31,083
15	0.68	13,595	1.54	33,474	47,069
13	0.83	16,553	2.47	53,777	70,331
11	1.57	31,173	2.51	54,718	85,891
9	2.90	57,510	2.99	65,066	122,576

[a] Average area planted in El Paraiso is 3.49 ha. Farmer survey, 2002.
[b] Average area planted in Olancho is 2.78 ha. Farmer survey, 2002.
Source: Farmer survey, 2002.

According to the most recent Agricultural Census (1993), farmers in El Paraiso and Olancho planted an average of 1.24 ha and 0.97 ha of beans, respectively. The fact that the sampled farmers in El Paraiso and Olancho planted and average of 3.49 ha and 2.78 ha to beans, respectively, suggests that these farmers were likely more interested in bean production, compared to the average bean farmer. Thus, the estimate of department demand is likely biased upwards. However, since demand is calculated based on 2002 actual hectares, the bias is likely to be capped. Also, Mather's (2003) farmer average total bean area (primera and postrera) for Mideast (El Paraiso and Francisco Morazan)/Northeast (Olancho) adds to 3.65 ha, which is similar to the results in this research sample, and thus the bias is thought to be minimal.

Consequently, the total potential annual demand for Amadeus 77 in El Paraiso, ranges from 7.6 mt (if sold at L 37/kg (L 17/lb)) to 57.5 mt (if sold at L 20/kg (L 9/lb)). In Olancho, ranges from 24 mt (if sold at L 37/kg (L 17/lb)) to 65 mt (if sold at L 20/kg (L 9/lb)). Total demand in both departments ranges from 31 mt (if sold at L 37/kg (L 17/lb)) to 123 mt (if sold at L 20/kg (L 9/lb)).

5.2.5 Factors Associated with Farmer Demand

A double hurdle model was used to assess variables associated with farmers desire to purchase each variety and their WTP. The explanatory variables in the model and the expected sign for each variable are presented in Table 22. Both varietal traits and farmer characteristics are hypothesized to affect farmers desire to purchase and WTP. Regarding varietal traits, the model could have included grain size, weight, and color because those are characteristics that the farmer can evaluate by observing the grain samples. Nevertheless, size and weight were not included because of the similarity of the varieties and the difficulty to distinguish them without an instrument. Grain color (lighter red colors) is expected to increase the probability to purchase and WTP because middlemen pay a higher price for light-red grain.

While characteristics like cooking time and flavor often influence farmers' varietal choices, they were not included because they could not be observed. Also, production characteristics (e.g. yield, disease resistance) are not included in the model since farmers could not observe these traits. However, farmers were told to assume that the varieties were disease resistant and would yield 1300 kg/ha, like Tio Canela.

Regarding socioeconomic characteristics, age was included as a proxy for farming experience; education to measure capability to understand the advantages of different varieties; land to measure access to capital (i.e. wealth); prior use of modern varieties to measure experience planting and awareness of modern varieties, and fertilizer use to measure adoption of recommended management practices. However, fertilizer and modern variety use are predetermined variables, since fertilizer use is for a previous season (Postrera 2001) and modern variety use indicates if the farmer had used a modern variety at least once in any of the past four seasons (i.e., Postrera 2000 to Primera 2002).

Table 22. List of explanatory variables in determining desirability to buy (DB) and willingness to pay (WTP) and the hypothesized relationship between these explanatory variables and farmers' decision to buy and WTP.

Variable	Unit of measure	Expected change in purchase decision and WTP
Variety attributes		
Color	Color (reddish black, dark red, light dark red, red, light red) (goes from very dark to light red)[a].	%
Farmer's management and Socioeconomic characteristics		
Age	Years	-
Education	Years in school	%
Land	ha	%
Fertilizer used in Postrera[b] 2001	0 = no 1 = yes	%
Use of modern varieties	0 = no 1 = yes	%

[a] Change from black through light red is suppose to increase DB & WTP.
[b] Postrera is the rainy season from September to November.

Farmer's age is expected to reduce the probability to purchase since it is widely assumed that older farmers stay loyal to their current varieties. Education is expected to

increase the probability to purchase and WTP because it is associated with capability of being able to differentiate between varieties. Land, fertilizer use in previous seasons, and use of modern varieties in the past are expected to increase the probability to purchase and WTP because these variables are associated with commercial orientation (compared to subsistence farming), better management practices, and awareness of benefits of modern varieties, respectively.

5.2.6 Results

The final model[25] included color, age, education, land, and fertilizer used in postrera 2001 as explanatory variables. The probit model correctly predicted 72.45% of the outcomes (Appendix B)**.** The marginal effects or change in probability, due to a change in one unit in the explanatory variables for the probit and truncated regressions, are shown in Table 23. The probit and truncated result tables are in Appendix C.

