THE PROFITABILITY ANALYSIS OF BEAN PRODUCTION IN NICARAGUA

By

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ABSTRACT

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In Nicaragua, government policies have historically favored agro-export industries, such as coffee, cotton and sugar. In the early-1990, the government began to implement policies favoring small-scale farmers cropping beans and maize. However, bean yields are still low. Since 1990, few studies have focused on Nicaragua's second most important crop, beans.

This study analyzes record-keeping (RK) data collected from 15 small bean farmers located in the Carazo and Masaya regions. The study assesses costs and patterns of input and labor use and the profitability of bean production. Five farmers among the sample grew traditional bean varieties and ten modern farmers cropped improved bean varieties.

The study found that the modern farmers intensively applied agrochemical input, while the traditional farmers applied only fertilizer and insecticide, and tended to substitute herbicide for manual weed control. Budget analysis showed that the modern farmers earned higher profits than the traditional farmers due to their higher yields. Bean yield was the most influential factor affecting profitability, while input and labor costs were not related to profitability. Regression analysis showed that the dummy variable "modern varieties", was the key variable affecting bean yield, and accounted for a 427kg/ha yield increase over traditional varieties. While promising, these results can not be generalized to the whole country – given the relatively small sample size and because farmers in only one region of the country were included in the sample. Thus, additional RK studies are recommended, and these studies should be carried out in other regions of the country and include more farmers.

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INTRODUCTION

1.1 Problem Statement

In most developing countries, increased production in agriculture, especially the food crop sector has been a catalyst for economic growth. In Asia, farmer adoption of new rice production technologies increased yields and farmer's profits and led to a Green Revolution. In Africa, farmer adoption of improved maize technologies has contributed to reducing food insecurity, and malnutrition.

However, in Nicaragua government policies have historically favored export crops. Thus, since the 19^{th} century, agro-export industries such as coffee, sugar, and cotton have led to economic growth in Nicaragua. While the development of export crops has benefited the Nicaraguan economy by generating foreign exchange, the recipients of these benefits have been concentrated among a handful of interested parties.

In contrast, in Nicaragua staples (maize and beans) are produced mostly by small-scale farmers with less than 10 hectares. While accounting for 70 percent[1] of the total farmers, the government has neglected these producers. During the 1960-79 period, average maize yields increased by only 3 percent (Godoy and Hockenstein, 1992). During the 1975-90 period, average bean yields in Nicaragua were 1.3 quintal/manzana (88 kg/ha) below the average yields of Honduras, Guatemala, and El Salvador (Godoy, *et al.* 1992).

[1] This figure is for 1978. Current statistics are not available.

Since 1990, when President Chamorro took office, the government has committed itself to promoting basic grain production, especially maize and bean, to meet the needs of domestic consumption and for export to regional markets in Central America. While new bean technologies have been promoted in Nicaragua since 1990, aggregate data suggest that improvements in productivity are still relatively small. For example, over the 1990-97 period, average of annual increases for bean yields was only 1.2 percent (FAO).

While many economists have described the economic policies of the Sandinista era, few studies have focused on documenting changes in Nicaraguan agriculture, especially since the early-1990s. Furthermore, no study has examined the economics of bean production and the constraints to bean production at the household level. Thus, given the importance of beans to small holder farmers, a better understanding of the profitability of bean production is needed to assess the status of bean production and identify research required to increase bean production in Nicaragua.

1.2 Objectives

The general objective of this study is to assess the current status of bean subsector in Nicaragua. More specifically, this study examines the profitability of small holder bean production and constraints facing farmers, by;

- Estimating the per hectare costs of production, profits, and returns to capital and labor;
- Carrying out sensitivity analysis to identify the most important factors affecting profits;

- Analyzing farmer's patterns of input use to assess the type and levels of technologies used, and to identify the degree to which farmers utilize recommended technologies;
- Analyzing farmer's patterns of labor use, focussing on identifying labor constraints that could be relaxed with appropriate technologies; and
- Identifying technical constraints that limit farmers' bean yields.

1.3 Thesis Outline

This study is divided into five chapters. Chapter II provides a historical overview of the general economy and the agricultural sector, focusing on socio-economic infrastructures for small farmers versus large farmers. Chapter III describes the recent performance of the bean subsector. Chapter IV characterizes the profitability of small farmers' bean production. Chapter V summarizes the findings of this study, and draws policy implications for increasing bean production.

CHAPTER II

THE NICARAGUAN ECONOMY

2.1 Historical Overview of Nicaragua

Nicaragua is a Central American country, bordered by two countries -- Honduras, Costa Rica -- and two oceans -- the North Pacific Ocean and the Atlantic Ocean. The country covers a total area of 129,494 square kilometers, making it the largest Central American country. The physical geography may be divided into three major zones: the Pacific lowland, the wetter, cooler central highland, and the Caribbean lowland.

Since its colonial era, Nicaragua has suffered from political instability, civil war, poverty, foreign intervention, and natural disaster.

After Christopher Columbus, the first European, visited Nicaragua in 1502, Spanish settlements were established in the 1520s. While resisted by indigenous groups, the Spanish finally conquered the indigenous people in 1552. The fertile volcanic soil and moderate climate in the Pacific lowlands attracted Spanish settlers, who set up a hacienda system to produce export products such as indigo, cacao, and cattle. On the Atlantic coast, the British settled in the 17th century, forming an agroexport system based on sugarcane production. However, the Spanish conquistadors ruled most of the country until Nicaragua gained independence in 1838.

From the mid-19th to the mid-20th century, the agricultural economy was dominated by coffee production for export. Coffee production was concentrated in the central highlands, while in the Pacific region farmers grew basic grains and developed a cattle industry. In the 1950s, cotton was introduced on a massive scale. This forced subsistence farmers from the highly-productive Pacific lowlands onto the slope of the mountains, where coffee growers already occupied the best lands in the central highlands (Vandermeer, 1993).

During most of the 20th century, Nicaragua was governed by several dictatorial regimes. From the 1930s to 1979, the Somoza family controlled the government and military and owned 10 to 20 percent of the nation's arable land. In addition, they were heavily involved in the food-processing industry and controlled import-export licenses. Armed opposition to the Somoza regime began with a small rural insurrection in the early-1960s and grew into a full-scale civil war in 1977. While the Sandinista National Liberation Front (FSLN) won the struggle in July 1979, the human and physical costs of the revolution were so great that the GDP shrank an estimated 25 percent in 1979 (Library of Congress, 1993).

Upon gaining power, the Sandinisa administration pledged to maintain a mixed (privately and publicly owned) economy. While all property and businesses owned by the Somoza family were nationalized, private business not previously owned by the Somoza family were allowed to continue to operate. However, the banking, insurance, mining, transportation and agricultural sector were nationalized, which was resisted by the elite and strengthen support among the elite for the opposition party.

In 1990 the opposition candidate -- Chamorro -- won the presidential election. Once in power, the new government radically changed the country's economic policies. In an effort to revitalize the economy, the Chamorro government focused on reactivating the private sector and stimulating agricultural exports. Soon after being elected, the government adopted the structural adjustment policy prescription, as recommended by the International Monetary Fund (IMF) and World Bank.

In addition to political instability, a series of natural disasters have plagued Nicaragua, including a catastrophic earthquake in 1972, Hurricane Joan in 1988, severe droughts in 1989 and 1992, and a tidal wave in 1992. Thus, it is not surprise that in the early-1990s Nicaragua competed with Haiti and Guyana as the poorest country in the Western Hemisphere (Library of Congress, 1993).

2.2 Macroeconomic Overview

2.2.1 Trends in the Gross Domestic Product

Throughout the 1980s, Nicaragua experienced economic decline, as indicated by a negative GDP growth rate of - 2.6 percent (World Bank 1998a). However, since 1990 the performance of the economy has improved. From 1990 to 1997, GDP growth averaged 5.7 percent (World Bank 1998a). Despite this turnaround, GDP per capita averaged only US$ 410 in 1997, the lowest among Central American countries[2] (World Bank, 1998b).

Since the 1970s, the agricultural sector (including forestry and fishery) has become increasingly important. In terms of its share of GDP, its contribution increased from 25 percent in 1970 to 34 percent in 1996 (World Bank, 1998b). In contrast, agricultural employment has declined from 25 percent of the economically active population in 1990 (FAO, 1997) to 22 percent in 1997 (World Bank 1998b). Combining food-related industries, in 1997 the agriculture sector accounted for 50 percent of GDP and employed more than 40 percent of total labor force. In contrast, the manufacturing

[2] Costa Rica ($2,640), El Salvador ($1,810), Guatemala ($1,500), Honduras ($700) in the same year.

sector and service sector accounted for 16 percent and 44 percent of GDP, respectively in 1997 (World Bank, 1998b).

External debt has been one of Nicaragua's greatest problems. In 1990, foreign debt stood at about US$10 billion. Among it creditors, Nicaragua owed US$ 4 billion to the former Soviet Union and US$ 6 billion to Western countries and international financial institutions, such as the World Bank, IMF, and IADB (Library of Congress, 1993). World Bank data indicated that in 1996 Nicaragua still owed approximately US$ 6 billion to external creditors.

2.2.2 Currency

In the late-1980s, Nicaragua experienced hyperinflation, with an annual inflation rate of 432 percent (World Bank, 1992). In the mid-1980s, the government devalued Nicaraguan currency (Cordoba) from US$1 = 7-10 Cordobas to US$1 = 20,000 Cordobas (official exchange rate). As part of its economic shock program, in February 1988 the Sandinista government introduced the New Cordoba, setting the rate at to 1,000 old Cordobas equal to 10 New Cordobas ($US 1.00). However, within a year, the exchange rate fell to US$1 = 920 new Cordobas. In 1990, the newly-elected government introduced a third currency, the Gold Cordoba, setting 5 million New Cordobas equal to 1 Gold Cordoba, which became the sole legal currency after 1991. In 1998, the current exchange rate was US$1 = 10 Gold Cordobas.

2.2.3 Social Indicators

In 1997 Nicaragua had a population of 4.4 millions (IADB, 1998). During the 1988-97 period, annual population growth averaged 2.5 percent. However, the total fertility rate has decreased rapidly from 6.2 in 1980 to 4.0 in 1996. Nicaragua's total population is expected to reach 5 millions by the year 2000. Typical of many developing countries, 40 percent of the population is under 15 years of age. Children aged 10-14 provides 13 percent of labor force and female provides 37 percent of the labor force (World Bank 1998a).

Poverty is widespread in Nicaragua. In 1993, a survey found that more than 50 percent of the population lived below the national poverty line, including 76 percent of the rural and 32 percent of urban population (World Bank 1998a). However, the Gini coefficient of income distribution was 50.3, which is somewhat lower than the average for Latin America and Caribbean countries (World Bank 1998a).[3]

2.3 The Agriculture Sector

2.3.1 Land Tenure and Agrarian Structure

Land is the traditional base of wealth in Nicaragua. While current data on land tenure are not available, Table 2.1 shows the land tenure structures in 1978 and 1986. During the Sandinista era (1979-90), there were several co-operatives, such as the Sandinista Agricultural Co-operative (CAS) and the Credit and Service Co-operative (CCS), which both managed farming enterprises and received support from the government, including agricultural services. In 1989, 23 percent of the total farm area

[3] Guatemala (59.6), Honduras (53.7), Mexico (50.3), Dominican Republic (50.5), Brazil (60.1)

was under the management of CAS and CCS (Spoor, 1995b). Since 1978, individual land holding have substantially decreased, while CAS, CCS, AP (large commercial farms) and APP (state farms) expanded as a result of the government's nationalization policy. As shown in Table 2.1, by 1986 30 percent of individual large farms (more than 141 ha) have been absorbed into co-operatives or state farms.

Table 2.1: Structure of Land Ownership in Nicaragua, 1978 and 1986.

	1978				1986			
	Area ('000 ha)	%	Families (1,000)	%	Area ('000 ha)	%	Families (1,000)	%
Co-operatives	NA	NA	NA	NA	708	13	25	10
State Farms	NA	NA	NA	NA	761	13	23	10
Subtotal	NA	NA	NA	NA	1,469	26	48	20
Individual Holdings > 141 ha	2,983	52	10	5	1,278	22	6	3
35-141 ha	1,714	30	24	11	1,704	30	25	10
< 35 ha not in co-ops.	935	17	108	50	690	12	55	23
<3.5 ha in credit and service co-ops.	60	1	6	3	550	10	66	28
Landless Worker	NA	NA	68	31	NA	NA	36	16
Subtotal	5,692	100	216	100	4,222	74	188	80
Total	5,692	100	216	100	5,691	100	236	100

Source: Barraclough, 1987.
NA - this type of land tenure did not exist in 1978.

However, after 1990 the state farms and co-operatives were rapidly privatized. By August 1991, 80 percent of the state-owned farmland had been redistributed, of which 26 percent went back to the former owners, 22 percent was assigned to the former *contras* (counter-revolutionary forces), 17 percent was given to demobilized army personnel, and 35 percent to the workers of parcelized farms (Spoor, 1994).

According to the most recent data (1997), subsistence farmers with less than 3.5 ha occupy 48 percent of total farmland -- 29 percent is now occupied by small farmers (3.5-17.5 ha), 17 percent by medium-sized farmers (17.5-70), and 6 percent by large farmers (70-500 ha or more)[4].

The small farmers, including subsistence farmers, are considered to be agrarian reform beneficiaries with poorly capitalized operations who use mainly family labor and occasionally hire labor from outside of the family (IADB, 1997). The medium-sized farmers have a more diversified production structures, which enables them to sell on the market in moderate volumes. In contrast, the large farmers are well-integrated into the market economy (IADB, 1997).

2.3.2 Major Crops

Nicaragua's major crops may be categorized into two types: traditional export crops and domestic food crops. The country's main export crops are coffee and cotton, while the typical *campesino*[5] crops are maize and beans. Figure 2.2 shows a comparison of area harvested for these four crops. However, since many *campesino* inter-crop maize-beans, maize-coffee, beans-coffee, etc. it is likely that these national statistics are somewhat inaccurate. These time series data clearly show that the area in maize and beans is substantially increasing, while the cotton area is decreasing, and the coffee area remains relatively constant.

[4] IADB, "Proposal for A Loan for a Food and Agricultural Production Revitalization Program" 1997. These figures do not include the region of North and South Atlantic, Chinandega, and León, since the Bank's loan program did not target on these regions.
[5] Small-scale subsistence farmer

Decrease in cotton area can be partially explained a substantial decline in world cotton prices. For example, the FOB price for cotton declined from US$ 76 per quintal (US$1.65/kg) in 1980, to US$ 41 per quintal (US$0.89) in 1985. Historically, cotton has been grown mostly by large landlords farming on the central Pacific coast. However, growing pest resistance to pesticides and later on, soil erosion and a lack of credit, discouraged cotton production in the mid-1980s. Consequently, by 1993, cotton production decreased below the level of 1980 (Figure 2.2) and average yield declined by 7.4 percent from the 1980s to the 1990s (FAO).

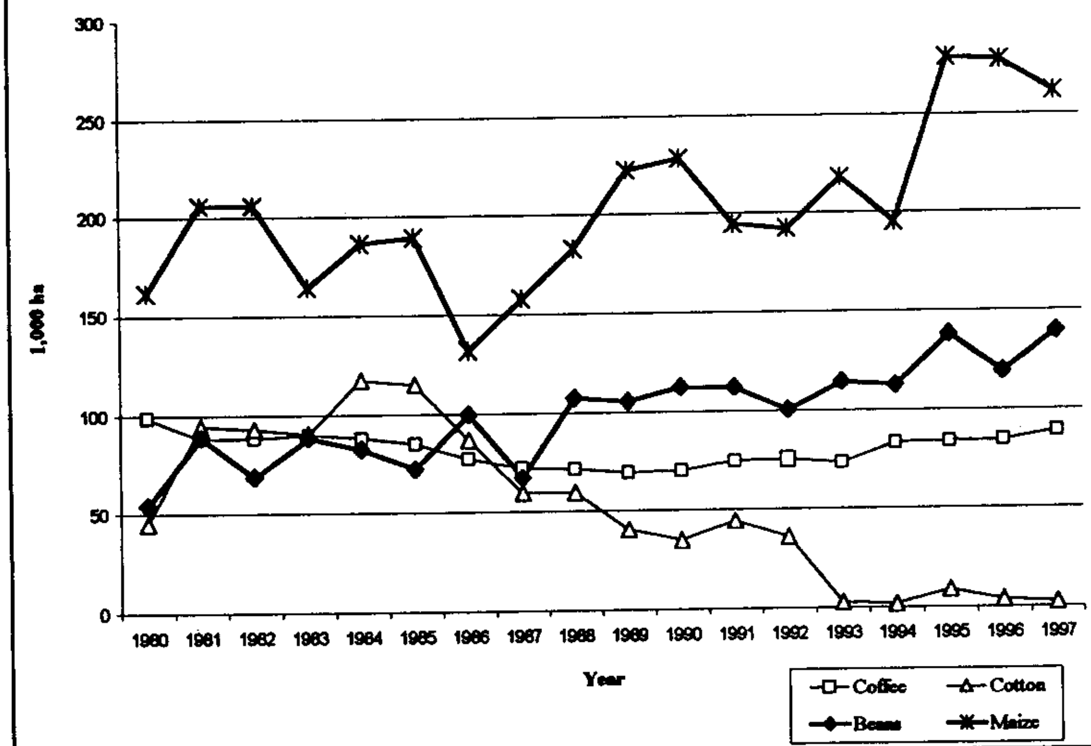

Figure 2.1 Area Harvested; Export Crops and *Campesino* Crops, Nicaragua 1980-97
Source: FAO

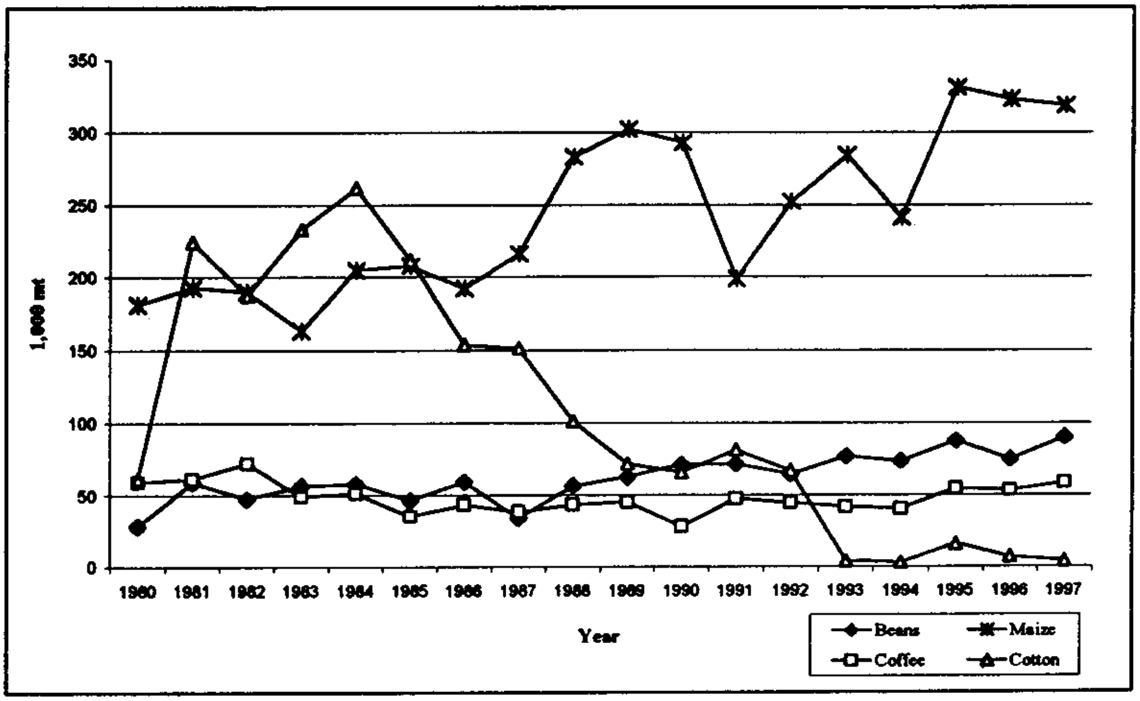

Figure 2.2 Production: Export Crops and *Campesino* Crops, Nicaragua 1980-97
Source: FAO

Coffee, which has played an important role in the Nicaraguan economy since the colonial era, is one of the country's main exports and sources of foreign exchange. Throughout the 1980-90s, the coffee area was relatively stable, compared to cotton. In the 1990s, the coffee area has increased, although average coffee yield decreased by 4 percent from the 1980s to the 1990s, keeping its total production level (FAO).