[25] Correlation matrix is in Appendix A.

Table 23. Marginal effects of bean attributes and farmer's characteristics on purchase decision and willingness to pay (WTP), Honduras, 2002.

Variable	Probit Model	Truncated Regression
Dark red color	-0.002	0.342
Std. error	0.084	0.909
p-value	0.975	0.706
Lighter dark red color	0.106	-0.178
Std. error	0.085	0.812
p-value	0.214	0.826
Red color	0.488*** [a]	0.403
Std. error	0.072	0.760
p-value	0.000	0.596
Light red color	-0.008	0.033
Std. error	0.072	0.822
p-value	0.917	0.968
Fertilizer used in Postrera 2001	-0.056	-0.677
Std. error	0.057	0.544
p-value	0.322	0.213
Age	0.002	0.053**
Std. error	0.002	0.023
p-value	0.400	0.021
Education	0.005	0.224***
Std. error	0.007	0.061
p-value	0.472	0.000
Land	-0.003	0.094***
Std. error	0.004	0.023
p-value	0.373	0.000
Use of modern variety	0.051	1.487***
Std. error	0.053	0.578
p-value	0.334	0.010
N= 432 , 72.45% of predicted outcomes are correctly predicted in the probit model. [a] * Significant at a 10% level, ** Significant at a 5% level, and *** Significant at a 1% level.		

First, a probit regression was carried out to observe the effect of color of the grain and farmers' characteristics on the farmers' purchase decision. In the probit regression,

red color was the only significant variable. The change in color from a reddish black to a red increases the probability to purchase a modern variety by almost one-half point (i.e. 50%). This is a high increase in probability. This color is associated to the color of Amadeus 77 while the reddish black color is associated with Dorado, the most widely adopted variety. This indicates that Amadeus appeals to farmers due to its color. Nevertheless, a lighter red color (e.g. Milenio and Catrachita) was not significant and had a negative sign, contrary to expectation. This could be due to the fact that Milenio and Catrachita have a pale red color. Finally, Carrizalito, which had a darker color than Amadeus 77, should not be released because the results indicated that its color did not impacted farmers' purchase decision.

The double hurdle model exemplifies the importance of separating the purchase decision from willingness to pay, since color was a major determinant in the purchase decision, while in willingness to pay socioeconomic characteristics were more important than varietal characteristics.

5.3 Summary

A farmer survey was conducted in El Paraiso and Olancho to collect socioeconomic characteristics of farmers and to assess the demand for improved bean seed. Also, farmers' seed use, production, and sales information was obtained. From farmers' socioeconomic characteristics, farmers' land ownership, age, and years in school was collected. Regarding seed use, production, and sales, information on bean area, source of bean seed, varieties planted, total production, bean sales, and prices was collected. Finally, a double-hurdle model was used to assess demand for modern

varieties as well as some demand curves that were constructed using information on preferred bag size, purchase frequency, and preferences on recent modern varieties.

The sampled farmers owned an average of 5.37 ha of land, had an average of 51 years of age, and had completed the fourth grade. Regarding the bean area planted, farmers in El Paraiso and Olancho grow an average area to beans in the primera season of 1.37 and 0.76 ha, respectively. In the postrera season, farmers in El Paraiso and Olancho grow an average area of 2.12 and 2.02 ha, respectively.

Farmers obtained bean seed from several different sources and planted 22 bean varieties. Farmers in El Paraiso and Olancho obtained bean seed mainly from saved seed from previous harvest (73% and 63%, respectively) and from another farmer (20% and 26%, respectively), and only a few farmers obtained it from NGO/Projects, certified seed dealer, or purchased in grain market. The most quoted reason (61% of farmers) for not buying certified seed was that it is too expensive. Also, farmers in El Paraiso and Olancho planted 10 and 18 bean varieties, respectively, for a combined total of 22 bean varieties.

Farmers in El Paraiso and Olancho obtained yields of 767 kg/ha and 713 kg/ha with traditional varieties, respectively, and 855 kg/ha and 441 kg/ha with modern varieties, respectively. From the harvest obtained, farmers in El Paraiso and Olancho commonly both consume and sell the grain (86% and 78%, respectively). Nevertheless, some farmers grow specific varieties only for consumption or only for sales. Regarding bean sales, farmers in El Paraiso sold twice as much of their harvest (57%) compared to farmers in Olancho (26%). Also as expected, in El Paraiso and Olancho, modern

varieties were sold at a lower price (L 8.67/kg and L 8.12/kg, respectively) compared to the traditional varieties (L 8.21 and L 7.10/kg, respectively).

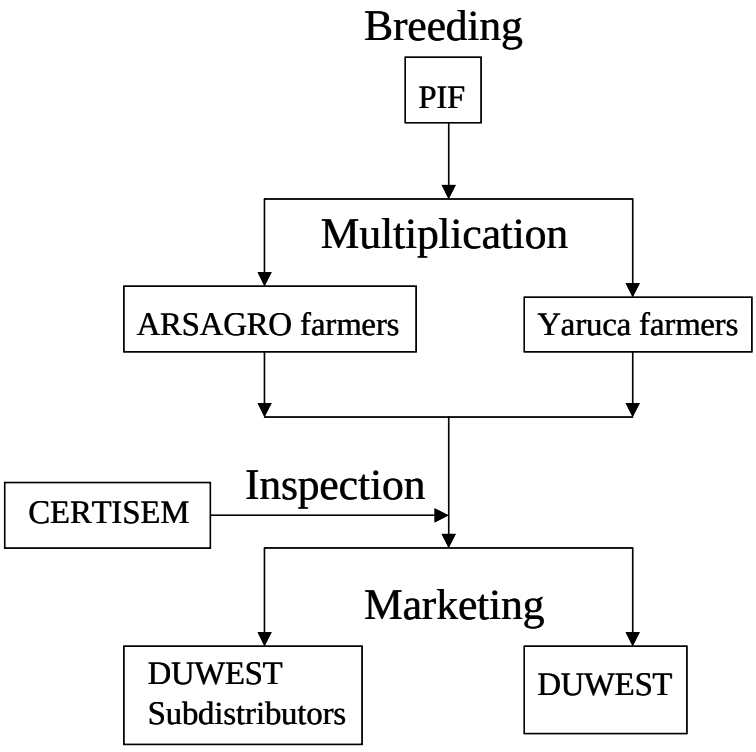
Finally, regarding the demand for modern varieties, most farmers (57%) prefer to buy bean seed of the varieties shown to them in 50 lb bags. Also, farmers average renewal time of varieties shown to them was of 1.7 years. From the six varieties shown to farmers, Amadeus 77 was the highest ranked by farmers and with the highest demand in both departments. The double-hurdle model used to assess demand reveals the importance of red color in farmers' purchasing decision. Socioeconomic characteristics like "land ownership", "education", and "previous use of modern varieties" were associated with farmers willingness to pay.

Chapter VI.

6. Bean Seed Production Scheme

Analysis presented previously indicates that farmers in El Paraiso and Olancho are interested in purchasing seed of the modern variety Amadeus 77. Drawing on information reported regarding options for producing and marketing improved bean seed, this chapter proposes a strategy for implementing the proposed bean seed multiplication and distribution scheme, in which small-scale farmers will produce the seed and sell it to DUWEST, as summarized in Figure 12. However, as will be discussed later, DUWEST is only willing to buy 23 mt of seed in year one. Thus, the target level of production is much lower than the estimated demand.

Figure 12 . Proposed bean seed production scheme.



6.1 Supervision of the Bean Seed Scheme

Dr Juan Carlos Rosas (PIF/Zamorano), who has expressed an interest in providing leadership for implementing the scheme, will supervise the bean seed scheme. That is, he will be responsible for training of the farmers, supervision of the farmer fields, and final approval of the seed to be sold to DUWEST. Zamorano will provide a certificate of good quality for the farmer groups' seed, so that DUWEST can trust the quality of the seed from these farmer groups.

6.2 Seed Production Sites and Participants

Two farmer groups, located in El Paraiso (ARSAGRO) and Atlantida (Yaruca farmer group), will be trained to produce commercial seed for sale to DUWEST. ARSAGRO farmers in El Paraiso are proposed due to several reasons. ARSAGRO farmers have experience growing seed, have access to credit and machinery by being a member of the association, and are located close to Zamorano. The Yaruca farmer group is proposed due to different reasons. Yaruca farmers can grow seed in the Apante season, which gives them the advantage of being able to produce seed closer to the planting seasons. Also, Yaruca farmers are supported by the Atlantic Litoral Region University Center (CURLA), which in turn collaborates with PIF. Therefore, extension services and supervision of farmer plots will be made easier.

6.3 Contracts

Two types contracts will be required to establish each participant's responsibility--one between the farmer groups and PIF, and another between the farmer groups and DUWEST.

The contract between farmer groups and PIF will establish PIF's responsibility to train and supervise the farmers through at least 7 visits to the farmers fields. PIF will also extend a certificate[26] of good quality, if farmers follow PIF's recommendations and the seed meets the required quality standards. The farmers will promise to pay PIF a fee for the training and supervision of the plots after they are paid by DUWEST (120 days after planting).