In contrast to these export crops, the country's major *campesino* crops have become increasingly important to the economy. Since 1980, maize production has grown by over 50 percent, from about 180,000 Mt. in 1980 to over 320,000 Mt. in the late 1990s (Table 2.2). However, maize production varies substantially from year-to-year. For example, in 1990-91, there was greater drop in production, partly due to a reduction in the area planted, as well as a drought in 1989. Maize area is roughly in expansion trend since 1986, recording its highest level in 1995 (Figure 2.1 and Table 2.2). Bean production has grown by over 50 percent, from the average of 51,000 Mt. in the 1980s, to 76,000 Mt. in the 1990s (Table 2.2). Similarly, Bean area has grown by 42 percent, from the average of 84,000 ha in the 1980s to 120,000 ha in the 1990s.

Table 2.2 Area Harvested and Production; Export Crops and *Campesino* Crops, Nicaragua 1980-97.

	Area Harvested (1,000 ha)				**Production (1,000 mt)**				**Yield (Kg/ha)**			
Year	Coffee	Cotton	Bean	Maize	Coffee	Cotton	Bean	Maize	Coffee	Cotton	Bean	Maize
1980	99	45	54	162	59	62	28	182	599	1380	523	1123
1981	88	94	89	206	61	224	59	193	694	2381	665	939
1982	88	93	68	206	72	188	47	190	819	2021	692	926
1983	90	90	88	164	49	233	56	163	549	2580	638	995
1984	88	117	83	186	51	262	58	205	583	2232	702	1100
1985	85	115	72	189	35	212	46	208	416	1843	641	1098
1986	77	87	100	132	43	154	59	192	562	1778	595	1460
1987	72	59	68	158	39	151	34	216	536	2549	503	1371
1988	71	59	108	183	43	101	56	283	608	1703	525	1550
1989	69	40	106	223	45	72	63	302	650	1781	592	1357
1990	70	35	113	228	28	66	71	293	400	1898	633	1283
1991	75	44	112	194	47	81	72	199	636	1841	639	1023
1992	75	36	101	192	45	67	64	252	591	1877	639	1313
1993	73	3	115	218	42	4	77	284	569	1609	670	1304
1994	83	1	113	195	41	3	74	241	487	2012	651	1237
1995	84	8	138	279	55	16	88	331	651	1887	637	1187
1996	84	4	119	278	53	7	75	323	633	1936	627	1162
1997	89	2	139	261	58	4	90	318	657	1936	648	1218

Source: FAO

2.3.3 Institutions

Research and Extension

In the 1980s, extension services and technical assistance were provided mostly by the Ministry of Agricultural Development and Agrarian Reform (MIDINRA). In the early-1980, MIDINRA initiated technical assistance projects particularly for state farms and cooperatives, which grew cotton and sorghum. In the mid-1980s, MIDINRA invested in a small number of large strategic projects. For example, in 1983, it launched the Contingency Plan for Basic Grains (PCGB), which was intended to increase maize production in irrigated area of 15,000-20,000 manzana (22,059-29,412 ha) in the Pacific region. However, throughout the 1980s, technical assistance mostly delivered to state farms and cooperatives rather than individual small producers (Spoor, 1995b).

In 1993, with World Bank support, the government of Nicaragua established the Nicaraguan Institute of Agricultural Technology (INTA). This institution was designed to transfer technologies to small and medium-sized farmers in order to increase productivity and farmers' income. INTA's mandate includes:

> The development and promotion of new varieties of seed, renovation of coffee trees, use of integrated pest management, assistance on processing, storage, and preservation of feed grains, development of irrigation area, improvement of livestock genetics and of cattle herd management, pasture improvement and applications on technical management to preserve forage and fodder in silos during the dry season (USDA, FAS 1997).

In addition, in the mid-1990s, the Ministry of Agriculture and Livestock (MAG) created the National Council for the Agricultural Production (CONAGRO), which is responsible for conducting research to improve agricultural productivity, and submitting proposals on agricultural production policies and implements the policies upon approval by MAG. Recently CONAGRO developed the Program for Rural Credit, which provides a variety of services to farmers including technical assistance, entrepreneurial management, credit, and commercialization assistance (USDA, FAS 1995).

Credit Service

During the Sandinista era, the National Development Bank (BANADES) provided credit primarily to large-scale farmers producing export crops. During 1979-88, an estimated 69 to 88 percent of BANADES' total credit outlays were made to these large-scale farmers, while the rest 12-31 percent were provided to small and medium-scale farmers producing domestic food crops.

After the Chamorro government took office, it initially provided subsidized credit to *campesino*. However, beginning in the 1992/93 agricultural season, the government reduced credit to the agricultural sector, as well as the commercial sector. As a part of the dominant neo-liberal policies of the government, BANADES became a private commercial bank, which provides credit almost exclusively to solvent producers with high yields and who use advanced technologies (Spoor, 1995a).

In spite of the efforts undertaken in the early-1990s to restructure state banks, their financial position, especially that of BANADES, has continued to deteriorate. Recently, with supports of IADB and World Bank, an effort was made to establish regional commercial banks and to set up branch offices in rural communities, in order to facilitate financial services in rural areas. In the first half of 1997, loan disbursements to the agricultural sector increased by 85 percent[6] over the middle of 1996 (IADB, 1997).

Food Grain Marketing

During the Sandinista era, there were a great number of service and trading parastatals. One of the most important parastatals, National Enterprise of Basic Foods (ENABAS), dominated grain markets, including maize, beans, rice, and sorghum. Although ENABAS had been undergoing privatization since 1991, it was still in the market in 1997. However, the government had made an effort to privatize its commercial distribution, by limiting ENABAS's participation to a 10 percent share of the local market for feed grains, privatizing its warehouses and silos, creating commercial private enterprises, and establishing the Agricultural Stock Exchange (BAGSA), which is designed to simplify agricultural commodity transactions between producers, traders, brokers, and other interested parties (USDA, FAS 1995).

[6] Data are from IADB, "Proposal for A Loan for a Food and Agricultural Production Revitalization Program" 1997. In monetary value, it increased from US$322 million to US$597 million.

CHAPTER III

THE BEANS SUBSECTOR

3.1 Demand Analysis

3.1.1 Beans in Nicaraguan Diet

In general, the diet of the Nicaraguan population is relatively high in carbohydrate and low in protein and vitamin (Liljestam, 1987).

Following maize, beans are the second most important staples in the Nicaraguan diet. On average, Nicaraguans consumed 12 kg per capita in 1996 (Table 3.1). According to FAO data, during 1980-96 beans provided a daily average of 159 calories and 10.4 grams of protein per capita, which was second to maize (15.7 grams)[7]. Due to their high protein, iron, calcium and vitamin B-12 content, beans are especially important complements to the diet of the Nicaraguan population.

Table 3.1 Annual Per Capita Consumption of Beans in Nicaragua, 1985-1996. (kg/year)[8]

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Kg	16.5	16.0	13.8	11.8	14.9	14.6	13.1	12.3	14.5	13.6	12.1	11.9

Source: PAN-FAO, Adopted from INTA Perfil de la Produccion de Frijol en Nicaragua, 1998.

[7] FAO Food Balance Sheet 1998.
[8] National recommended consumption = 17.0 kg/year.

However, in Nicaragua as in most developing countries, access to food varies greatly among income groups. The most recently available data show that in 1970, the daily calorie intake for the richest 5 percent of income group averaged 3,931, which is three times greater than that of the poorest 50 percent group[9]. Based on the same data, the national average value was 2,379 calories in 1970. According a USAID study (1976), 57 percent of the rural population suffered from deficiency in daily calorie intake (Liljestam, 1987). Furthermore, the richer population (*i.e.* top 15 percent) obtained approximately three times more calories and proteins from animal products than did the poorest, and consumed twice as many vegetables as the poorest households. In 1996, national daily nutritional intake averaged 2,328 calories (FAO Food Balance Sheet, 1998), which was 10 percent below the United Nations' recommended value of 2,600 calories and slightly below average nutritional intake in 1970 (2,379 calories).

These data imply that for low-income people, especially subsistence families, beans are an especially important source of proteins and calories.

3.1.2 Consumer Preferences

Consumer preferences for beans depend on both visual and qualitative characteristics. The former includes color, size, shape and uniformity of color. The later includes cooking time, flavor, and hardness after cooking.

The type of beans consumed in Nicaragua can be grouped into three market classes: light-red bean, dark-red bean and black bean. Most Nicaraguan prefers light-red

[9] Barraclough, 1982.

bean. According to the survey conducted by PROFRIJOL[10] among 100 housewives located in 27 towns, and whose households also cultivated beans, 39 percent preferred light-red beans, while only 2 and 3 percent preferred black beans, and dark-red beans, respectively. However, 56 percent of the housewives reported no preference.

In terms of quality characteristics, the above study reported that consumers prefer beans that can be kept longer after having been cooked. This is because most Nicaraguan do not keep their cooked beans in the refrigerator. Also, softer beans are preferred. The survey reported that 81 percent of housewives soak beans before cooking, in order to reduce cooking time. Interestingly, the report noted that consumers prefer traditional varieties (Criolla or Creole) over the improved varieties due to their superior visual and texture qualities. Consequently, the study found that 70 percent of the interviewees (who also planted beans) preferred traditional varieties because they sold more quickly and at a higher price than improved varieties.

3.1.3 Domestic Utilization

Total national utilization is obtained by subtracting the amount of seed, waste from domestic production and net imports. While these values are somewhat different from the estimates presented in Table 3.1, the trends are roughly similar (Figure 3.1), and indicate that annual consumption decreased from 1981 to 1987, and then rose through the 1990s.

[10] Regional Cooperative Program of Bean in Central America. Source: Munguia *et al.* 1995.

This is partially because in the 1985-1988, and 1993-95 (see Section 3.4)the producer prices of beans was relatively high, compared to the maize price. Therefore, bean consumers may have reduced their bean consumption during these periods.

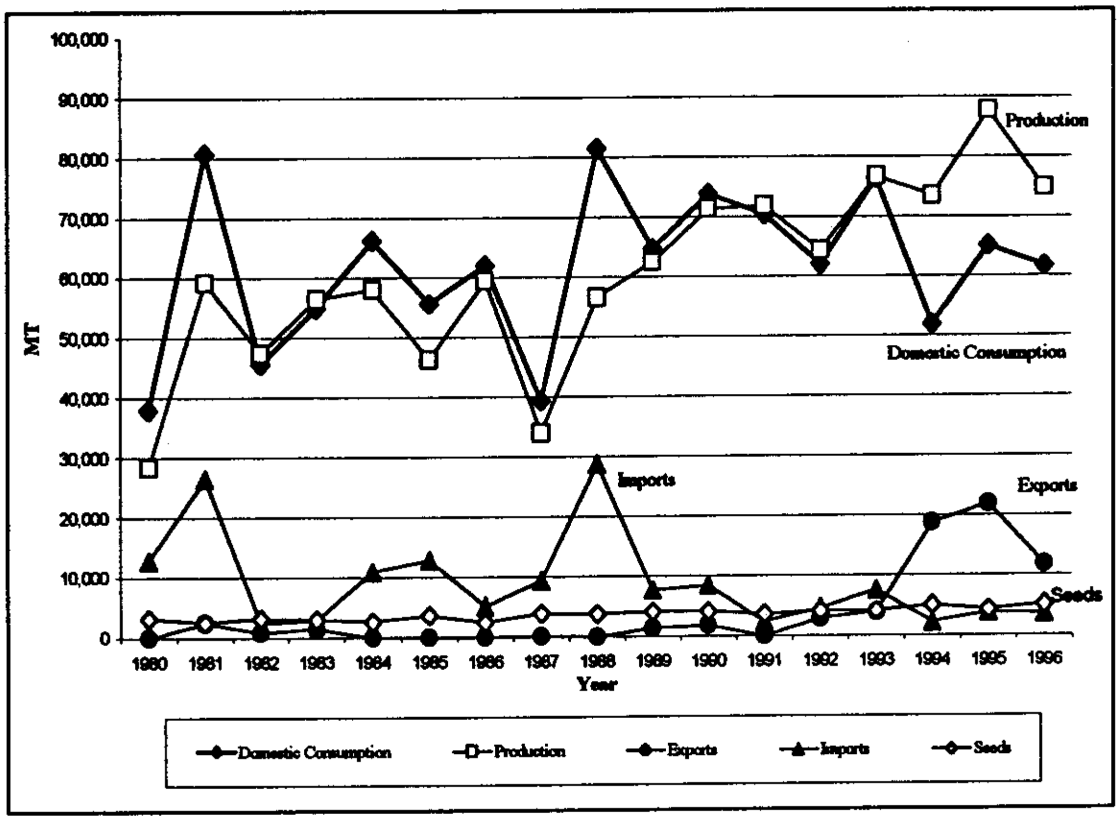

Figure 3.1 Dry Bean Utilization in Nicaragua, 1980-96.
Source: FAO Food Balance Sheet.

3.1.4 Central American Export Demand

During the 1960s and 1980s, Nicaragua was a net importer of beans (Figure 3.2). However, since 1988 imports have greatly declined and exports have begun to increase. In 1994 Nicaragua became a net exporter of beans, and in 1995 bean exports exceeded 20,000 Mt., which is equal to 25 percent of 1995 production.

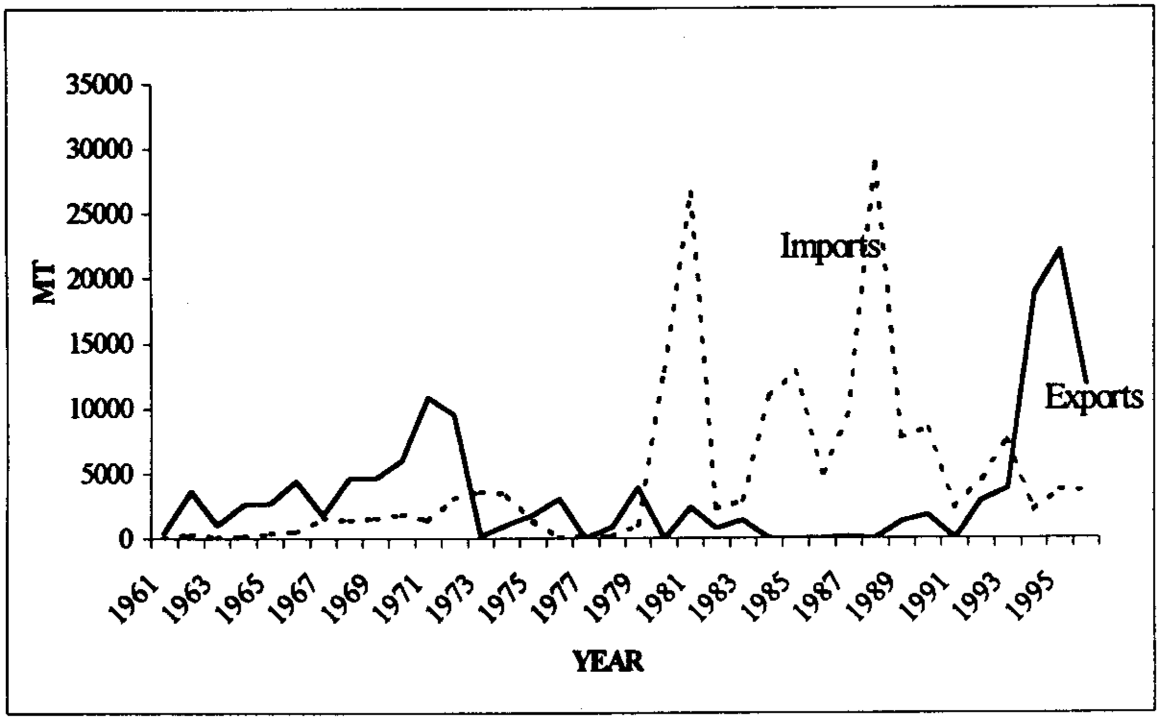

Figure 3.2 Dry Bean Trade of Nicaragua, 1961-96.
Source: FAO

In 1995 the primary destinations for Nicaraguan beans were El Salvador, Costa Rica, Cuba, Peru, Haiti and Guatemala (INTA, 1998). While data for each country's export share are not available, the most attractive export market was likely to have been El Salvador, because annual average bean prices of El Salvador were comparatively higher than in Nicaragua[11]. Secondly, in the future, Mexico will be an increasingly attractive market, since Nicaragua has signed a tariff rate-quota agreement with Mexico, as described below.

During the 1980s, Honduras was the dominant bean exporter in Central America (Martel, 1995), followed by Guatemala (black beans) and Nicaragua. However, in the 1990s, Nicaragua became the largest exporter in the region (Figure 3.3), largely due to the government's export promotion policy.