The contract between farmer groups and DUWEST will commit DUWEST to purchase 17 mt of commercial seed from ARSAGRO farmers and 6 mt from the Yaruca farmer group at a guaranteed pre-planting price to be paid 30 days after delivery, conditional on it being certified by PIF and CERTISEM. The farmer groups will promise to deliver the specified amount of commercial seed in sealed bags, at the department capital, no later than 100 days after planting. This delivery date insures enough time to process and bag the seed after CERTISEM laboratory test results are available. To insure that the farmers sell the seed to DUWEST, DUWEST will pay the plot registration fee and for CERTISEM field visit. This cost will be deducted from the payment that DUWEST makes to the farmers. The contract will also specify that DUWEST is the exclusive seed distributor for these farmer groups.

6.4 Credit

ARSAGRO farmers will obtain credit from their association, which extends credit to its member for up to 24 months at a monthly interest rate of 5%. While this rate is

[26] Zamorano's management has no objection for the seed to be labeled "Zamorano Approved Seed", since the label would only guarantee that it meets physical and variety characteristics.

higher than the interest rate of other commercial banks, it has the advantage of requiring less paperwork and time is shortened. On the other hand, the Yaruca farmer group will obtain credit from a bank to pay for the registered seed and inputs-- either BANADESA or Banco de Occidente due to their orientation to work with small-scale farmers.

6.5 Commercial Seed/Variety

Both farmer groups will purchase registered seed[27] from PIF/Zamorano.

Amadeus

77 will be the variety produced and distributed under the scheme because of its high productivity and high ranking of the varieties by El Paraiso and Olancho farmers. PIF is willing to sell up to 9,000 kg of registered seed at a price of L 2,000 per 45 kg bag. However, since DUWEST will only buy 23,000 kg of commercial seed and expecting approximately an average yield of 1100 kg/ha, only a total of 21 ha will be planted. ARSAGRO farmers will plant 15 ha and Yaruca farmers will plant the other 6 ha. ARSAGRO farmers will be allocated a larger quota than the Yaruca farmers because of their greater seed production experience.

6.6 Farmer Training and Supervision

To insure high seed quality, Zamorano/PIF will train and supervise the farmer groups in bean seed production. Training will only take place during the first season. After the first season, PIF will only do supervision visits. The farmers will be trained in

[27] Regarding the use of the variety Amadeus 77 (property of Zamorano), Zamorano will not collect intellectual property rights royalties because Zamorano is trying to promote widespread distribution and adoption of its modern varieties.

the seed producing techniques, especially disease control and threshold pest levels in order to know the right time to spray. Training and supervision visits will be scheduled for the following periods: land plowing, planting, fertilization, flowering, grain filling, harvest, and selection and bagging.

In the first season, both training and supervision will be done on the same visits to the farmers. PIF will charge $30/training day, plus transport and lodging costs–which are discounted rates considering that Zamorano normally charges $100/person/day plus transport and lodging costs, and that the Honduran Agricultural Research Foundation (FHIA) charges $80/person/day.

In subsequent seasons, PIF will charge $30 per day, plus transport and lodging costs for routine inspections during the bean growing season.

6.7 Seed Processing/Packaging

The ARSAGRO farmers will be responsible for seed drying, cleaning and selection in the fields. Then, the seed will be taken to ARSAGRO's office in Danli, where it will be inspected by CERTISEM. After CERTISEM provides the seed labels, fungicide and insecticide will be applied to the seed prior to bagging.

The Yaruca farmers will also be responsible for drying, cleaning and selection in the fields. Then they will take the seed to their village seed bank to await seed inspection by CERTISEM. Similarly, after CERTISEM provides the seed labels, fungicide and insecticide will be applied to the seed prior to bagging.

The bean seed will be marketed in 50 lb bags, due to farmers response that this was their preferred size bag. Although the bag will not carry Zamorano University logo, it will have a "Zamorano Approved" sticker.

6.8 Seed Inspection

CERTISEM will carry out the final seed inspection and provide the seed label certifying that it meets commercial seed requirements. This will be done by CERTISEM staff taking random samples of the seed and running germination and purity tests. After approved by CERTICEM, PIF will issue the certificate of good quality seed to the farmers.

6.9 Distribution

After the seed is bagged and labeled, the farmer groups will transport the seed to subdistributors in the closest department capital--Danli for ARSAGRO farmers and La Ceiba for the Yaruca farmers. DUWEST will likely later leave a portion of the seed in those cities and also distribute some of it to Juticalpa and San Francisco de la Paz in Olancho and to the city of Yoro and the town Yorito in the department of Yoro. Also, the seed obtained from the Yaruca Farmer Group could be distributed to other bean producing regions such as Colon.

6.9.1 Price

DUWEST will pay the farmer groups L 8/lb for the seed. Assuming a yield of 1,090 kg/ha, ARSAGRO farmers can produce seed for L 4.60/lb (L 10.12/kg) and the Yaruca farmers can produce seed for L 4.95/lb (L 10.89/kg), excluding training or supervision costs (Table 24). Including training cost for the first year and supervision

costs for the second year, in the first year the cost per pound for the ARSAGRO and Yaruca farmers is L 4.87/lb (L 10.71/kg) and L 7.14/lb (L 15.71/kg), respectively, and in the second year the cost is L 4.81/lb (L 10.58/kg) and L 6.59/lb (L 14.50/kg), respectively (Table 25). Assuming that ARSAGRO and Yaruca farmers plant 15 ha and 6 ha, respectively, DUWEST's purchase price of L 8/lb is very appealing for both farmer groups. ARSAGRO farmers and Yaruca farmers would need to produce 1,461 lbs/ha (664 kg/ha) and 2,142 lbs/ha (974 kg/ha), respectively, to break even in the first year, and would need to produce 1,443 lbs/ha (656 kg/ha) and 1,977 lbs/ha (899 kg/ha), respectively, to break-even in the second year.

DUWEST will markup the purchase price by 20-25% (which includes transportation costs to the towns (3%) and its subdistributor in each town will markup the seed by an additional 10-15%. Thus the retail price at small towns like Juticalpa, Salama, and San Francisco de la Paz in Olancho and Danli, Linaca, and Chirinos will be of approximately between L 11/lb and 12/lb (Table 26).

At a price of L 12/lb, the estimated seed demand in El Paraiso and Olancho is of 24 mt and 54 mt, respectively (Table 21). However, DUWEST is only willing to purchase 23,000 kg–which is equal to approximately 30% of the combined total demand in both departments. This suggests that DUWEST will face minimal risk of not being able to sell its stock of seed.

Table 24. Estimated commercial seed production costs in El Paraiso and Atlantida, Honduras, 2002.

		ARSAGRO			Yaruca		
Activity	**unit**	**units/ha**	**cost/unit**	**cost/ha**	**units/ha**	**cost/unit**	**cost/ha**
Land Preparation							
Plow	rental	1	643	643	n.a.[a]	n.a.	n.a.
Disk	rental	1	360	360	n.a.	n.a.	n.a.
Cultivator	rental	1	630	630	n.a.	n.a.	n.a.
Thresher	rental/kg	1,090	0.55	600	n.a.	n.a.	n.a.
Inputs							
Seed	kg	32	44	1,408	32	44	1,408
Fertilizer (12-24-12)	kg	136	4	539	136	4	539
Foliar	lt	2	120	240	2	120	240
Herbicides							
Gramoxone	lt	n.a.	n.a.	n.a.	1	100	100
Fungicides							
Poliran	kg	2	90	180	2	90	180
Captan	kg	1	60	60	1	60	60
Insecticides							
Decis	lt	2	150	300	n.a.	n.a.	n.a.
Folidol	lt	n.a.	n.a.	n.a.	0.5	400	200
Labor							
Manual land prep.	man-day	n.a.	n.a.	n.a.	17	50	850
Planting	man-day	n.a.	n.a.	n.a.	10	50	500
Fertilizing	man-day	n.a.	n.a.	n.a.	6	50	300
Foliar	man-day	6	40	240	2	50	100
Herbicide	man-day	n.a.	n.a.	n.a.	3	50	150
Insecticide	man-day	11	40	440	4	50	200
Weeding	man-day	29	40	1,160	30	50	1,500
Roguing	man-day	6	40	240	6	50	300
Harvest	man-day	14	10	140	14	50	700
Beating	man-day	3	40	120	10	50	500
Transport field-home	kg	1,182	0.11	130	1,182	0.22	260
Processing							
Drying	man-day	4	40	160	4	50	200
Cleaning	man-day	3	40	120	3	50	150
Selection	man-day	7	40	280	7	50	350
Bagging	man-day	2	40	80	2	50	100
Bag cost[b]	units	48	4	180	48	4	180
Tag	kg	24	20	480	24	20	480
CERTISEM	ha	1	104	104	1	137	137
Transport							
House- Dept. capital	km	20	35	700	30	50	1,500
Opportunity Cost							
Land	ha	1	1000	1,000	1	450	450
Interests for 4 month period	%	2,483[c]	0.20	497	3,616[d]	0.07	253
TOTAL				**11,031**[e]			**11,887**[f]

[a] n.a. is not applicable; [b] Assumes a yield of 2,400 lbs.;
[c & d] Cash expenses (excludes land preparation, labor, and seed); [e] cost is L 4.60/lb;
[f] cost is L 4.95/lb; Source: Key informants 2002.