In 1991 the Chamorro government signed an export promotion decree, which favored non-traditional export crop growers. One of the benefits that the law provided was the right to a tax benefit certificate, equivalent to 15 percent of the FOB values of

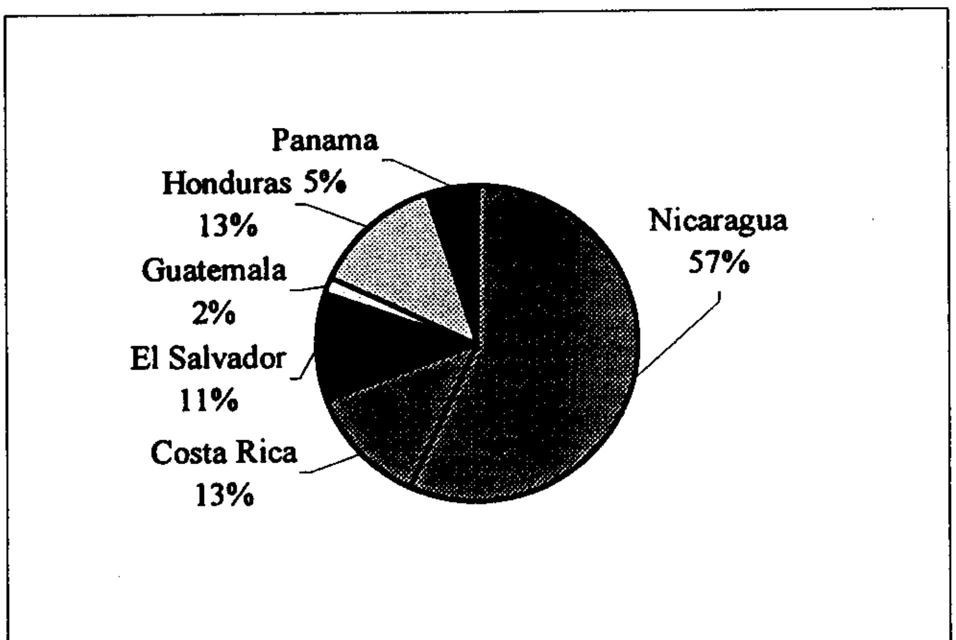

Figure 3.3 Country Shares of Bean Exports in Central America, 1991-96
Source: FAO

[11] In 1996 the average prices/quintal were US$51.42 (El Salvador), US$43.00 (Nicaragua), (INTA, 1998).

exported non-traditional goods. The introduction of this policy in 1990 matches the bean export trend shown in Figure 3.2.

More recently, the Nicaragua government signed a Free Trade Agreement with Mexico (effective from July 1, 1998). As a result of this tariff rate-quota agreement, Nicaragua gained access to the Mexican market, and can export up to 4,000 Mt of dry beans per year, which is equal to approximately 34 percent[12] of Nicaraguan total bean exports in 1996. The quota is expected to increase by 3 percent per year over the next 10 years. Thus, beginning with the Chamorro era, beans have become one of the country's key non-traditional exports.

[12] Nicaragua exported 11,794 Mt. of drybeans in 1996 (FAO).

3.2 Production Analysis

3.2.1 Regional Perspectives

In Nicaragua beans are grown throughout the country during all three crop cycles: the *primera* (May-August), the *postrera* (September-December), and the *apante* (December-February). Nicaragua's bean production regions can be divided into six regions and the *apante* regions of North and South Atlantic areas, as listed below (See Figure 3.4).

Region 1: Estelí, Nueva Segovia and Madriz

Region 2: Chinandega and León

Region 3: Managua and Carazo

Region 4: Masaya, Granada and Rivas

Region 5: Boaco, Chontales

Region 6: Matagalpa and Jinotega

North and South Atlantic Region[13]: Rama, La Esperanza, Muelle de los Bueyes, Nueva Guiana, and San Carlos (INTA, 1998)

Region 1 and 6, located in northern interior of the country, are the most important bean production regions. These two regions accounted for more than 60 percent of national bean production (Table 3.2). Farmers in these areas use improved technology to obtain high yields, and are in close proximity to urban markets. The third most important bean area is region 4, which accounts for 15 percent of national bean production. The rest of the country's bean production comes from the other regions, which contribute 15-20 percent of national production.

[13] *Apante* Region

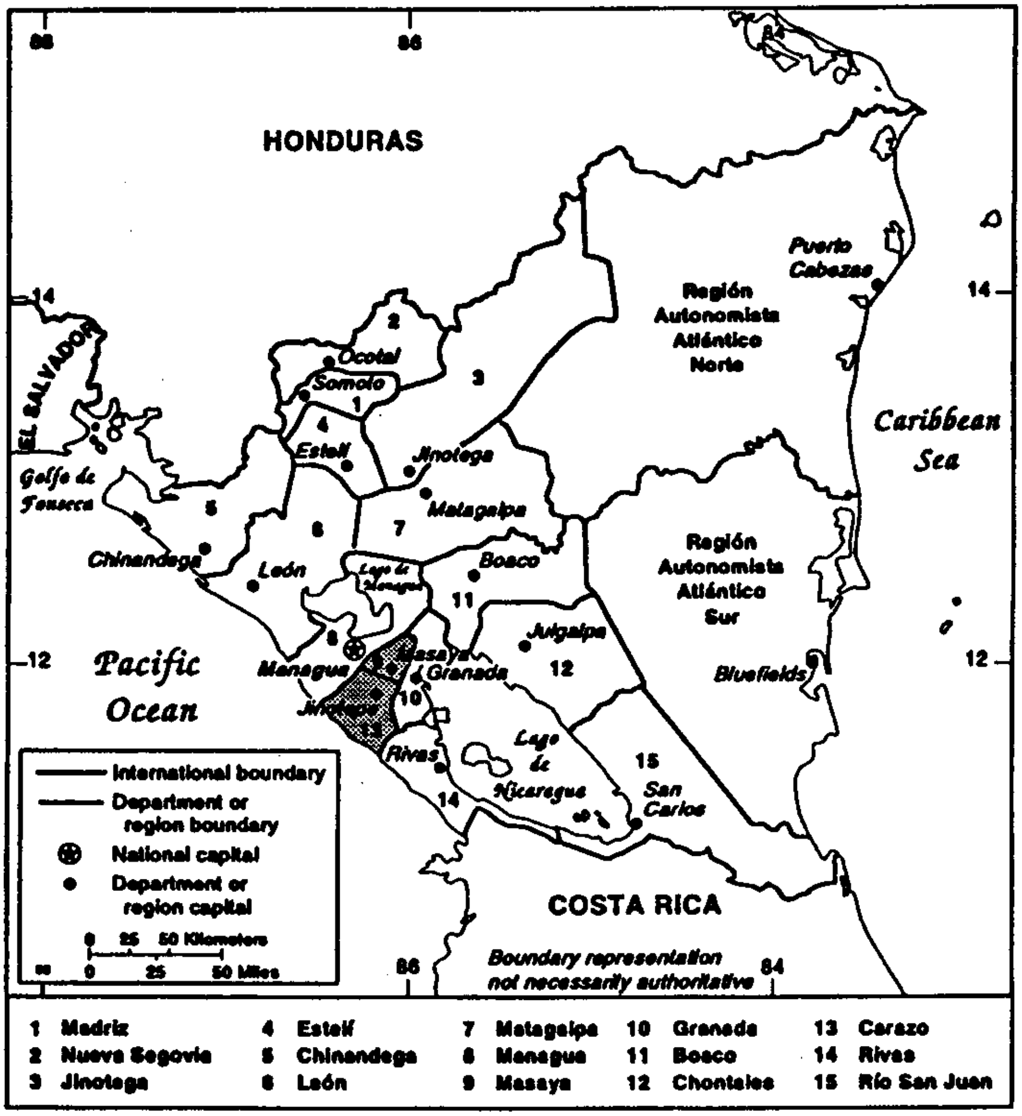

Figure 3.4 Nicaragua by Regions
Source: Library of Congress, Country Study: Nicaragua, 1993

In the North and South Atlantic regions, where annual average temperatures and humidity are high, beans are grown during the *apante* cycle, at the end of rainy season. However, the soil in these areas is relatively poor and has a low pHdue to the leaching of nutrients and toxicity from iron, aluminum, and magnesium. Besides, due to the hilly topography, it is impossible to use oxen or tractor. Farmers in these regions use traditional technology and yields are generally low. However, Table 3.2 shows that yields, especially during the *apante*, were quite high in 1997[14].

While most of the country's beans are produced during the *postrera* (40 percent), both the *apante* season (34 percent) and the *premera* (26 percent) account for a substantial share of total production (Table 3.2).

[14] Since the data for only single year are available, level of yield varies year by year.

Table 3.2 Bean Production, Area, and Yield by Regions and Crop Cycles in 1996/97 Crop Year, Nicaragua.

	Primera					Postrera					Apante				
Region	Area (ha)	%	Production ('000 mt)	%	Yield	Area (ha)	%	Production ('000 mt)	%	Yield	Area (ha)	%	Production ('000 mt)	%	Yield
Estelí, N.Segovia, Madriz	11,107	29.7	6,334	25.2	570	37,292	33.2	13,133	34.0	352	882	1.3	340	1.0	386
Chinandega, León	2,442	6.5	1,550	6.2	635	5,983	5.3	1,835	4.7	307	0	0	0	0	0
Managua, Carazo	813	2.2	547	2.2	673	3,562	3.2	593	1.5	167	0	0	0	0	0
Masaya, Granada, Rivas	6,015	16.1	2,778	11.0	462	18,242	16.2	4,425	11.4	243	0	0	0	0	0
Boaco, Chontales	2,540	6.8	2,001	7.9	788	7,186	6.4	1,564	4.0	218	18,293	27.0	4,540	13.9	248
Matagalpa, Jinotega	14,536	38.8	11,969	47.5	823	37,231	33.2	16,689	43.2	448	36,751	54.3	17,489	53.5	476
N.Atlantic	0	0	0	0	0	2,791	2.5	414	1.1	148	5,637	8.3	5,419	16.6	961
S.Atlantic	0	0	0	0	0	0	0	0	0	0	6,172	9.1	4,885	15.0	791
Total	37,452	100	25,180	100	659	112,285	100	38,654	100.0	289	67,736	100	32,674	100	573

Source: INTA, 1998

3.2.2 Bean Production System

Farm Size

Bean farmers are mostly small-scale farmers, who sell roughly one-half of their harvests to generate cash incomes. The rest of their harvest is used for personal consumption or seed for planting. Official data show that small farmers (<1.3 ha) account for a significant majority of the bean producers in the *primera* (Table 3.3).

In the same year (1996), farmers with less than 1.3 ha accounted 38 percent during the *postrera*, which decreased from 51 percent in the *primera*. In contrast, farmers with between 1.3 to 2.7 ha of beans, increased from 28 percent during the *primera* to 35 percent during the *postrera*. Similarly, farmers with between 2.7 to 6.8 ha increased from 13 percent during the *primera* to 18 percent during the *postrera*, and farmers with more than 6.8 ha slightly increased by 1 percent from the *primera* to the *postrera*.

Table 3.3 Bean Areas by Size of Farms in *Primera* of 1996.

Region	Department	*Primera*				Total
		< 1.3ha	1.3-2.7ha	2.7-6.8ha	>6.8ha	
1	Estelí, N.Segovia, Madriz	12,916	9,104	2,483	1,069	25,572
2	Chinandega, León	3,744	1,580	16	260	5,600
3	Managua, Carazo	775	804	351	857	2,787
4	Masaya, Granada, Rivas	8,826	1,251	1,123	1,199	12,399
5	Boaco, Chontales	3,239	1,477	865	396	5,977
6	Matagalpa, Jinotega	11,434	8,773	4,728	2,947	27,882
Apante	North/South Atlantic	240	63	652	0	955
Total		41,180	23,052	10,218	6,728	81,172
Percent		51%	28%	13%	8%	100%

Source: MAG, 1997. Adopted from INTA, 1998.

Bean Production, Area, and Yield

In Nicaragua, bean production has increased largely as a result of expanding its harvested area (Figure 3.5). From the parallel trends between the area and production, one can easily assume that capitals (seeds, fertilizer, other chemicals, machines, and so on) and labors have contributed only minimally to improve bean yields, leaving land as the most important factor in bean production.

In the 1970s, the annual rate of growth in the bean area was negative in Nicaragua (averaging - 0.2 percent), compared to Honduras and El Salvador which increased their bean area by 1.1 percent and 3.3 percent, respectively (PROFRIJOL, 1998). However, during the period 1991-97, the annual growth rate reached 7.9 percent[15], which was the highest level in Central America.

The production trend in Figure 3.5 can be divided into two periods: 1980-89 and 1990-1997. In the former period, the trend was somewhat flat, and then turned upward after 1989. This growth in bean production is primarily explained by the large increase in the area planted by *campesino*[16] following the demobilization of thousands of *contras*[17] and government soldiers, who benefited from a government led and UN-supported land distribution program (Spoor, 1995a).

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[15] mean of annual changes for each year in the 1990s

[16] Small-scale farmers who primarily grow maize and beans to supply their family's food requirements.

[17] U.S.-backed counter revolutionary forces against the Sandinista government.

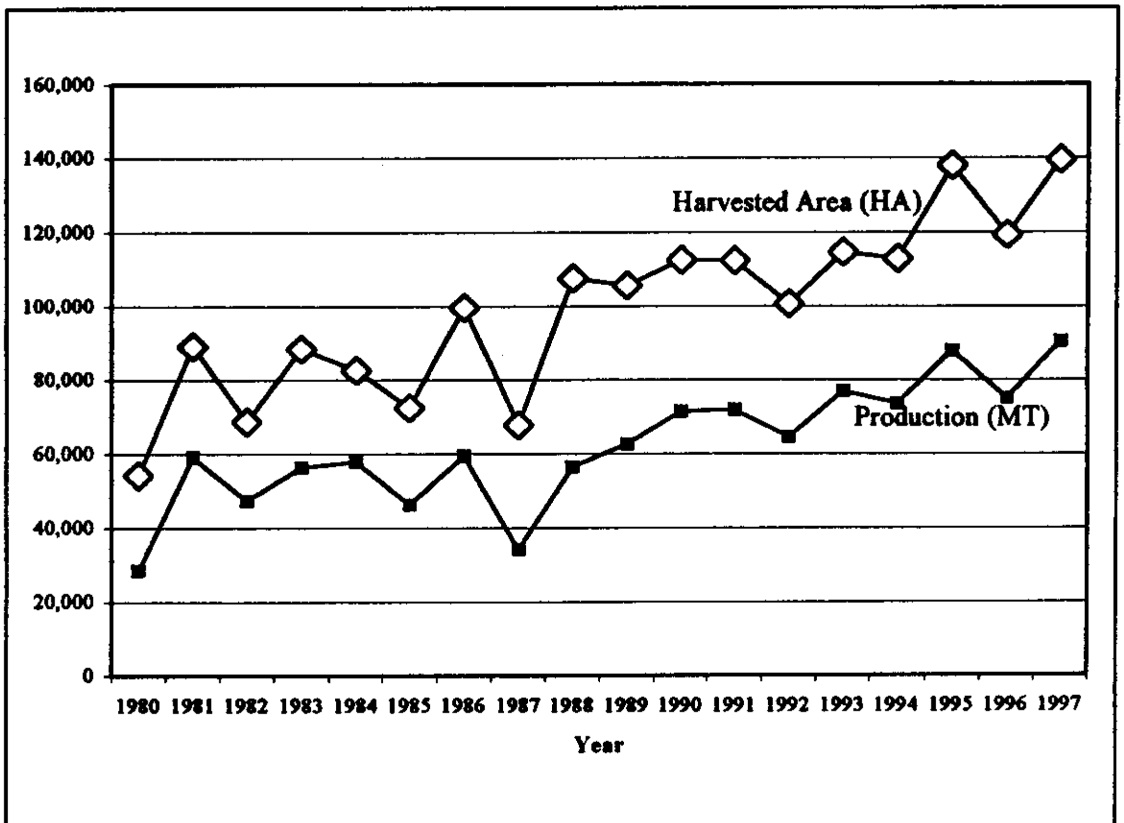

Figure 3.5 Bean Production and Harvested Area, 1980-1997, Nicaragua.
Source: FAO

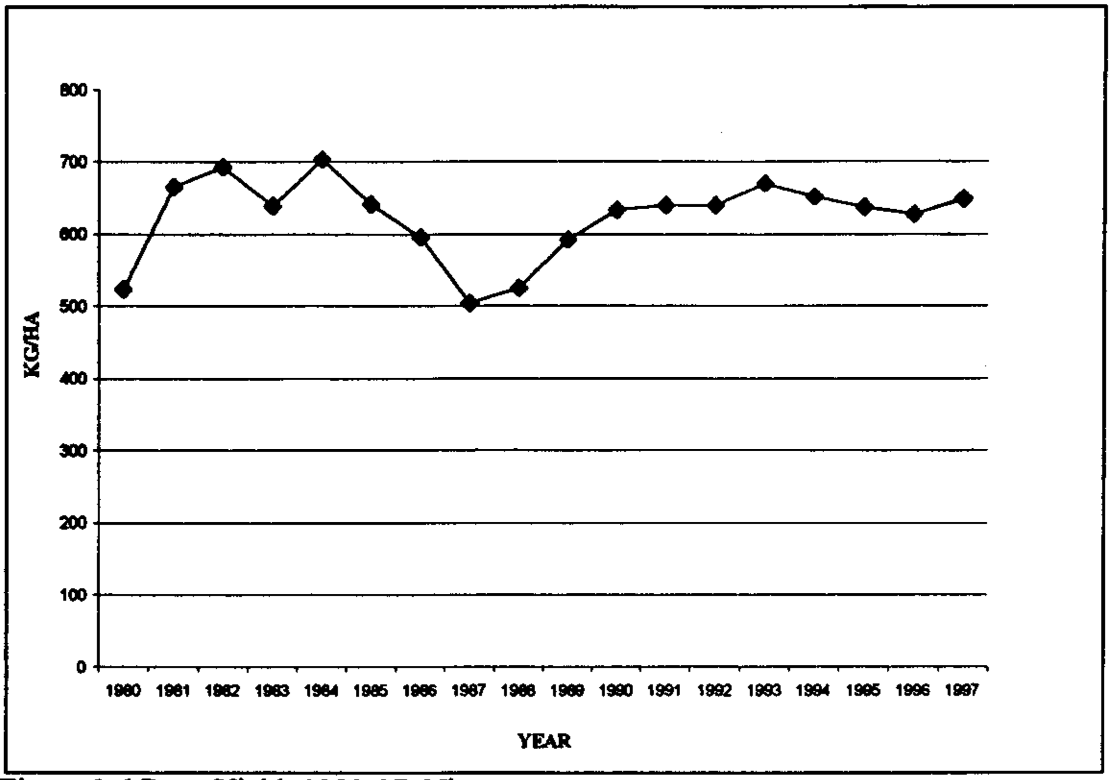

Figure 3.6 Bean Yield, 1980-97, Nicaragua
Source: FAO

In the 1960s, annual bean yields averaged 827 kg/ha (FAO). However, in the 1970s, the annual average yield decreased to 722 kg/ha (FAO), and by 1987 further declined to 86 percent of the 1970s average yield[18]. In contrast, bean yields began to increase in 1988. During the 1990-97 period, annual yields averaged 644 kg/ha, but still did not attain the yield levels achieved during the 1960s and 70s. Thus, while national average bean yields were relatively higher in the previous two decades (1960s-70s), and in the 1990s, yields recovered to the level of the 1980s.

However, bean yields vary greatly among the regions in Nicaragua. For example, highly productive region, such as Jinotega and Matagalpa, averaged 823 kg/ha in the

[18] The annual average yield in the 1980s was 619 kg/ha (FAO).

primera of 1996. In contrast, yields averaged only 462 kg/ha in Granada, Rivas, and Masaya, in the same season (Table 3.2). Pachico (1984) noted that since small farm technologies are frequently suitable only for a given region in a country, the impact of even very successful new technology may not be easily apparent in national production statistics. Given the regional dispersion of yields (Table 3.2) and aggregate yield trend (Figure 3.6), Pachico's observation likely characterizes the situation in Nicaragua.

Limited farmer adoption of improved bean technology is partially due to the fact that beans (and maize) are a *campesino* crop. Beans are risky to grow because they are subject to great variations in both yield due to environmental factors and prices (Pachico, 1984). Also, since the state has historically been the principal agency responsible for promoting new technologies in Nicaragua, farmers with whom the state agencies were frequently in contact were the ones who most often adopted the improved varieties (CIAT, 1989). However, the state farmers accounted for only 20 percent of total agricultural production area in 1986 (Barraclough, 1987). Thus, it is not surprising that the impact of adoption has been limited at the national level, given that the government has focused on meeting the technology needs of state farmers and the co-operatives, while neglecting the *campesino* who farm the rest (80 percent) of the agricultural area.

3.3 Input Use and Supply

3.3.1 Input Use

One of the constraints to increasing bean production is limited farmer adoption of inputs, such as improved varieties of seeds, fertilizer, and pesticide. While aggregate (national) data for input use are not available, data are available for the main bean region, which accounts for more than 40 percent of national bean production.

In 1994, the Nicaraguan Institute of Agricultural Technology (INTA) conducted a study in the regions of Jinotega and Matagalpa[19]. The study revealed that: a) 59 percent of surveyed bean farmers used oxen for land preparation, while 41 percent manually cultivated, and only 10 percent used a tractor[20]; b) 54 percent used herbicides for weed control, ranging from 40 to 75 percent (rate varied by town); c) 86 percent used insecticides; d) 68 percent used fungicides; e) 46 percent used inorganic fertilizers; and f) 30 percent planted improved bean seeds, ranging from 60 percent to 20 percent (rate varied by town).

Since these figures represent average values and the rate of input uses varied between the towns and regions, it is likely that the national average rates of input use are less than those of Jinotega and Matagalpa -- the two most important bean production regions in Nicaragua.

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[19] INTA, *Diagnostico de la Produccion de Frijol de la Region B-5*, 1996.
[20] For a), and b) above, low use of tractors and herbicide may not be a constraint to high yields.

3.3.2 Input Supply

Nicaragua has a mixed history of varietal development for beans. In the 1960s, several improved black bean varieties were released in Nicaragua, with experimental yields reaching 39 quintal per manzana (2,638 kg/ha[21].) -- six times of national average yields (Godoy, 1992). However, farmer adoption of these varieties was limited because black beans were not well accepted in the domestic market (Winter, 1964). Since 1978 Nicaragua has released 11 improved red bean varieties (PROFRIJOL, 1998). Yet, in 1996, approximately 72 percent of bean area was still planted to traditional varieties (Criollas), while only 28 percent was planted to improved varieties. Furthermore, the adoption rate is relatively low, compared to other Central American countries[22], despite evidence that the average yield of today's improved varieties is significantly higher than of traditional varieties (875 kg/ha vs. 676 kg/ha) (PROFRIJOL, 1998[23]).

During the 1980s, around 60 percent of agrochemical inputs were imported by the state enterprises and 40 percent by the private sector, while distribution shares were the other way around (Spoor, 1995b). The major recipients (purchasers) of these inputs were the state farms and agricultural co-operatives, which took advantage of subsidies from the government. Currently, private enterprises import and sell agrochemical inputs in shops in local towns.

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[21] 1 quintal = 46 kg, 1 manzana = 0.68 ha
[22] Costa Rica (85 %), Honduras (46 %), Panama and Guatemala (40 %). (PROFRIJOL, 1998)
[23] The data are from PROFRIJOL report, *Flujo de germoplasma e impacto del PROFRIJOL en Centroamerica*, 1998.

Access to credit is crucial to enable farmers to purchase inputs that enhance yield. During the Sandinista era, the National Development Bank (BANADES) provided credit to mostly large-scale farmers producing export crops. As mentioned in Chapter II, it is increasingly difficult for farmers to obtain credit from the National Development Bank. For example, bean farmers received 1.8 million Cordobas of credit in 1995, but in the following year (1996) they received only 0.2 million Cordobas (INTA, 1998). In addition, Carter (1989) argues that Nicaraguan small farmers are the least likely group to effectively use credit, as they often use it for non-agricultural purchases. Supporting this argument, Enriquez (1991) contends that credit functioned as a consumption subsidy and has contributed to raising inflation in the countryside.

However, recently the government implemented a policy that exempts the agricultural sector from tax payment for imported raw materials, capital goods, and spare parts until the year 2000. Since most chemical inputs are imported from industrial countries, input supplies are expected to increase. Thus, this policy may benefit bean farmers by reducing input costs.

3.4 Bean Price Analysis

3.4.1 Trends in Real and Relative Bean Prices

Economists often analyze trends in real prices[24] to assess the impact of changes in crop productivity over time. However, in order to obtain real bean prices, it is necessary to adjust prices to account for inflation.

[24] Real prices refer to nominal (market) prices that have been deflated to take out the effect of inflation.

From the late-1980s to the early-1990s, Nicaragua experienced hyperinflation as mentioned in Chapter II (900 percent in 1987, 1 million percent in 1988, 4,700 percent in 1989, 7,400 percent in 1990, and 2,900 percent in 1991). In addition, new currencies were introduced in 1989 (New Cordoba) and in 1991 (Gold Cordoba). As these financial changes make it extremely difficult to estimate real prices, this section examines the trend in the relative price of beans (the bean-to-maize price ratio) (Figure 3.7).

During the early-1980s, the bean-to-maize price ratio declined to a low of 1.2 (1986) – compared to maize, beans became increasingly less expensive. However, from

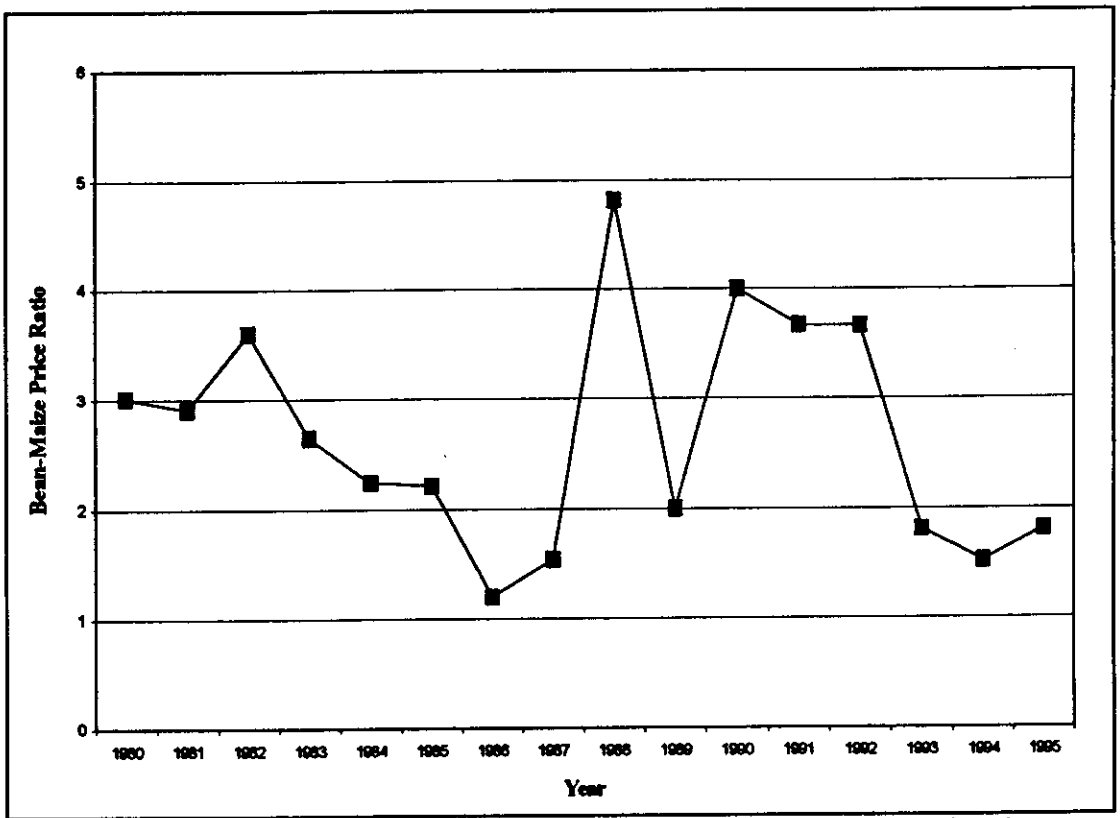

Figure 3.7 Bean-Maize Relative Price (Bean Price divided by Maize Price) in Nicaragua, 1980-95.
Source: FAO

1987 to 1990 the bean-to-maize price ratio fluctuated greatly[25]. In 1988, the relative bean prices reached their highest level (4.9), which corresponds to the lowest level of per-capita bean consumption (11.8 kg) during the 1980-96 period (Table 3.1).

After 1990, the ratio declined steadily, falling to 1.8 in 1995, which may partially explain the high levels of per-capita beans consumption in 1993 (14.5 kg) and 1994 (13.6 kg) (INTA, 1998).

3.4.2 Bean Price Seasonality

Bean prices in Nicaragua follow a seasonal pattern that reflects the bean production seasons, the *primera* and *postrera* (Figure 3.8). Bean prices begin to rise each season before the harvest, as bean stocks decrease, and then fall as farmers harvest and sell their beans.

In the *primera*, 1996, beans were harvested in June-July. Following the harvest, bean prices fell slightly through August. As inventories fell, bean prices rose through October. Following the October 1996 *postrera* harvest (main bean season), which was earlier than usual, bean prices fell in November and typically remained relatively low through March of the following year.

[25] This may be due to substantial increase in maze production during this period. Maize production increased by more than 30 percent from 1986 to 1990, while bean production increased only 15 percent during the same period (FAO).

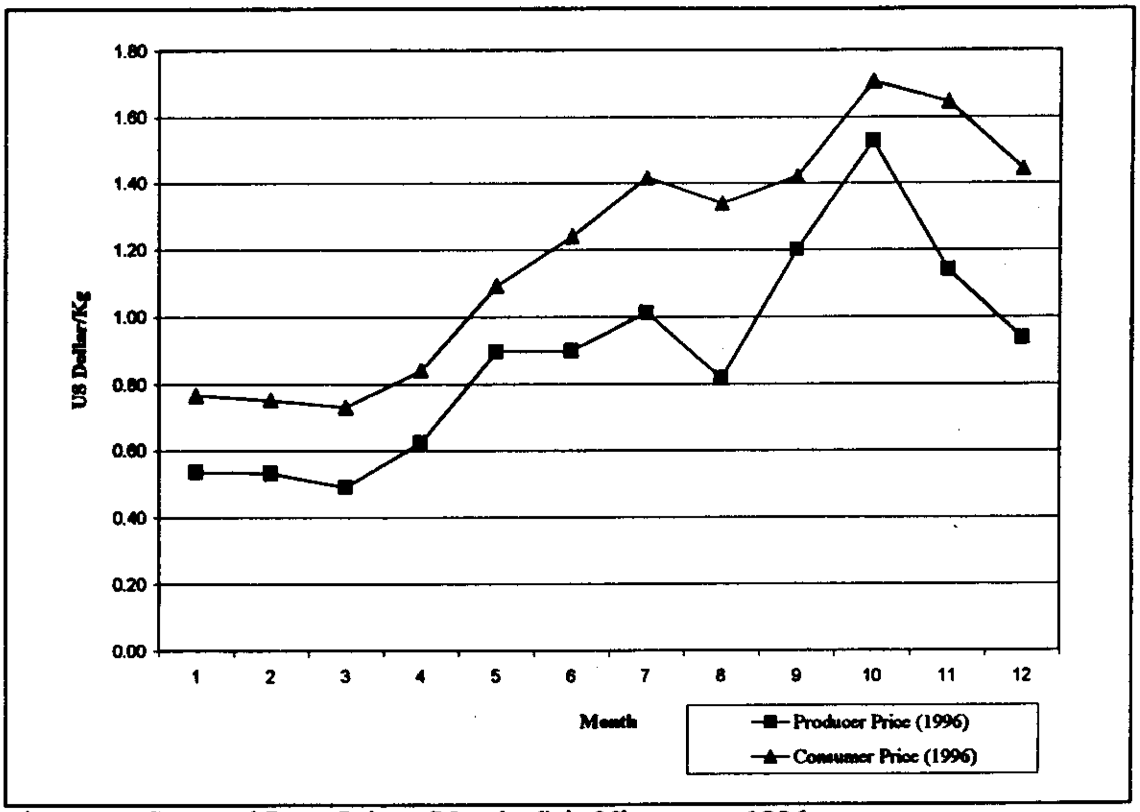

Figure 3.8 Seasonal Bean Prices (Nominal) in Nicaragua, 1996.
Source: INTA, 1998.

As observed in 1996, seasonal bean price fluctuation was relatively small for the *primera*. This may be because the figure is based on a single year of data[26]. Seasonal bean price fluctuation varies somewhat from year-to-year, due to both variations in yield and the level of imports.

3.5 Bean Market

In the 1980s, bean marketing was dominated by a government parastatal, the National Enterprise for Basic Grains (ENABAS). Although basic grains, particularly

[26] There is also monthly bean price data for 1995. However, the trend in 1995 shows quite different pattern (See Appendix A, Table A-1).

maize and beans, are produced by the most marginal sector of Nicaragua, the primary intent of ENABAS has been to aid consumers, not producers (Colburn, 1986). Spoor (1995b) reported that in 1985, traditional bean farmers' cost of production averaged 11,800 Cordoba per manzana, while ENABAS's purchasing price from farmers was 1,000 Cordoba per quintal (1 quintal = 46 kg). Assuming a yield of 7 quintal per manzana (Corburn, 1986), traditional farmers would earn gross returns of only 7,000 Cordoba per manzana, if they sold their whole crop to ENABAS. On the other hand, consumer had to pay 3,600 Cordoba per quintal to purchase the basic food, bean. As a result, many *campesino* faced low or negative rate of returns, and their terms of trade seriously deteriorated, given the high percentage increase in the cost of other consumer goods and services (Colburn, 1986).

Recent available data show that bean marketing margin are still large and vary through the season, from 43 to 67 percent of producer price in 1995 (INTA, 1998), even though ENABAS marketing share has significantly decreased since 1990. One possible reason for this is that very few private or public investments have been made to improve market infrastructure, including low cost storage facilities and technologies. Since traders consider grain trade as a high-risk operation, they try to include sufficient profit in their marketing margins (Tijerino, 1993; Spoor, 1995a). In addition, Spoor (1995a) argues that increased rural insecurity (*i.e.* danger of theft) has made transporting grain a somewhat risky business.

CHAPTER IV

PROFITABLITY ANALYSIS OF BEAN PRODUCTION

4.1 Methodology

4.1.1 Data Source

During the 1997-*postrera* season (September-December), farm record keeping data were collected by INTA staff, supervised by PROFRIJOL economist, Abelardo Viana. The data were collected on the primary bean field cultivated by 15 small rainfed farmers (average field size = 0.58 ha, ranged from 0.17 to 0.68 ha.) located in Carazo (N=10) and Masaya (N=5) Provinces. All farmers grew beans as a monoculture on hillside fields. The data collected included yields per manzana, bean prices received at time of sale, types of farming operations, cost and amount of labor used (family and hired), and input used for each operations.

4.1.2 Analytical Model

As an analytical model, the methods recommended by Dillon and Hardaker (1980)[27] are employed in this analysis. In the Dillon and Hardaker analytical model, the unit of analysis is the farm. However, the data analyzed in this study were collected for a single bean parcel. Thus, while the following definitions are based on those proposed by Dillon and Hardaker, they have been modified to reflect the unit of analysis in this study (*i.e.* the bean parcel).

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[27] Dillon, J I. and J. B. Hardaker, *Farm Management Research for Small Farmer Development*, FAO Agricultural Services Bulletin. 1980.

Gross parcel income (GPI) per hectare is defined as the value of the total output of the parcel, whether the output is sold or not. Therefore, GPI includes the output, which is sold, used for household consumption, used on the farm for seed, and used for payments in kind (*i.e.* sharecropper earnings paid as share of outputs).

Total parcel expenses (TPX) per hectare are defined as the value of all inputs used in production, excluding the value of in-kind payments to labors (*i.e.* lunch provided for hired labor). Family labor – which is valued at its opportunity cost (local wage rate) – is also included as an expense. Total expenses are generally divided into variable expenses and fixed expenses. However, in this analysis fixed expenses are excluded. Since fixed expenses are minimal in small farming operations in Nicaragua, these data were not collected. Thus, all expenses are considered to be variable expenses.

The difference between gross parcel income and total parcel expenses is defined as net parcel income (NPI). NPI measures the reward to the family for both its production management and all capital invested in the parcel. Therefore, in this analysis, NPI represents the profitability of the parcel.

As an analytical method, comparative analysis is used in this study. Comparative analysis is defined as a method of assessing the performance of individual parcels (Dillon *et al.* 1980). In survey data analysis, the survey results are typically set out in tables and figures, in order to facilitate comparisons between different groups of farms (parcel) in the sample. In this process, comparisons of the farms' (parcels') performance are accompanied with some "standard" (Dillon *et al.* 1980). All values are estimated in US dollar per hectare, converted from local currency (Cordoba) and local area unit (manzana). However, Appendix C reports these same results in the local currency (Cordoba) and local unit of land measure (manzana).

This study first estimates average performance for the total sample of farms (parcels), and then compare the performance of farmers using traditional and improved technologies (varieties). Hence, "traditional farmers" refers to the farmers who planted traditional bean varieties, and "modern farmers" refers to the farmers who planted improved bean varieties, applied more fertilizer, and used herbicide. Of the total number of farms (parcels) included in this analysis, five are traditional farms and ten are modern farms using improved technologies.

4.2 Data Analysis

4.2.1 Bean Farming System

The farmers who participated in the record-keeping study grow two bean crops per year. In the *primera* (May-August), beans are typically intercropped with maize and in the *postrera* (September-December) beans are typically grown as a monoculture. Figure 4.1 shows the rainfall pattern during the *postrera* and the time period during which farmers carried out each farming operation. The *postrera* crop is planted during the mid-September to the late-October period, and harvested during the late-November to the early-January period (Figure 4.1).