Table 25. Seed production training and inspection costs of farmers fields, Honduras, 2002.

Activity	Farmer Group	Days	Cost/day ($)	Total
Training	ARSAGRO			
Year 1	Fee	8	30	240
	Meals in Danli[a]	8	15	120
	Transport Zamorano-field	8	30	240
			Total	**600**[b]
	Yaruca			
	Fee	8	30	240
	Lodging and meals[c]	16	55	880
	Transport	8	100	800
			Total	**1920**[d]
Inspections	ARSAGRO			
Year 2	Fee	6	30	180
	Lodging and meals[e]	6	15	90
	Transport	6	30	180
			Total	**450**[f]
	Yaruca			
	Fee	6	30	180
	Lodging and meals[g]	12	55	660
	Transport	6	100	600
			Total	**1440**[h]

[a] For one person; [b] Cost is $600*L16.44/$/(15ha * 2,400lbs/ha) = L0.27/lb;
[c] For one person, one night; [d] Cost is $1920*L16.44/$/(6ha * 2,400lbs/ha) = L 2.19/lb
[e] For one person; [f] Cost is $450*L16.44/$/(15ha * 2,400lbs/ha) = L 0.21/lb
[g] For one person, one night; [h] Cost is $1440*L16.44/$/(6ha * 2,400lbs/ha) = L 1.64/lb
Source: PIF, 2002.

Table 26. Estimated prices for commercial seed by stage in proposed bean seed scheme, Honduras, 2002.

Stage	**Cost (Lempiras/lb)**	**Total Price (Lempiras/lb)**
Price DUWEST will pay farmers for commercial (inspected and bagged) seed at department capital	8	8
DUWEST's markup (22%) on seed purchased from farmers at department capital	1.76	9.76
Transport cost from department capital to smaller town or to department capital in another department[a] (3%)	0.29	10.05
DUWEST subdistributor's markup (15%) on seed supplied by DUWEST to smaller towns	1.51	11.56

[a] Smaller towns refer to towns like Chirinos and Linaca; department capitals refer to towns like Juticalpa and Yoro.
Source: Key informants, 2002.

Chapter VII

7. Summary, Conclusions, and Policy Implications

7.1 Summary

In Honduras, new varieties have been released with high yield potential and resistance to various diseases, especially Bean Golden Yellow Mosaic Virus (BGYMV). On-farm trials in Honduras indicated that recently-released modern varieties (MVs) like Tio Canela produce higher yields than traditional varieties (TVs). A recent study found that over 50% of bean farmers in the main bean-producing areas of Honduras (El Paraiso, Olancho and Francisco Morazan) planted MVs, which indicates that they see advantages to planting MVs–primarily due to their higher yield potential and disease resistance. However, many of the farmers planted varieties that were released in 1990 and virtually all of the farmers obtained their seed from a neighbor or planted farmer-saved seed.

The general objective of the study was to assess the feasibility of both increasing the physical supply of improved seed of modern bean varieties and expanding farmer access to these varieties. In order to recommend actions to increase the productivity of a seed system, it is necessary to take into account the varietal characteristics preferred by farmers and their willingness to pay and to evaluate alternative bean seed production and marketing schemes that can deliver good quality seed at low prices. A seed system model is proposed in which small farmers are contracted to multiply seed of modern bean varieties, under the supervision of Zamorano, and the seed is marketed through a private sector firm that currently distributes agricultural inputs.

A rapid appraisal methodology was used to collect information from key informants required to describe the bean seed subsector in Honduras, identify potential bean seed producers, and identify marketing agents interested in selling the seed. In addition, a farmer survey was conducted to assess the potential demand for improved bean seed.

The bean seed supply in Honduras is characterized by a series of seed production stages leading up to the distribution of seed through a marketing network. The first stage is breeding, followed by seed multiplication, seed inspection, and finally sales and distribution of seed. The breeding is done by Zamorano/PIF and DICTA. Following this, seed multiplication is done by Zamorano (PIF, ZCE, and ZCE's contractees), DICTA, Hondugenet, and NGOs (including NGO participating farmers). Seed inspection is done by CERTISEM. Finally, seed distribution and sales are done by Zamorano/ZCE, Hondugenet, and NGOs.

Two farmer groups, located in El Paraiso (ARSAGRO) and Atlantida (Yaruca farmer group), expressed an interest in growing bean seed under contract. A bean seed budget was constructed to estimate the cost of producing commercial seed. This analysis found that commercial bean seed could be produced for L10.58/kg (ARSAGRO farmers cost in second year) and L14.50/kg (Yaruca farmer group cost in second year), and compared to the price of L 17.6/kg that farmers would sell their seed, they considered it very attractive.