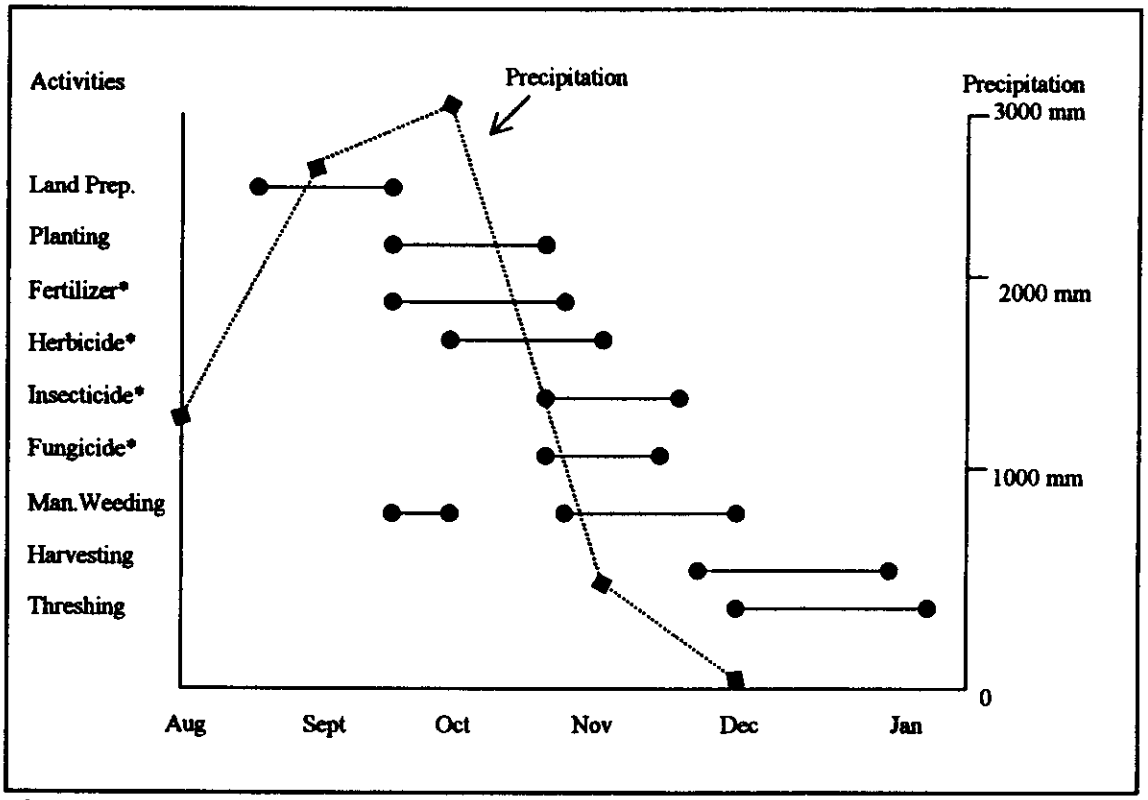

Figure 4.1 Period of Farm Operations and Monthly Average Precipitation during the *Postrera*, Carazo in Nicaragua.
Source: Precipitation data are from Salomon, 1987.
* Application of fertilizer, herbicide, insecticide, and fungicide.

4.2.2 Patterns and Costs of Input Use

Traction Contract

None of farmers in the sample owned a tractor. For land preparation, which is carried out in the late August to mid-September, farmers contracted these services from their neighbors, mostly medium-to-large scale farmers who own oxen or a tractor[28]. For the total sample, land preparation costs averaged US$19.30/ha. The cost of land preparation was similar, regardless of whether the farmer used oxen or a tractor.

The traditional farmers tended to spend relatively more on land preparation than the modern farmers. All traditional farmers plowed their parcels at least twice using animal traction. In contrast, the modern farmers plowed their parcels an average of 1.3 times. While most used animal traction, two of the farmers hired a tractor. Interestingly, on average the traditional farmers spent US$24.82/ha, while the modern farmers spent only US$16.54/ha for land preparation.

Seed

Farmers in the record-keeping study most commonly planted seed that they had saved from their previous harvest or obtained from other producers who were located close to them.

Among the sample of 15 farmers, five used traditional varieties (TVs), which they planted at an average seeding rate of 66 kg/ha (Table 4.1), and 10 farmers used modern varieties (MVs), which they planted at an average rate of 56 kg/ha (eight farmers planted MVs, DOR-364, and two planted Compañia[29]). All farmers planting TVs paid roughly

[28] Informal Discussion with Abelardo Viana.
[29] Experimental yield of DOR-364 is 1353-2368kg/ha, and of Compañia is 1353-2029kg/ha, INTA, 1998.

same unit price, US$1.03/kg. In contrast, for farmers planting MVs, the unit price varied among the farmers. For example, three farmers located in Jinotepe (the regional capital) paid the same unit price as for TVs (US$1.03/kg), while the five farmers in Masatepe paid US$1.61/kg, and the two farmers in Dolores, paid US$1.38/kg.

Table 4.1 Average Quantity and Cost of Input Use Per Hectare by Type of Farmer, *Postrera*, 1997, Carazo and Masaya Regions, Nicaragua.

Item	Total Sample (N=15)		Traditional (N=5)		Modern (N=10)	
	Quantity	Cost (US$/ha)	Quantity	Cost (US$/ha)	Quantity	Cost (US$/ha)
Seed (kg/ha)	59.4	74.63	66.1	68.24	56.1	77.82
Fertilizer (kg/ha)	103.80	33.86	94.7	25.74	108.35	37.92
Herbicide (l/ha)	0.9	15.47	0	0	1.3	23.21
Insecticide (l/ha)	1.3	6.23	2.0	9.10	0.9	4.79
Fungicide (g/ha)	189.0	2.89	0	0	283.5	4.34
Traction Contract[30] (times/ha)	1.5	19.30	2.0	24.82	1.3	16.54
Total Cost (US$/ha)	152.38		127.90		164.62	

Fertilizer

Farmers in the study area used three types of fertilizers; 18-46-0, 12-30-10, and Urea (46-0-0). For the total sample, farmers spent an average of US$33.86 for fertilizer (Table 4.2).

All traditional farmers exclusively applied 12-30-10 (average rate of 94.7 kg/ha), while modern farmers applied 18-46-0 (average rate of 114.9 kg/ha), although one

[30] Cost per hectare of traction contract includes oxen or a tractor used and a man who operates them. Since original data indicate traction contract as a unique price for both hiring traction and a man, it is impossible to estimate this cost separately.

modern farmer did not apply any of fertilizer. In addition, two of the modern farmers applied 2 kg of urea per hectare mixed with a gallon of water.

Table 4.2 Average Fertilizer Use Per Hectare by Types of Farmers, Postrera, 1997, Carazo and Masaya Regions, Nicaragua

	Traditional (N=5)	Modern (N=10)
Formulation	12-30-10	18-46-0*
Quantity (kg/ha)	94.71	107.94
Cost (US$/ha)	25.74	37.81
Unit Price (US$/kg)	0.27	0.35
Nutrient Equivalent		
Nitrogen (kg/ha)	11.4	19.4
Phosphate (kg/ha)	28.4	49.7
Potassium (kg/ha)	9.5	0.0

* Excluding urea (46-0-0).

On average, modern farmers applied more nitrogen (19.4 kg/ha) than traditional farmers (11.4 kg/ha) (Table 4.2). Modern farmers also applied more phosphate of 49.7 kg/ha than traditional farmers (28.4 kg/ha). However, modern farmers did not apply any of potassium, compared to traditional farmers (9.5 kg/ha).[31]

As was the case for the seed price, on average farmers in Jinotepe paid a lower price (US$0.28/kg) for fertilizer (18-46-0), compared to farmers in other areas (US$0.36/kg for 18-46-0). In contrast, on average traditional farmers paid an identical price ($0.27/kg) for fertilizer (12-30-10). Since the farmers in this record keeping study obtained fertilizer as well as other agrochemical inputs from the market closest to their

[31] It is surprising that the modern farmers used a fertilizer without potassium, since many soils in the tropics are phosphorus deficient, and potassium is also an important essential nutrient. One possible explanation is that unlike in the Atlantic region, in the Pacific region soil may natively contain potassium nutrient.

farm, this price variation may be due to differences in marketing costs among the locations studied.

Herbicide

In contrast to fertilizer, which was used by most of the farmers (14 out of 15), none of traditional farmers applied herbicide and only six of the 10 modern farmers applied herbicide. Modern farmers spent an average of US$23.21/ha for herbicide.

Furthermore, the pattern of herbicide application varied among the modern farmers. For example, four farmers applied only one type (brand) of herbicide and two farmers applied more than two types of herbicides. The most popular type of herbicide applied was *Gramoxone* (manufactured by Zeneca Agricultural Products), which was the least expensive (US$6.25/l) among the products used by farmers in the record-keeping study. The second inexpensive herbicide, *Loundup* (US$9.38/l, manufactured by Monsanto) was used by only one farmer. On the other hand, the most expensive types of herbicide were *Fusilade* and *Flex*[32] (US$26.56/l), which were used by two farmers.

Insecticide

For whole sample, farmers spent an average of US$6.23 per hectare for herbicide. All farmers who used insecticide in the study area primarily applied *Monitor*, manufactured by Bayer Corporation[33].

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[32] *Flex* is the name noted in the Record-keeping data. *Flex* refers to *Flexstar*, produced by Zeneca Agricultural Products. All of herbicides (*Gramoxone, Flex, Fusilade*) except one (*Roundup*) used by farmers in the sample are manufactured by this company.

[33] In the record-keeping data, the name of the insecticides was recorded on the datasheets was Methamidophos, or MTD. The only insecticide product containing Methamidophos has been found to be the *Monitor*, which is recommended for beans crop for pest control (MSU Extension Bulletin, 1999).

Among the sample, all (five) of the traditional farmers and six of the modern farmers applied insecticide. Interestingly, traditional farmers applied insecticide at a higher rate than modern farmers. Traditional farmers applied an average of 2.0 liter/ha of the same chemical, while modern farmers applied an average of 0.9 liter/ha. On average, traditional farmers spent US$9.10/ha, while modern farmers spent US$4.79/ha. As with other inputs, the price of insecticide varied by location. The three modern farmers located in Masatepe paid a higher unit price (US$6.30/l), while both the traditional and modern farmers in other locations paid an identical unit price of $4.60/l for the same insecticide.

Fungicide

Farmers in the study area applied two types of fungicide (an unidentified copper-based fungicide recorded as *Cobre*, and *Benlate*, manufactured by DuPont). As was observed for herbicide use, none of traditional farmers applied fungicide. In contrast, six modern farmers spent an average of US$4.34/ha. All fungicide users, except two farmers in Dolores, applied both the copper-based fungicide and *Benlate*. The farmers located in Masatepe paid identical prices (the copper-based: $0.01/g, *Benlate*: $0.02/g) for these two types.

Input Cost Shares

For the typical traditional farmers, the main purchased input components (excluding labor) are contract traction services, seeds, and fertilizer. Among the recommended technology used, insecticide accounted for only seven percent of total input costs, and fertilizer accounted for 20 percent (Figure 4.2)[34]. On average, seed costs accounted for the largest share (54 percent) of traditional farmers' material input costs, followed by fertilizer (20 percent), animal traction services (19 percent), and insecticide (7 percent).

For the typical modern farmers, the cost shares for seed (47 percent) and fertilizer (23 percent) are roughly similar to those of traditional farmers (Figure 4.3). However, while traditional farmers do not apply herbicide, this input accounts for 14 percent of modern farmers' input costs.

[34] Excluding cost of spray applicators for fungicides and insecticides, as these data were not available.

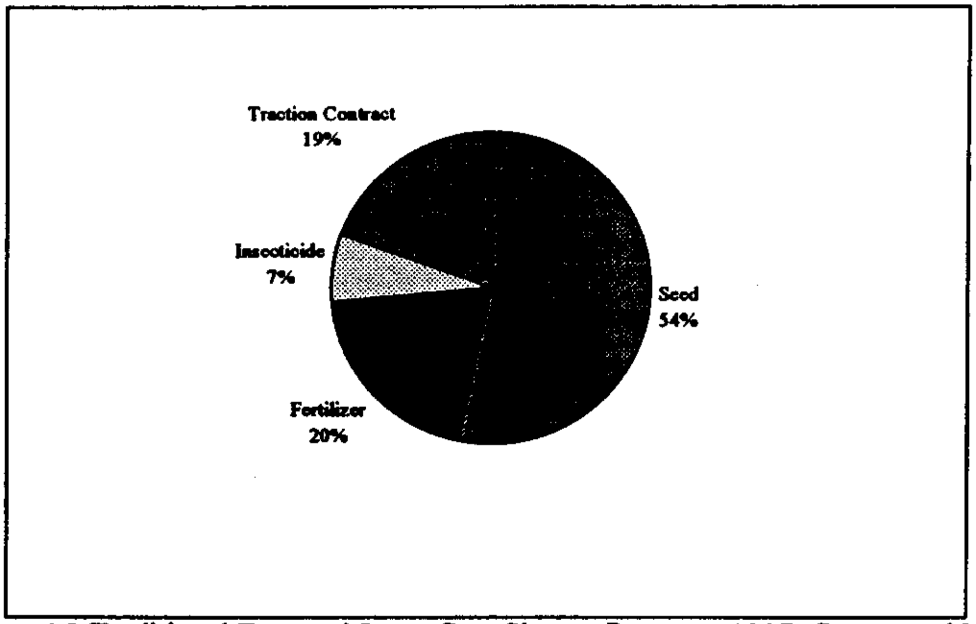

Figure 4.2 Traditional Farmers' Input Cost Shares, *Postrera,* 1997, Carazo and Masaya Regions, Nicaragua

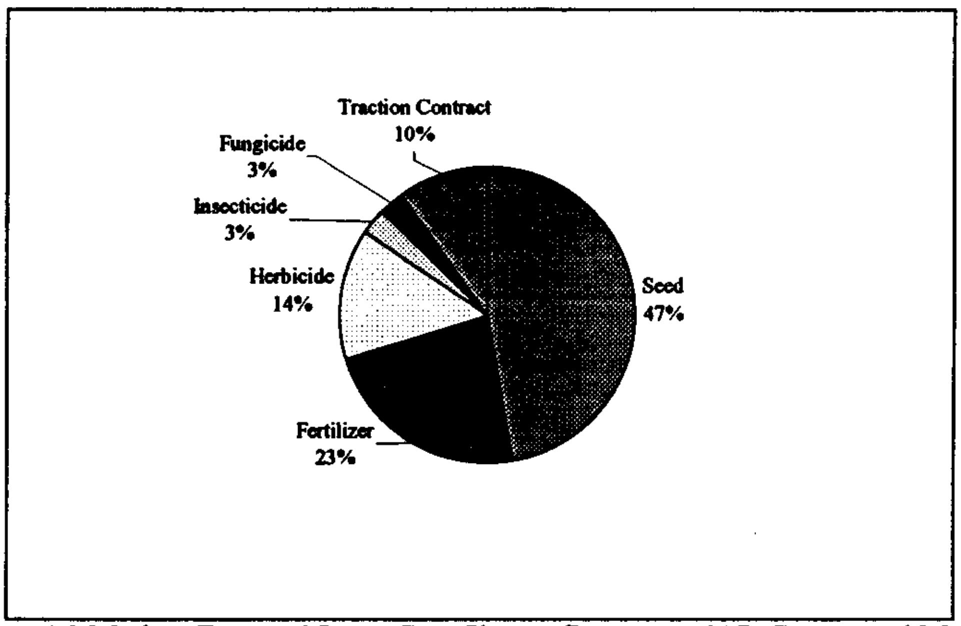

Figure 4.3 Modern Farmers' Input Cost Shares, *Postrera,* 1997, Carazo and Masaya Regions, Nicaragua

4.2.3 Patterns and Costs of Labor Use

Labor Use by Type of Operations

Table 4.3 and 4.4 shows average man-days used for each farm operation for traditional farmers and modern farmers, respectively. On average, traditional farmers used 65.6 man-days during the season, while modern farmers used 57.7 man-days per hectare.

Prior to using oxen or a tractor for primary tillage, the farmers in the sample most typically used manual labor for preliminary land preparation. While traditional farmers used 11.5 man-days per hectare, modern farmers used 9.1 man-days per hectare. As described previously, most farmers contract with neighboring farmers for land preparation services, using either oxen or a tractor. While traditional farmers used an additional 1.8 man-days for land preparation by oxen (Table 4.3), modern farmers used no additional land preparation labor (Table 4.4)[35].

Modern farmers hired twice as much labors for planting (4.0 man-days/ha), compared to traditional farmers (2.1 man-days/ha). This difference can not be rationally explained, since modern farmers used less seed than traditional farmers[36].

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[35] A traction contract typically includes oxen plus one man, who drives the oxen. Additional labor refers to labor used in addition to the operator in order to assist in land preparation by oxen or a tractor.

[36] This difference may be due to difference in perception for planting between the two types of farmers For example, modern farmers generally practice seedbed preparation before planting, while traditional farmers don't. Thus, modern farmers may have reported seedbed preparation as part of their planting activity, which may have resulted in higher labor used than for traditional farmers.

Table 4.3 Traditional Farmers' Labor Use (Man-days/ha), *Postrera*, 1997, Carazo and Masaya Regions, Nicaragua

Type of Operation	Family		Hired	Total Man-Days
	Male	Female	Male	
Land preparation[37]				
Manual	6.5	2.4	2.6	11.5
Oxen	1.2	0	0.6	1.8
Planting	1.8	0.3	0	2.1
Fertilizing	2.1	0	0	2.1
App. Insecticide	4.1	0	0	4.1
Manual weeding	14.4	4.1	2.9	21.5
Harvesting	8.8	1.5	3.2	13.5
Threshing	4.7	0.6	3.8	9.1
Total	43.5	8.8	13.2	65.6

Table 4.4 Modern Farmers' Labor Use (Man-days/ha), *Postrera*, 1997, Carazo and Masaya Regions, Nicaragua

Type of Operation	Family		Hired	Total Man-days
	Male	Female	Male	
Land preparation[37]				
Manual	5.1	0	4.0	9.1
Planting	3.7	0	0.3	4.0
Fertilizing	1.2	0	0.6	1.8
App. Herbicide	1.9	0	2.4	4.3
App. Insecticide	1.0	0	0.4	1.5
App. Fungicide	0.9	0	1.0	1.9
Manual weeding	9.7	0.2	1.6	11.5
Harvesting	6.9	0.4	5.6	12.9
Threshing	5.1	0	5.6	10.7
Total	35.6	0.6	21.5	57.7

For the application of agrochemicals (fertilizer, herbicide, insecticide, and fungicide), comparison is limited to only fertilizer and insecticide, which are applied by both traditional and modern farmers. For fertilizer application, traditional farmers used

[37] Manual land preparations (using plow by hands) are carried out prior to plowing by oxen or a tractor.

slightly more labor (2.1 man-days/ha) than modern farmers (1.8 man-days/ha), even though traditional farmers applied less fertilizer. For application of insecticide, traditional farmers used much more labor (4.1 man-days/ha) than modern farmers (1.5 man-days/ha)[38].

For harvesting and threshing, traditional farmers used slightly more labors (roughly 1 man-day/ha more) than modern farmers, although traditional farmers obtained lower yields. A possible explanation is that since modern farmers used more hired labor for harvesting and threshing, work done by hired (male) labor is more efficient than family (female) labor.

Among the two types of farmers, the greatest difference in labor use was for manual weeding. For traditional farmers, manual weeding accounted for 33 percent of total labor, compared to 20 percent for modern farmers. Total labor for weed control is assumed to be total man-days for manual weeding and application of herbicide (and possibly land preparation). For modern farmers, total labor for weed control accounted for 28 percent of total man-days of labor, which is still less than 33 percent of traditional farmers who only did manual weeding (Figure 4.4 and 4.5). However, in terms of man-days, traditional farmers used more labor for weed control (21.5 man-days), compared to modern farmers (15.8 man-days for manual weeding + application of herbicide). This suggests that traditional farmers could potentially reduce their labor use for weed control by using herbicide.

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[38] This is partly because all traditional farmers (5) used insecticide, while only six of the ten modern farmers applied insecticide. These six modern farmers used an average of three man-days/ha for insecticide application, which is still lower than traditional farmers. Therefore, it may be also due to differences in application (spray) technologies between these different systems.

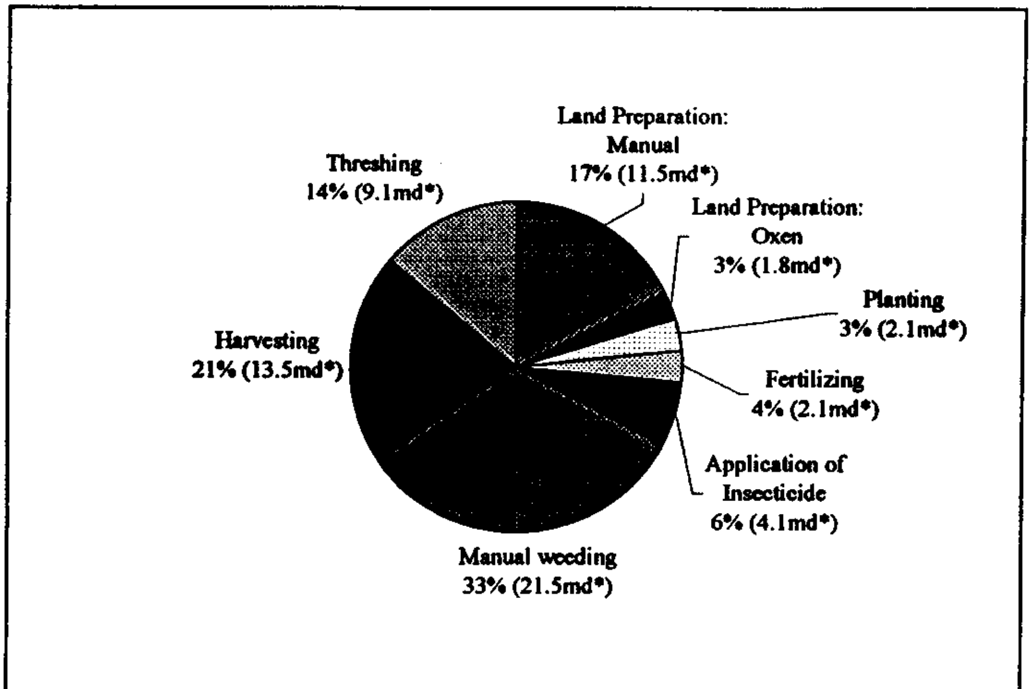


Figure 4.4 Traditional Farmers' Labor Use by Type of Operations, *Postrera*, 1997, Carazo and Masaya Regions, Nicaragua
*md represents man-days.

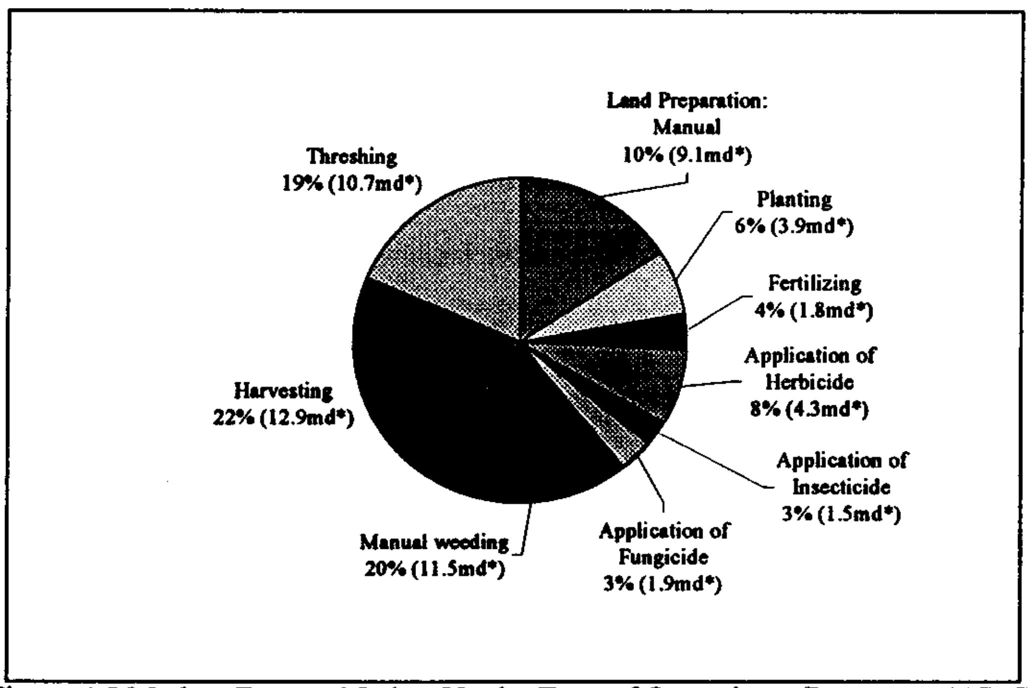


Figure 4.5 Modern Farmers' Labor Use by Type of Operations, *Postrera*, 1997, Carazo and Masaya Regions, Nicaragua
* md represents man-days.

Type of Labor

The type of labor used (male vs. female and family vs. hired) differed between traditional and modern farmers. In terms of labor use by gender, modern farmers mostly used male labor (99 percent), while male labor accounted for 87 percent for traditional farmers. For traditional farmers, female (family) labor was used mostly for manual weeding, followed by manual land preparation. In contrast, although modern farmers used a very small amount of female (family) labors (0.6 man-day/ha), female labor primarily participated in harvesting. Modern farmers employed more hired labor (37 percent), compared to traditional farmers (20 percent). While family male labor accounted for roughly the same percentage of total labor for both types of farmers, traditional farmers tended to substitute family labor (both male and female) for hired labor. In total, family labor accounted for 80 percent of total labor for traditional farmers, but only 63 percent for modern farmers (Figure 4.6 and 4.7).

Modern farmers are likely to employ hired labor, because they either have cash available and/or family members have greater access to off-farm activities, which generate more cash income (*i.e.* pay a wage rate that is higher than the cost of hiring farm labor).

In terms of total man-days per ha, traditional farmers used 52.3 man-days of family labor and 13.2 man-days of hired labor, while modern farmers used 36.2 man-days of family labor and 21.5 man-days of hired labor (Figure 4.6 and 4.7). Thus, traditional farmers used more family labor (16 man-days), but less hired labor (8 man-days) than modern farmers did. Overall, modern farmers used eight fewer man-days per hectare than traditional farmers.

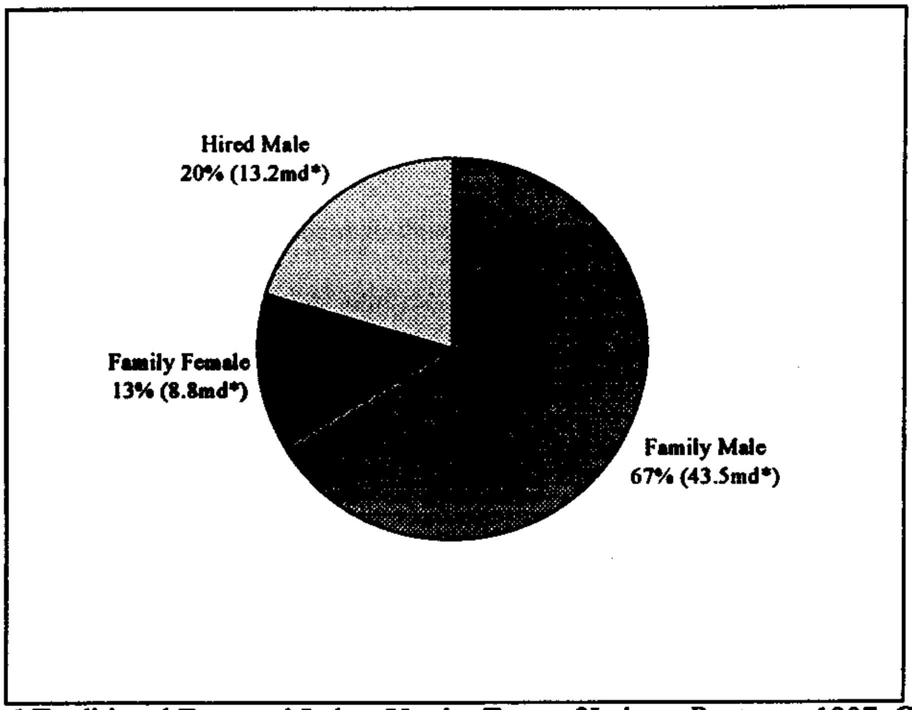


Figure 4.6 Traditional Farmers' Labor Use by Type of Labors *Postrera*, 1997, Carazo and Masaya Regions, Nicaragua *represents man-days.

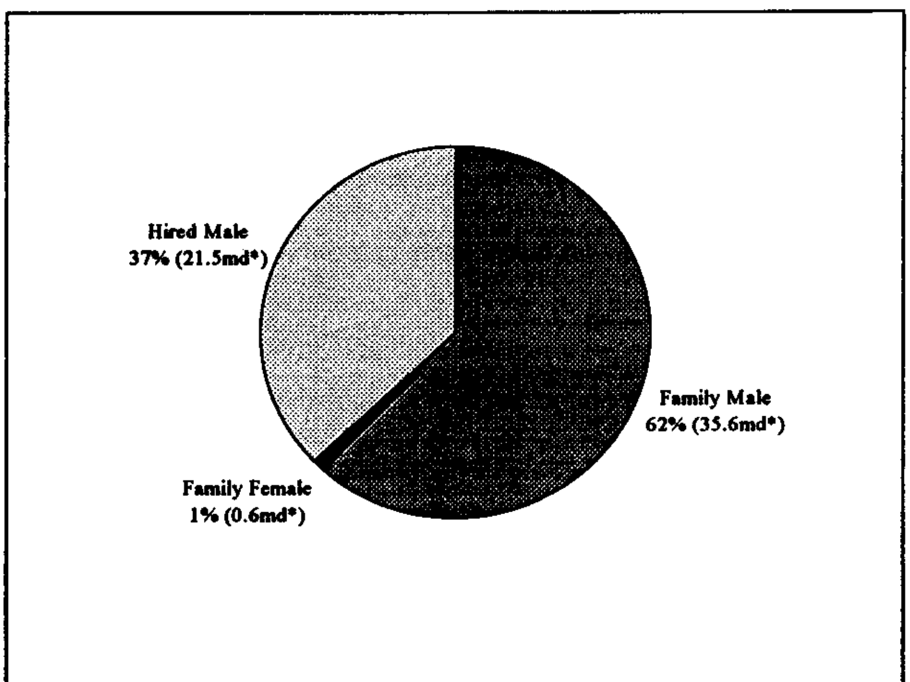


Figure 4.7 Modern Farmers' Labor Use by Type of Labors *Postrera*, 1997, Carazo and Masaya Regions, Nicaragua *represents man-days.

Labor Costs by Type of Operations

On total average, traditional farmers paid[39] US$104.01/ha for labor, which is about 20 percent higher than for modern farmers (US$86.24/ha) (Table 4.5 and 4.6).

The most costly operation was manual weeding for traditional (US$33.55/ha) while it was harvesting for modern farmers (US$19.36/ha), followed by manual weeding (US$16.28) (Table 4.5 and 4.6). For traditional farmers, the second most expensive operation was harvesting (US$21.14/ha). However, the third highest was land preparation for traditional farmers (US$20.69/ha), and threshing for modern farmers (US$15.95/ha).

Wage rate differed by type of operation and between farms. For example, on average modern farmers paid US$1.80 per man-day for hired male labor, who did manual land preparation and manual weeding. In contrast, they paid US$1.60 per man-day for hired male labor for the other operations. Generally, modern farmers paid a higher wage for an activity, which required special skills (spraying herbicide, insecticide and fungicide). In contrast, for traditional farmers, wage rates (US$1.56 per man-day) for hired labor are not significantly different between type of operations.

[39] For both traditional and modern farmers, labor costs include both the costs of hired labor and family labor. The wage rate for family labor is valued at the shadow price of family labor, which represents the opportunity cost of family labor.

Table 4.5 Traditional Farmers' Labor Costs (US$/ha) *Postrera*, 1997, Carazo and Masaya Regions, Nicaragua

Type of Operation	Family		Hired	Total Labor Costs
	Male	Female	Male	
Land preparation[40]				
Manual	10.11	3.68	4.14	17.92
Oxen	1.84	0	0.92	2.76
Planting	2.76	0.46	0	3.22
Fertilizing	3.22	0	0	3.22
App. Insecticide	6.59	0	0	6.59
Manual weeding	22.52	6.43	4.60	33.55
Harvesting	13.79	2.30	5.06	21.14
Threshing	8.73	0.92	5.97	15.63
Total	69.55	13.79	20.68	104.01

Table 4.6 Modern Farmers' Labor Costs (US$/ha) *Postrera*, 1997, Carazo and Masaya Regions, Nicaragua

Type of Operation	Family		Hired	Total Labor Costs
	Male	Female	Male	
Land preparation[40]				
Manual	7.34	0	7.17	14.54
Planting	4.95	0	0.46	5.41
Fertilizing	1.84	0	0.92	2.76
App. Herbicide	2.99	0	3.68	6.66
App. Insecticide	1.61	0	0.69	2.30
App. Fungicide	1.38	0	1.61	2.99
Manual weeding	13.45	0.23	2.60	16.28
Harvesting	9.94	0.69	8.73	19.36
Threshing	7.22	0	8.73	15.95
Total	50.74	0.92	34.59	86.24

[40]Additional costs, above the cost of the traction contract, which is presented in the section 4.2.1.

4.2.4 Profitability of Two Typical Farmers

On average, traditional farmers obtained yield of 534 kg/ha and modern farmers obtained 936 kg/ha (Table 4.7). The yield that traditional farmers obtained (534 kg/ha) is somewhat lower than the national average yield of TVs (676 kg/ha) (PROFRIJOL, 1998). In contrast, modern farmers in this study area obtained higher yield (936 kg/ha) than the national average yield (875 kg/ha) (PROFRIJOL, 1998). Interestingly, traditional farmers received a higher average price of US$0.69/kg, compared to price that modern farmers received (US$0.67/kg). This price difference may be due to consumers' preference for traditional varieties.

Table 4.7 Average Yields, Prices Received, and Gross Parcel Income by Type of Farmers, *Postrera*, 1997, Carazo and Masaya Regions, Nicaragua

	Traditional (N=5)	Modern (N=10)
Yield (kg/ha)[41]	534	936
Price (US$/kg)	0.69	0.67
Gross Parcel Income (US$/ha)	367.95	641.39

In this study, since the prices shown in Table 4.7 have been obtained by taking average value of each farmer received, gross parcel incomes (GPI) are not simply obtained by multiplying yields and prices in Table 4.7. Rather, GPI are obtained by taking average values of prices times yields for each farmer. Because this study is interested in average profits for two typical farmers, GPI obtained in Table 4.7 are considered to most reflect the average values of returns to farmers.

[41] Some of the yield difference may be due to differences in cultural and management practices used by modern and traditional farmers.

Even though traditional farmers received a slightly higher average price, traditional farmers earned a much lower GPI (US$368) than modern farmers (US$641), as shown in Table 4.7.

Among the sample, modern farmers spend more on capital inputs than traditional farmers, while traditional farmers spend more on labor than modern farmers. Thus, since modern farmers took advantage of labor saving technologies, their returns to labor are greater. In contrast, traditional farmers used more labor as a substitute for capital inputs, so their returns to capital are greater.

As shown in Table 4.8, while total parcel expenses are greater for modern farmers (US$251), compared to traditional farmers (US$232), net parcel income is US$255/ha higher for modern farmers (Table 4.8)

Table 4.8 Small Bean Farm Budgets during the *Postrera*, 1997, Carazo and Masaya Regions, Nicaragua

Item ($/ha)	Whole Sample (N=15)	Traditional (N=5)	Modern (N=10)
Gross Parcel Income*	550.25	367.95	641.39
Parcel Expenses			
Variable Input	152.38	127.90	164.62
Family Labor	62.21	83.33	51.65
Hired Labor	29.95	20.68	34.59
Labor Subtotal	92.16	104.01	86.24
Total Parcel Expenses	244.55	231.91	250.87
Net Parcel Income	305.70	136.04	390.52

* Gross Parcel Incomes are obtained by taking average values of Gross Parcel Income for each farmer

Traditional farmers earned only 35 percent of modern farmers' net parcel income. This is simply because while traditional farmers obtained only 57 percent of modern farmers' GPI, their costs averaged 92 percent of modern farmers' total farm expenses.

Accordingly, the profitability of small bean farming depends primarily on GPI, which is largely a function of farmers' yields, since prices are similar across farms.

4.3 Sensitivity Analysis

4.3.1 Introduction

In the previous section, the net parcel incomes are obtained for traditional and modern farmers. In the followings, for each type of farmers, sensitivity analysis is carried out by changing bean yields, bean prices, labor and input costs -- using the net parcel incomes as base runs -- in order to identify the variables that most affect the level of net parcel income (profit).

However, sensitivity analysis does not generally take into account the probability of any of the changes actually occurring. Also, it does not show the correlation between the variables that are changed (*i.e.* bean yield and price, input and labor prices).

4.3.2 Changes in Bean Yields and Prices

The results of sensitivity analyses are reported for traditional (Table 4.9) and modern (Table 4.10) farmers with respect to ± 50 percent changes of bean yield and ± 25 percent changes of bean price.

Table 4.9 Traditional Farmers: Sensitivity Analysis[42] with Changing Bean Yield and Price, *postrera*, 1997, Carazo and Masaya Regions, Nicaragua

		Bean Price ($/kg)										
		0.51	0.55	0.58	0.61	0.65	0.68	0.72	0.75	0.79	0.82	0.86
Bean Yield (kg/ha)	% Change	-25	-20	-15	-10	-5	±0	+5	+10	+15	+20	+25
267kg	-50	-94	-85	-76	-66	-57	-48	-39	-30	-20	-11	-2
321kg	-40	-66	-55	-44	-33	-22	-11	0	11	22	33	44
374kg	-30	-39	-26	-13	0	13	26	39	51	64	77	90
428kg	-20	-11	4	18	33	48	62	77	92	107	121	136
481kg	-10	16	33	50	66	83	99	116	132	149	165	182
534kg	±0	44	62	81	99	118	136	154	173	191	210	228
588kg	+10	72	92	112	132	153	173	193	213	234	254	274
641kg	+20	99	121	143	165	188	210	232	254	276	298	320
695kg	+30	127	151	175	199	223	246	270	294	318	342	366
748kg	+40	154	180	206	232	257	283	309	335	360	386	412
802kg	+50	182	210	237	265	292	320	348	375	403	430	458

Table 4.10 Modern Farmers: Sensitivity Analysis with Changing Bean Yield and Price, *postrera*, 1997, Carazo and Masaya Regions, Nicaragua

		Bean Price ($/kg)										
		0.51	0.54	0.58	0.61	0.65	0.68	0.71	0.75	0.78	0.80	0.85
Bean Yield (kg/ha)	% Change	-25	-20	-15	-10	-5	±0	+5	+10	+15	+20	+25
468kg	-50	-10	6	22	38	54	70	86	102	118	234	150
563kg	-40	38	57	76	95	115	134	153	172	192	211	230
655kg	-30	86	108	131	153	176	198	221	243	265	288	310
749kg	-20	134	160	185	211	237	262	288	314	339	365	391
843kg	-10	182	211	240	269	298	326	355	384	413	442	471
936kg	±0	230	262	294	326	358	391	423	455	487	519	551
1030kg	+10	278	314	349	384	419	455	490	525	560	596	632
1124kg	+20	326	365	403	442	480	519	557	596	634	673	711
1217kg	+30	374	416	458	500	541	583	625	666	708	750	791
1311kg	+40	423	467	512	557	602	647	692	737	782	827	872
1404kg	+50	471	519	567	615	663	711	759	807	856	904	953

[42] Input and labor costs (including harvesting and threshing labors) are held constant, assuming that yield changes are due to weather-related risk.