A farmer survey was conducted in El Paraiso and Olancho to collect socioeconomic characteristics of farmers and to assess the demand for improved bean seed, including their assessment of six modern varieties and their willingness to pay for these varieties. To assess farmer demand for modern bean varieties, a double hurdle model was used to determine the degree and direction of influence that farmers' and varietal characteristics have on farmers' purchase decision and willingness to pay. In addition, farmers' preferred bag size, purchase frequency and willingness to pay was used to appraise bean seed demand.

Among the six varieties shown to the farmers, farmers in both departments ranked Amadeus 77 highest in terms of preferences. The double-hurdle model confirmed the importance of red color in farmers' purchasing decision and that socioeconomic characteristics (i.e. land ownership, education, previous use of modern varieties) were associated with greater farmer willingness to pay a premium price for a modern bean variety. The farmers preferred a 50 lb bag and on average reported that they would purchase new seed every 1.7 years.

While several input distribution firms were contacted, DUWEST was the only marketing firm interested in participating in the proposed bean seed scheme. DUWEST agreed to initially purchase 23,000 kg of improved seed and distribute it to its sub-distributors.

Finally, this study demonstrated that it is feasible to contract small-scale farmers to produce commercial seed of modern varieties and sell the seed through an input dealer at department capitals at lower prices (L 12/lb (L 26.4/kg)) than the normal selling price

of L15/lb (L 33/kg) for commercial seed sold in Tegucigalpa, L 15.90/lb (L 35/kg) for certified seed in Zamorano, or from L 17.27 (L 38/kg) to L 19.86/lb (L 43.69/kg) for certified seed in Danli or a smaller town. At a price of L 12/lb (L 26.4/kg), the estimated seed demand in El Paraiso and Olancho is of 24 mt and 54 mt, respectively. The total amount of seed DUWEST is going to buy (23,000 kg) is approximately 30% of the estimated combined total demand in both departments. This means that DUWEST faces low risk of not being able to sell its stock of seed.

7.2 Conclusions

In summary, this study suggests that it is feasible to increase small-scale producers' access to commercial seed of modern bean varieties by contracting small-scale farmers to produce the seed and marketing it through an existing input dealer.

First, small-scale farmers and input distributing firms are willing to work together to increase the supply of improved bean seed and make it more affordable to farmers by selling commercial seed for L 12/lb (L 26.4/kg)–compared to the price in 2002 of L15/lb (L 33/kg) for commercial seed (Hondugenet), L 15.90/lb (L 35/kg) for certified seed (Zamorano), and a range from L 17.27 (L 38/kg) to L 19.86/lb (L 43.69/kg) in Danli or a smaller town.

Second, collaboration with Zamorano for third party certification will establish trust regarding the quality of seed produced by the small-scale farmers and assures the willingness of DUWEST to participate in the scheme.

Third, a substantial share of small-scale farmers in El Paraiso (35%) and Olancho (54%) would be willing to pay L12/lb (L 26.4/kg) for commercial seed of the variety Amadeus 77 due to its preferred seed color-- compared to widely grown modern varieties such as Tio Canela and Dorado.

7.3 Policy Implications

In the past, initiatives to improve small-scale farmers access to improved bean seed have been largely associated with relief projects. Given the immediate need to make seed available for the coming planting season, NGO and government projects have provided farmers free or highly subsidized seed. Clearly, these projects met the immediate seed needs of farmers. However, they have also undermined the development of a sustainable seed system. Since private sector seed firms cannot compete against projects that distributed subsidized seed, the private sector has largely abandoned this potential market.

Fieldwork for this study was carried out in summer 2002. At that time, it appeared that it would be possible to design a sustainable bean system and encourage NGOs and the government to no longer distort demand by distributing subsidized seed. However, in 2004 DICTA obtained funding from FAO to initiate a new a seed project. Under the project, DICTA supplied improved seed to small-scale farmers, who paid the seed by giving DICTA the same amount of grain of a landrace or traditional varieties or harvest of the modern variety (kilo for kilo[28]). While the project had a small budget

[28] This project was based on similar schemes that have been implemented in Mexico, Guatemala, and Nicaragua. See Gonzalez for an analysis of Mexico's kilo-for-kilo seed distribution.

($16,729.97), it benefitted 600 small-scale bean and corn farmers of the northern municipalities of Olancho. DICTA distributed the seed to farmers through NGOs, rural cashiers, and municipalities, which were in charge of collecting grain at harvest as payment for the seed. In 2005, DICTA submitted a new proposal which was designed to distribute improved bean and corn seed over a larger region of Honduras.