For traditional farmers, when yield decreases by 30 percent (or more) and price decreases by 10 percent (or more), NPI falls below zero. When yield declines by 40 percent (or more) and price increase by 5 percent (or more), NPI also falls below zero. Thus, for traditional farmers, NPI is likely to be more sensitive to bean yield change than bean price change, since NPI becomes negative, when the yields are reduced by 40 and 50 percent, while fixing the bean price at ± 0. In contrast, fixing bean yield at ± 0, NPI does not become negative, regardless of the change in the bean price.

For modern farmers, the only scenario that results in a negative NPI is when yield is reduced by 50 percent and price is lowered by 25 percent (Table 4.10). However, a 50 percent-lower yield is unlikely to happen, except when a natural disaster occurs. In Nicaragua, this occasionally happens due to hurricane (*i.e.* Hurricane Mitch in October 1998)[43]. Furthermore, if national yields fell by 50 percent, the resulting reduction in the bean supply would put upward pressure on bean prices. Therefore, the scenario observed in the sensitivity analysis for modern farmers are unlikely to occur. Thus, for modern farmers -- over the range of yield declines considered in this analysis -- the NPI is unlikely to ever become negative, given the changes in yields and prices assumed in this analysis.

[43] According to the recent report (USDA, Foreign Agricultural Service, Global Agriculture Information Network, *Nicaragua: Preliminary Agricultural Damage Report from Hurricane Mitch* 1998), dry bean losses are estimated 50-80 percent during the *postrera*, 1998.

4.3.3 Changes in Input and Labor Prices

The results of sensitivity analyses with respect to changes in input, labor prices showed no negative NPI for all levels of changes (reported in Appendix B). Therefore, changes in the costs of production are less correlated with bean farmers' profitability, than for changes in bean yields and prices.

As expected from Table 4.7, the breakeven points (*i.e.* point where NPI become zero) for both traditional and modern farmers are extremely high, resulting in all positive net parcel incomes[44] (Appendix B). Traditional farmers still earn US$78/ha at 25 percent-higher input and labor costs. Modern farmers earn US$328/ha at the same increases in input and labor costs. This implies that ever with a 25 percent increase in the cost of production, farmers would still earn a positive NPI.

[44] Breakeven points of labor are 553 and 231 percent increases for modern and traditional farmers, respectively. Breakeven points of input are 337 and 206 percent increases for modern and traditional farmers, respectively.

4.4 Regression Analysis

Sensitivity analysis results have shown that bean yield is a major influential factor on profitability. Since sensitivity analysis does not indicate which inputs contributed to explaining the yield differences among farmers, regression analysis is carried out in order to confirm the budget result and identify the reason for higher yields among modern farmers. The model used in this analysis is a linear function. That is, bean yield is assumed as a linear function of input and labor cost[45]. The specific model is;

$$Y_i = \beta_{1i}X_{1i} + \beta_{2i}X_{2i} + D + e_i$$

Where Y_i = Bean yield (kg/ha) for farmer i,
X_{1i} = Quantity of seed (kg/ha) for farmer i,
X_{2i} = Amount of Nitrogen[46] applied (kg/ha) for farmer i,
D = Dummy variable, coding 1 = Modern varieties, 0 = Traditional varieties,
e_i = Random error term for farmer i.

Table 4.11 Regression Result from the model (Dependent variable = Bean yield)

Variable	Coefficient	Std.Error	t-statistics
Quantity of Seed (kg/ha)	7.54	1.83	4.11*
Nitrogen (kg/ha)	4.45	7.42	0.60**
Dummy	426.91	118.31	3.61*
Adjusted-R^2 = 0.529, F = 8.89*, Durbin-Watson d = 2.18[47]			

* 5 percent, ** 20 percent levels of significance

[45] Because of high correlation between variables for input cost and labor cost, these two variables are excluded. Therefore, finally obtained model is reported above.
[46] Nitrogen and phosphate are correlated with each other, and potassium is correlated with the dummy variable. Therefore, only nitrogen is included in the model.
[47] Durbin-Watson d-statistics shows that there is no autocorrelation among the error terms.

The regression results reported in Table 4.11 show that the quantity of seed and the dummy variable are statistically significant at the 5 percent level. The Adjusted-R^2 (0.53) is relatively high for primary data, especially given the small sample size. The model estimates that if a farmer plants one kg/ha more of seed, yield would increase by 7.5 kg/ha. An additional kg of Nitrogen would contribute 4.5 kg/ha increase in yield. The model also indicates that the MVs' dummy variable accounted for a yield difference between TVs and MVs of 427 kg/ha (Table 4.11).

Thus, the regression result shows that bean yields are strongly dependent on the type of seed planted. As shown in the previous section, modern farmers have higher profitability due to higher yield. The regression result supports the evidence that modern farmers earned higher profits because they planted MVs of beans. However, since traditional and modern farmers may utilize different cultural and management practices, part of the yield differences may be due to these factors.

CHAPTER V

SUMARRY AND CONCLUSIONS

Historically, the Nicaraguan government has given priority to developing agro-export industries (sugar, cotton, and coffee), which have been dominated by the country's elites. However, in the early-1990s the Nicaraguan government began to implement policies favoring small-scale farmers, especially, farmers cropping staple food crops, such as beans and maize. While maize is the country's primary staple crop (261,000 hectares, 1997), beans are the second most important food crop (139,000 hectares).

This study analyzes record-keeping data collected from 15 small bean farmers in Carazo and Masaya regions near the Pacific Coast of Nicaragua. Five of these farmers grew traditional bean varieties and ten planted improved (modern) varieties (DOR-364 or Compañia).

Summary

Key findings of the study are:

- Per-hectare costs of production were higher for modern farmers than for traditional farmers because modern farmers applied more agrochemical inputs (fertilizer, herbicide).
- Traditional farmers tended to employ more family labor (both male and female), especially substituting manual weed control for herbicide, while modern farmers employ more hired labor.

- Modern farmers obtained higher yield (936 kg/ha), compared to traditional farmers (534 kg/ha).
- Modern farmers (US$391) obtained approximately three times higher net parcel income (NPI) than traditional farmers (US$136).
- Budget analysis showed that modern farmers earned higher profits than traditional farmers due to higher yield.
- Sensitivity analysis showed that both traditional and modern farmers still earned a positive net parcel income with 25 percent higher input and labor prices (costs).
- Regression analysis showed that the major influential factor on bean yield was the type of seed planted. However, some of the yield difference may have been due to improved cultural practices used by modern farmers.
- Regression analysis also showed that MVs has a 427 kg/ha more of yield potential, compared to TVs.

Policy Implications

These findings show that among the sample of farmers included in the study, bean production is more profitable for modern farmers (compared to traditional farmers), even though they purchased more input. Sensitivity analysis showed that modern farmers' profits are relatively insensitive to yield and price changes (compared to traditional farmers), due to their absolute advantage from higher yields. Furthermore, modern farmers utilized more of the recommended technologies (MVs and a package of agrochemical inputs). In contrast, while traditional farmers applied less fertilizer, they applied more insecticide. Thus, use of agrochemical input is dependent on the type of farmer in the sample of farms used for this analysis.

This study has also shown that bean yield is the most influential variable affecting profitability. Based on the regression results, planting an improved bean variety was associated with a yield increase of 427 kg/ha.

As presented in Chapter III, the bean area under MVs is still relatively low (28 percent). Data analyzed in this study indicate that MVs' yields are 75 percent higher than the yields of TVs and are substantially more profitable to grow. Thus, an increased effort to promote greater farmer adoption of MVs has the potential to substantially increase bean production in the study area.

However, farmers who grow modern varieties of bean generally applied agrochemical more intensively than TVs growers. Thus, farmers' success in achieving higher profit may require farmers to adopt a technology package, which includes both an improved variety and higher fertilizer rates. For farmers to adopt these technologies, they must be readily available locally. In addition, farmers may require access to credit in order to be able to afford purchasing these inputs.

Limitations

This study has five limitations as follows. First, this study does not provide insights as to why traditional farmers plant TVs, which this study showed are less profitable than MVs. Therefore, it is recommended that in association with future record-keeping studies, a short questionnaire should be administered to both traditional and modern farmers to determine key factors that influence their choice of bean varieties.

Second, cultural and management factors may also explain some of the differences in yield and profitability between traditional and modern farmers. In addition, the study did not analyze risk associated with growing MVs versus TVs.

Third, this analysis is based on a relatively small sample size – five TVs growers and ten MVs growers – and the data is for a single season. Thus, to confirm these results, there is a need to both carry out similar analysis for at least two additional seasons and increase the sample size to include at least 15 farmers growing TVs and 15 farmers growing MVs.

Fourth, as this analysis is based on only two provinces (Carazo and Masaya) in the Pacific area, the results can not be generalized to other area (*i.e.* Central and Atlantic regions). Thus, similar analysis for these regions is needed as further research.

Fifth, yields are affected by both input use and the agroclimatic environment (*e.g.* all five traditional farmers were located in the same town). Thus, future record-keeping studies should collect sufficient agroclimatic data to assess the agroclimatic similarities and differences among the traditional and modern farmers.

Appendix A

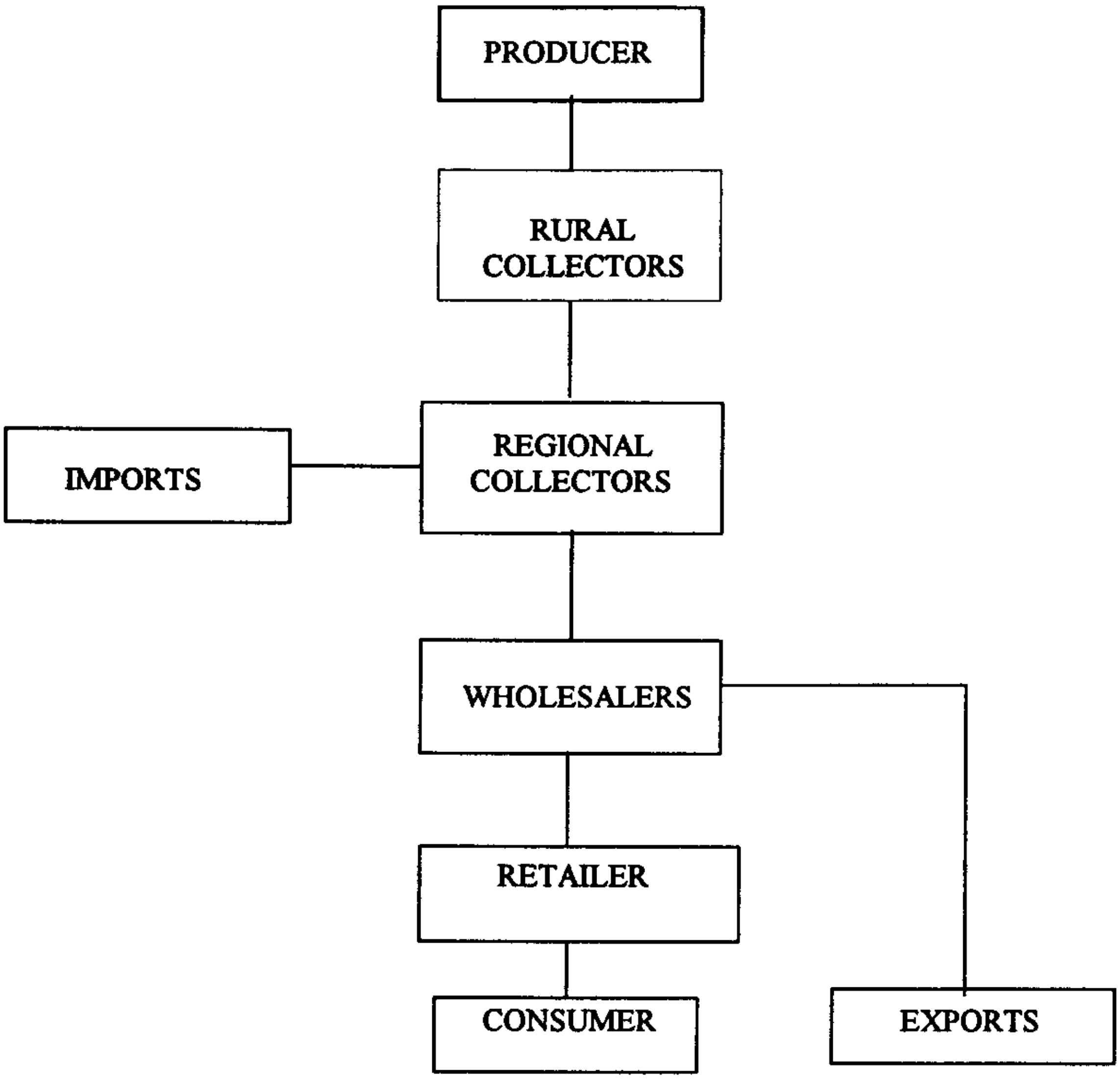
Table A-1 Monthly average bean prices to the producer, wholesaler and consumer, Nicaragua, 1995 and 1996 (US$/kg)

Month	1995			1996		
	Producer	Wholesaler	Consumer	Producer	Wholesaler	Consumer
January	0.25	0.32	0.38	0.54	0.88	0.77
February	0.26	0.35	0.42	0.53	0.60	0.75
March	0.27	0.35	0.42	0.49	0.55	0.73
April	0.27	0.35	0.42	0.62	0.71	0.84
May	0.28	0.35	0.42	0.90	0.96	1.09
June	0.28	0.35	0.43	0.90	1.05	1.24
July	0.27	0.35	0.44	1.01	1.29	1.42
August	0.30	0.43	0.50	0.82	1.02	1.34
September	0.41	0.55	0.64	1.20	1.23	1.42
October	0.54	0.71	0.82	1.53	1.55	1.71
November	0.61	0.70	0.91	1.14	1.38	1.64
December	0.55	0.61	0.79	0.94	1.11	1.44
Average	**0.36**	**0.45**	**0.55**	**0.88**	**1.03**	**1.20**

Source: INTA, 1998

Monthly average prices for 1995 are also available (prices in 1996 are reported in Chapter III). However, price fluctuations in 1995 showed a counter L-shaped (low in the beginning of year and high in the end of year), which is an unusual pattern of price fluctuation. Farmers most typically sell beans soon after harvest in order to obtain cash to meet household expenses.

Figure A-1 Bean Marketing Channels, Nicaragua.



Source: MAG-FAO, adopted from INTA, 1998

Beans are collected first by rural collectors, who are typically located in rural towns. Then, beans go to regional collectors, wholesalers, retailers, and consumers. The connections between these channels are supported by transport middlemen, who are typically truck drivers or truck owners.

Appendix B

Table B-1 Traditional Farmers' Sensitivity Analysis With Respect To Input, Labor Prices (US$/ha), *postrera*, 1997, Carazo and Masaya Regions, Nicaragua

		Input Price Changes										
		-25%	-20%	-15%	-10%	-5%	Base	+ 5%	+10%	+15%	+20%	+25%
Labor Price Changes	-25%	194	188	181	175	168	162	156	149	143	136	130
	-20%	189	182	176	170	163	157	150	144	138	131	125
	-15%	184	177	171	164	158	152	145	139	132	126	120
	-10%	178	172	166	159	153	146	140	134	127	121	114
	-5%	173	167	160	154	148	141	135	128	122	116	109
	Base	168	162	155	149	142	136	130	123	117	110	104
	+ 5%	163	156	150	144	137	131	124	118	112	105	99
	+ 10%	158	151	145	138	132	126	119	113	106	100	94
	+ 15%	152	146	140	133	127	120	114	108	101	95	88
	+ 20%	147	141	134	128	122	115	109	102	96	90	83
	+ 25%	142	136	129	123	116	110	104	97	91	84	78

Table B-2 Modern Farmers' Sensitivity Analysis With Respect To Input, Labor Prices (US$/ha), *postrera*, 1997, Carazo and Masaya Regions, Nicaragua

		Input Price Changes										
		-25%	-20%	-15%	-10%	-5%	Base	+5%	+10%	+15%	+20%	+25%
Labor Price Changes	-25%	453	445	437	429	420	412	404	396	387	379	371
	-20%	449	441	432	424	416	408	400	391	383	375	367
	-15%	445	436	428	420	412	403	395	387	379	371	362
	-10%	440	432	424	416	407	399	391	383	374	366	358
	-5%	436	428	420	411	403	395	387	378	370	362	354
	Base	432	423	415	407	399	391	382	374	366	358	349
	+ 5%	427	419	411	403	394	386	378	370	362	353	345
	+ 10%	423	415	407	398	390	382	374	365	357	349	341
	+ 15%	419	411	402	394	386	378	369	361	353	345	336
	+ 20%	414	406	398	390	382	373	365	357	349	340	332
	+ 25%	410	402	394	385	377	369	361	353	344	336	328

As discussed in the section 4.3.3, the net parcel incomes never fall below zero with regard to any changes in input and labor prices for traditional and modern farmers.

Appendix C

Table C-1 Average Yields, Prices Received, and Gross Parcel Income, *Postrera*, 1997, Carazo and Masaya Regions, Nicaragua (Cordoba/manzana)

	Traditional (N=5)	Modern (N=10)
Yield (kg/manzana)	363	637
Price (Cordoba/kg)	6.61	6.41
Gross Parcel Income (Cordoba/manzana)	2402	4187

Table C-2 Small Bean Farm Budgets, *Postrera*, 1997, Carazo and Masaya, Nicaragua (Cordoba/manzana)

Item (Cordoba/manzana)	**Whole Sample (N=15)**	**Traditional (N=5)**	**Modern (N=10)**
Gross Parcel Income*	3592.00	2402.00	4187.00
Parcel Expenses			
Variable Input	994.74	834.90	1074.66
Family Labor	406.13	544.00	337.20
Hired Labor	195.53	198.53	225.80
Labor Subtotal	601.67	742.53	563.00
Total Parcel Expenses	1596.41	1577.43	1637.66
Net Parcel Income	1995.59	824.57	2549.34

* Gross Parcel Incomes are obtained by taking average values of Gross Parcel Income for each farmer

Table C-1 and C-2 in local currency and local unit of area is corresponding to Table 4.7 and 4.8. The analysis in this study used US$1 = 9.6 Cordoba, and 1 manzana = 0.68 ha.