If the expanded project is funded and implemented throughout the country, the proposed bean seed scheme can not be implemented, due to the lower cost of the subsidized seed being offered by DICTA.

Projects like kilo-for-kilo should not be implemented except for relief purposes because they prevent the development of a private seed market. Private firms cannot compete with the bean seed prices that such projects offer farmers.

Similarly, NGO-sponsored subsidized seed projects (where food security is the main goal), that give free seed to farmers prevent the development of a private seed market. Rather than giving farmers seed, seed schemes should seek to develop linkages between small-scale bean seed producers and input distributors, as proposed by this study. For example, NGOs could give poor farmers seed vouchers which they could use to buy seed at a participating input dealer. Subsequently, the input distributor could redeem the voucher from the NGO. Such a system will provide farmers more flexibility in their choice of seed, enhance competitiveness, and promote the development of a private sector-based bean seed system (Remington, *et.al.*, 2002).

Finally, if government is to be involved in bean seed supply, it should direct its efforts on advertising campaigns to promote the purchase of improved seed and on fairs that expose farmers to these modern varieties.

7.4 Limitations

The demand results reported in this study apply to only the departments of El Paraiso and Olancho. While these departments account for a large acreage of bean planted in Honduras, farmers in other departments may have different varietal preference and may not be willing to pay a premium for improved bean seed.

Another limitation is that the expected demand for Amadeus will be lower than projected in this study if Amadeus 77 yields less in farmers fields than Tio Canela and Dorado. This is because the projected demand for Amadeus 77 was based on the assumption that Amadeus 77 produced the same yield as those two varieties.

7.5 Future Research

Future research should be directed towards building and supporting stronger linkages between the input distributing firms and small-scale bean seed farmers (i.e. input contracting) to insure the sustainability of these types of schemes.

Also, if the proposed scheme is implemented, a follow up study should be carried out to assess the actual seed demand of small-scale farmers to validate or reject the demand estimate reported in this thesis. Such a study would provide valuable information to seed producers and input distributing firms regarding the actual demand for improved seed by small-scale farmers.

Finally, a benefit-cost analysis of the current kilo-for-kilo project in Honduras should be implemented to determine if the project is economically feasible.

Appendix A. Explanatory variables correlation matrix[a].

	size	weight	fertilizer	age	school	land	Mod Var
size	1.00						
weight	-0.98	1.00					
fertilizer	0.02	-0.02	1.00				
age	-0.07	0.08	-0.29	1.00			
school	-0.01	0.02	0.24	-0.54	1.00		
land	0.06	-0.04	0.12	-0.05	-0.05	1.00	
Mod Var	0.04	-0.05	-0.09	-0.03	-0.16	0.14	1.00
drcolor	0.00	-0.00	-0.00	0.00	0.00	0.00	-0.00
dlrcolor	0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00
rcolor	0.00	-0.00	0.00	-0.00	0.00	0.00	-0.00
lrcolor	0.00	-0.00	-0.00	0.00	0.00	0.00	-0.00
	drcolor	dlrcolor	rcolor	lrcolor			
drcolor	1.00						
dlrcolor	-0.20	1.00					
rcolor	-0.20	-0.20	1.00				
lrcolor	-0.32	-0.31	-0.31	1.00			

[a] Refer to table 22 for details of variables.

Appendix B. Table of probit predicted outcomes

	True		
Classified	Positive	Negative	Total
Positive	54	18	72
Negative	101	259	360
Total	155	277	432

Appendix C. Probit and truncated model coefficients of bean attributes and farmers' characteristics on purchase decision and WTP.

Variable	Probit Model	Truncated Regression
Dark red color	-0.007	0.541
Std. error	0.224	1.437
p-value	0.975	0.706
Lighter dark red color	0.277	-0.282
Std. error	0.220	1.287
p-value	0.208	0.826
Red color	1.314	0.637
Std. error	0.228	1.202
p-value	0.000	0.596
Light red color	-0.020	0.052
Std. error	0.196	1.299
p-value	0.918	0.968
Fertilizer used in Postrera 2001	-0.150	-1.071
Std. error	0.151	0.860
p-value	0.321	0.213
Age	0.005	0.084
Std. error	0.006	0.036
p-value	0.399	0.021
Education	0.014	0.354
Std. error	0.019	0.104
p-value	0.451	0.001
Land	-0.009	0.149
Std. error	0.007	0.040
p-value	0.201	0.000
Use of modern variety	0.140	2.352
Std. error	0.146	0.916
p-value	0.340	0.010
Constant	-0.918	4.454
Std. error	0.447	2.942
p-value	0.040	0.130

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