Table C-3 Average Quantity and Cost of Input Use Per Manzana by Type of Farmer, *Postrera*, 1997, Carazo and Masaya Regions, Nicaragua. (Cordoba/manzana)

Item	Total Sample (N=15)		Traditional (N=5)		Modern (N=10)	
	Quantity	Cost (Cordoba/mz)	Quantity	Cost (Cordoba/mz)	Quantity	Cost (Cordoba/mz)
Seed (kg/manzana)	40.4	487.17	44.9	445.50	38.1	508.00
Fertilizer (kg/manzana)	73.7	221.04	64.4	168.00	78.4	247.56
Herbicide (l/manzana)	0.6	101.00	0	0	0.9	151.50
Insecticide (l/manzana)	0.9	40.67	1.4	59.40	0.6	31.30
Fungicide (g/manzana)	128.5	18.87	0	0	192.8	28.30
Traction Contract (times/manzana)	1.0	126.00	1.4	162.00	0.9	108.00
Total Cost (Cordoba/manzana)	994.74		834.90		1074.66	

Table C-3 in local currency and local unit of area is corresponding to Table 4.1.

Table C-4 Traditional Farmers' (N=5) Labor Use by Type of Operations, *postrera*, 1997, Carazo and Masaya Regions, Nicaragua (Cordoba/manzana)

	Mandays/manzana				Mean Costs (Cordoba/manzana)					
	Family Labor		Hired Labor	Total	Family Labor		Hired Labor	Costs of	Costs of	Total
Type of Operation	Male	Female	Male	Mandays	Male	Female	Male	Family Labor	Hired Labor	Labor Costs
Land preparation										
Manual	4.4	1.6	1.8	7.8	66.00	24.00	27.00	90.00	27.00	117.00
Oxen	0.8	0.0	0.4	1.2	12.00	0.00	6.00	12.00	6.00	18.00
Planting	1.2	0.2	0.0	1.4	18.00	3.00	0.00	21.00	0.00	21.00
Fertilizer	1.4	0.0	0.0	1.4	21.00	0.00	0.00	21.00	0.00	21.00
Insecticide	2.8	0.0	0.0	2.8	43.00	0.00	0.00	43.00	0.00	43.00
Manual weeding	9.8	2.8	2.0	14.6	147.00	42.00	30.00	189.00	30.00	219.00
Harvesting	6.0	1.0	2.2	9.2	90.00	15.00	33.00	105.00	33.00	138.00
Threshing	3.2	0.4	2.6	6.2	57.00	6.00	39.00	63.00	39.00	102.00
Total	29.6	6.0	9.0	44.6	454.00	90.00	135.00	544.00	135.00	679.00

Table C-5 Modern Farmers' (N=10) Labor Use by Type of Operations, *postrera*, 1997, Carazo and Masaya Regions, Nicaragua (Cordoba/manzana)

	Mandays/manzana				Mean Costs (Cordoba/manzana)					
	Family Labor		Hired Labor	Total	Family Labor		Hired Labor	Costs of	Costs of	Total
Type of Operation	Male	Female	Male	Mandays	Male	Female	Male	Family Labor	Hired Labor	Labor Costs
Land preparation										
Manual	3.5	0.0	2.7	6.2	48.10	0.00	46.80	48.10	46.80	94.90
Oxen	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00
Tractor	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00
Planting	2.5	0.0	0.2	2.7	32.30	0.00	3.00	32.30	3.00	35.30
Fertilizer	0.8	0.0	0.4	1.2	12.00	0.00	6.00	12.00	6.00	18.00
Herbicide	1.3	0.0	1.6	2.9	19.50	0.00	24.00	19.50	24.00	43.50
Insecticide	0.7	0.0	0.3	1.0	10.50	0.00	4.50	10.50	4.50	15.00
Fungicide	0.6	0.0	0.7	1.3	9.00	0.00	10.50	9.00	10.50	19.50
Manual weeding	6.6	0.1	1.1	7.8	87.80	1.50	17.00	89.31	17.00	106.30
Harvesting	4.7	0.3	3.8	8.8	64.90	4.50	57.00	69.40	57.00	126.40
Threshing	3.5	0.0	3.8	7.3	47.10	0.00	57.00	47.10	57.00	104.10
Total	24.2	0.4	14.6	39.2	331.21	6.00	225.80	337.21	225.80	563.00

Table C-4 is corresponding with Table 4.3 and 4.5, and Table C-5 is corresponding to Table 4.4 and 4.6.

Table C-6 Traditional Farmers' Sensitivity Analysis with Changing Bean Yield and Price, *Postrera*, 1997, Carazo and Masaya regions, Nicaragua (Cordoba/manzana)

		Bean Price (Cordoba/kg)										
		4.90	5.28	5.57	5.86	6.24	6.53	6.91	7.20	7.58	7.87	8.26
Bean Yield (kg/mz)	% Change	-25	-20	-15	-10	-5	Base	+5	+10	+15	+20	+25
182	-50	-613	-553	-493	-433	-373	-313	-253	-193	-133	-73	-13
218	-40	-433	-361	-289	-217	-145	-73	-1	71	143	215	288
254	-30	-253	-169	-85	-1	83	167	252	336	420	504	588
291	-20	-73	23	119	215	312	408	504	600	696	792	888
327	-10	107	215	324	432	540	648	756	864	972	1080	1188
363	Base	288	408	528	648	768	888	1008	1128	1248	1368	1489
400	+10	468	600	732	864	996	1128	1260	1392	1525	1657	1789
436	+20	648	792	936	1080	1224	1368	1513	1657	1801	1945	2089
473	+30	828	984	1140	1296	1453	1609	1765	1921	2077	2233	2389
509	+40	1008	1176	1344	1513	1681	1849	2017	2185	2353	2521	2690
545	+50	1188	1368	1549	1729	1909	2089	2269	2449	2629	2810	2990

Table C-7 Modern Farmers' Sensitivity Analysis with Changing Bean Yield and Price, *Postrera*, 1997, Carazo and Masaya regions, Nicaragua (Cordoba/manzana)

		Bean Price (Cordoba/kg)										
		4.90	5.18	5.57	5.86	6.24	6.53	6.82	7.20	7.49	7.68	8.16
Bean Yield (kg/mz)	% Change	-25	-20	-15	-10	-5	Base	+5	+10	+15	+20	+25
318	-50	-68	37	142	246	351	456	560	665	770	1527	979
383	-40	246	372	498	623	749	874	1000	1126	1251	1377	1503
445	-30	560	707	854	1000	1147	1293	1440	1586	1733	1879	2026
509	-20	874	1042	1209	1377	1544	1712	1879	2047	2214	2382	2549
573	-10	1188	1377	1565	1754	1942	2131	2319	2507	2696	2884	3073
636	Base	1503	1712	1921	2131	2340	2549	2759	2968	3177	3387	3596
700	+10	1817	2047	2277	2507	2738	2968	3198	3429	3659	3889	4126
764	+20	2131	2382	2633	2884	3135	3387	3638	3889	4140	4392	4643
828	+30	2445	2717	2989	3261	3533	3805	4078	4350	4622	4894	5166
891	+40	2759	3052	3345	3638	3931	4224	4517	4810	5103	5396	5690
955	+50	3073	3387	3701	4015	4329	4643	4957	5271	5585	5899	6219

Table C-6 and C-7 in local currency and local unit of area is corresponding to Table 4.9 and 4.10.

Table C-8 Traditional Farmers' Sensitivity Analysis With Respect To Input, Labor Prices, *Postrera*, 1997, Carazo and Masaya regions, Nicaragua (Cordoba/manzana)

		Input Price Changes										
		-25%	-20%	-15%	-10%	-5%	Base	+5%	+10%	+15%	+20%	+25%
Labor Price Changes	-25%	1267	1225	1183	1141	1100	1058	1016	974	933	891	849
	-20%	1233	1191	1149	1107	1066	1024	982	940	899	857	815
	-15%	1199	1157	1115	1073	1032	990	948	906	865	823	781
	-10%	1165	1123	1081	1039	998	956	914	873	831	789	747
	-5%	1131	1089	1047	1006	964	922	880	839	797	755	713
	Base	1097	1055	1013	972	930	888	846	805	763	721	679
	+ 5%	1063	1021	979	938	896	854	812	771	729	687	645
	+ 10%	1029	987	945	904	862	820	778	737	695	653	611
	+ 15%	995	953	911	870	828	786	745	703	661	619	578
	+ 20%	961	919	878	836	794	752	711	669	627	585	544
	+ 25%	927	885	844	802	760	718	677	635	593	551	510

Table C-9 Modern Farmers' Sensitivity Analysis With Respect To Input, Labor Prices *Postrera*, 1997, Carazo and Masaya regions, Nicaragua (Cordoba/manzana)

		Input Price Changes										
		-25%	-20%	-15%	-10%	-5%	Base	+5%	+10%	+15%	+20%	+25%
Labor Price Changes	-25%	2959	2905	2851	2798	2744	2690	2636	2583	2529	2475	2421
	-20%	2931	2877	2823	2769	2716	2662	2608	2554	2501	2447	2393
	-15%	2902	2849	2795	2741	2688	2634	2580	2526	2473	2419	2365
	-10%	2874	2821	2767	2713	2659	2606	2552	2498	2444	2391	2337
	-5%	2846	2792	2739	2685	2631	2577	2524	2470	2416	2363	2309
	Base	2818	2764	2711	2657	2603	2549	2496	2442	2388	2334	2281
	+ 5%	2790	2736	2682	2629	2575	2521	2467	2414	2360	2306	2253
	+ 10%	2762	2708	2654	2601	2547	2493	2439	2386	2332	2278	2224
	+ 15%	2734	2680	2626	2572	2519	2465	2411	2357	2304	2250	2196
	+ 20%	2705	2652	2598	2544	2490	2437	2383	2329	2276	2222	2168
	+ 25%	2677	2624	2570	2516	2462	2409	2355	2301	2247	2194	2140

Table C-8 and C-9 in local currency and local unit of area is corresponding to Table B-1 and B-2.

Appendix D

Table D-1 Seed Quantity and Cost for Farmers in The Record-Keeping Data (US Dollar and Hectare Base)

Choice of Seed				
Modern Farmers (N=10)				
Farmer#	Type of Seed	Quantity(kg)	Costs	Unit Price
1	DOR364	67	92	1.38
2	DOR364	67	92	1.38
3	Compana	53	55	1.03
4	DOR364	53	55	1.03
10	Compana	53	55	1.03
11	DOR364	53	86	1.61
12	DOR364	53	86	1.61
13	DOR364	53	86	1.61
14	DOR364	53	86	1.61
15	DOR364	53	86	1.61
	Average Value	56.1	77.8	1.39
Traditional Farmers (N=5)				
Farmer#	Type of Seed	Quantity(kg)	Costs	Unit Price
5	Creole	63	65	1.03
6	Creole	67	69	1.03
7	Creole	67	69	1.03
8	Creole	67	69	1.03
9	Creole	67	69	1.03
	Average Value	66.1	68.2	1.03
Overall (N=	Ave.Qtty.	Ave.Costs	ve. Price	
	59.42	74.63	1.26921	

The average values obtained in Table 4.1. For each type of samples (Total sample, traditoinal farmers, and modern farmers)

Table D-2 Fertilizer Quantity and Cost for Farmers in The Record-Keeping Data (US Dollar and Hectare Base)

Fertilizer Use							
Modern Farmers (N=10)							
Farmer#	**Type**	**Quantity(kg)**	**Costs**	**Unit Price**	**Nitrogen(N)**	**Phosphate(P)**	**Potassium(K)**
1	18-46-0	135	48	0.36	24	62	0
2	18-46-0	135	48	0.36	24	62	0
3	18-46-0	66	18	0.28	12	30	0
10	18-46-0	66	18	0.28	12	30	0
11	18-46-0	135	49	0.36	24	62	0
12	18-46-0	135	49	0.36	24	62	0
13	18-46-0	135	49	0.36	24	62	0
14	18-46-0	135	49	0.36	24	62	0
15	18-46-0	135	49	0.36	24	62	0
	Total	**1079.4**	**378.1**	**3.1**	**194.3**	**496.5**	**0.0**
		Ave. Qtty.	**Ave. Costs**	**Ave. Unit Price**	**Average N**	**Average P**	**Average K**
	N=10	**107.94**	**37.81**	**0.35**	**19.43**	**49.65**	**0.00**
	N=9	**119.93**	**42.01**	**0.35**	**21.59**	**55.17**	**0.00**
15	46-0-0	2	1	0.27	1	0	0
12	46-0-0	2	1	0.30	1	0	0
	Total	**4.1**	**1.2**	**0.6**	**1.9**	**0.0**	**0.0**
		Ave. Qtty.	**Ave. Costs**	**Ave. Unit Price**	**Average N**	**Average P**	**Average K**
	N=10	**0.41**	**0.12**	**0.28**	**0.19**	**0.00**	**0.00**
	N=2	**2.06**	**0.58**	**0.28**	**0.95**	**0.00**	**0.00**
Overall including 18-46-0 & urea							
	N=10	**108.35**	**37.92**	**0.35**	**19.62**	**49.65**	**0.00**
Traditional Farmers (N=5)							
Farmer#	**Type**	**Quantity(kg)**	**Costs**	**Unit Price**	**Nitrogen(N)**	**Phosphate(P)**	**Potassium(K)**
5	12-30-10.	101	28	0.27	12	30	10
6	12-30-10.	101	28	0.27	12	30	10
7	12-30-10.	68	18	0.27	8	20	7
8	12-30-10.	68	18	0.27	8	20	7
9	12-30-10.	135	37	0.27	16	41	14
	Total	**473.5**	**128.7**	**1.4**	**56.8**	**142.1**	**47.4**
		Ave. Qtty.	**Ave. Costs**	**Ave. Unit Price**	**Average N**	**Average P**	**Average K**
	N=5	**94.71**	**25.74**	**0.27**	**11.36**	**28.41**	**9.47**
Overall (N=15)		**Ave. Qtty.**	**Ave. Costs**	**Ave. Unit Price**			
	N=15	**103.80**	**33.86**	**0.33**	**16.87**	**42.57**	**3.16**
	N=14	**111.22**	**36.28**	**0.33**	**18.07**	**45.61**	**3.38**

Average values obtained in Table 4.1 and 4.2 for fertilizer use. For each type of samples, the values in the rows of "N=10", "N=5", and "N=15" are used as average values for modern and traditional farmers, Total sample, respectively.

Table D-3 Herbicide Quantity and Cost for Farmers in The Record-Keeping Data (US Dollar and Hectare Base)

Herbicide Use (Traditional Farmers did not apply.)				
Farmer#	Type	Quantity(liter)	Costs	Unit Price
1	Fusilade	1.5	39.1	26.56
2	Roundup	1.5	13.8	9.38
11	Gramoxone	1.5	9.2	6.25
12	Flex	1.5	39.1	26.56
12	Fusilade	1.5	39.1	26.56
14	Gramoxone	1.5	9.2	6.25
15	Gramoxone	1.5	9.2	6.25
15	Flex	1.5	34.5	23.44
15	Fusilade	1.5	39.1	26.56
	Total	13.24	232.08	157.81
		Ave. Qtty.	Ave. Costs	Ave. Price
N= 15		0.88	15.47	17.53
10		1.32	23.21	17.53
6		2.21	38.68	17.53

Table D-5 Fungicide Quantity and Cost for Farmers in The Record-Keeping Data (US Dollar and Hectare Base)

Fungicide Use (Traditional Farmers did not apply.)				
Farmer#	Type	Quantity(g)	Costs	Unit Price
1	NA	167	2	0.011
2	NA	167	2	0.011
11	Benlate	250	5	0.021
11	Copper	500	6	0.012
12	Benlate	250	5	0.021
12	Copper	500	6	0.012
14	Benlate	250	5	0.021
15	Benlate	250	5	0.021
15	Copper	500	6	0.012
	Total	2834.90	43.35	0.14
		Ave. Qtty.	Ave. Costs	Ave. Price
N= 15		188.99	2.89	0.02
10		283.49	4.34	0.02
6		472.48	7.23	0.02

Table D-4 Insecticide Quantity and Cost for Farmers in The Record-Keeping Data (US Dollar and Hectare Base)

Insecticide Use				
Modern Farmers (N=10)				
Farmer#	Type	Quantity(liter)	Costs	Unit Price
1	MTD	1.5	6.7	4.6
2	MTD	1.5	6.9	4.7
4	MTD	1.5	6.7	4.6
11	Methamidophos	1.5	9.2	6.3
13	MTD	1.5	9.2	6.3
15	MTD	1.5	9.2	6.3
	Total	8.82	47.95	32.60
		Ave. Qtty.	Ave. Costs	Ave. Price
N= 10		0.88	4.79	5.43
6		1.47	7.99	5.43
Traditional Farmers (N=5)				
Farmer#	Type	Quantity(liter)	Costs	Unit Price
5	MTD	2.6	11.8	4.6
6	MTD	2.9	13.5	4.6
7	MTD	1.5	6.7	4.6
8	MTD	1.5	6.7	4.6
9	MTD	1.5	6.7	4.6
	Total	9.93	45.50	22.92
		Ave. Qtty.	Ave. Costs	Ave. Price
N= 5		1.99	9.10	4.58
Overall (N=15)		Ave. Qtty.	Ave. Costs	Ave. Price
N=15		1.25	6.23	4.98
N=11		1.70	8.49	4.98

Table D-6 Traction Contract Quantity and Cost for Farmers in The Record-Keeping Data (US Dollar and Hectare Base)

Traction Contract				
Modern Farmers (N=10)				
Farmer#	Type	Quantity	Costs	Unit Price
1	Animal	1	12.3	12.25
2	Animal	1	12.3	12.25
3	Animal	1	12.3	12.25
4	Animal	1	10.7	10.72
10	Animal	1	12.3	12.25
11	Animal	1	12.3	12.25
11	Machine	3	33.7	11.23
12	Animal	1	15.3	15.32
14	Animal	1	15.3	15.32
15	Machine	2	29.1	14.55
	Total	13.00	165.44	128.42
		Ave. Qtty.	Ave. Costs	Ave. Price
N= 10		1.30	16.54	12.73
9		1.44	18.38	12.73
Traditional Farmers (N=5)				
Farmer#	Type	Quantity	Costs	Unit Price
5	Animal	2	24.5	12.25
6	Animal	2	24.5	12.25
7	Animal	1	12.3	12.25
8	Animal	2	24.5	12.25
9	Animal	3	38.3	12.77
	Total	10.00	124.08	61.79
		Ave. Qtty.	Ave. Costs	Ave. Price
N= 5		2.00	24.82	12.41
Overall (N=15)		Ave. Qtty.	Ave. Costs	Ave. Price
N=15		1.53	19.30	12.59
N=14		1.64	20.68	12.59

Average values obtained in Table 4.1 for other input use. For each type of samples, the values in the rows of "N=10", "N=5", and "N=15" are used as average values for modern and traditional farmers, Total sample, respectively.
Other "N"s (N=6, N=9, N=11, and N=14) represent number of farmers who actually used these particular inputs.

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