TRADITIONAL AND COMMERCIAL FARM SUPPLY RESPONSE IN AGRICULTURAL DEVELOPMENT: THE CASE FOR BASIC GRAINS IN GUATEMALA

By

Jose Alvarez

A DISSERTATION PRESENTED TO THE GRADUATE COUNCIL OF
THE UNIVERSITY OF FLORIDA
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1977

A los pequeños agricultores del Altiplano Central que conocí durante mi breve estadía en Guatemala:

- A los que perecieron a consecuencia del terremoto del 4 de Febrero de 1976, como sencillo tributo a su laboriosidad y hospitalidad;
- A los sobrevivientes de la catástrofe, con la esperanza de que el futuro les depare la prosperidad que nunca han tenido y que tanto merecen.

A la nostalgia que produce la imposibilidad de hacer esta investigación sobre los guajiros de mi Cuba, pero compensado por haberla hecho por los de ese pedazo de América por el que José Martí sintió especial devoción.

To the small farmers of the Central Highlands I met during my short stay in Guatemala:

-To those who died because of the earthquake on February 4th, 1976, as a humble tribute to their diligence and hospitality;

-To the survivors of that catastrophe, hoping that the future will bring them the prosperity they have never had and so much deserve.

To the nostalgic feeling produced by the impossibility of conducting this research on the <u>guajiros</u> of my Cuba, but compensated for having done it on those from that part of Latin America for which José Martí felt special devotion.

ACKNOWLEDGMENTS

In most cases, every research product is the result of multiple endeavors. This one is no exception. Since its very beginning, many persons and institutions have provided enormous contributions. Without them this dissertation would never have been possible. The list is long as deep is my indebtedness.

Special thanks go to every member of my Supervisory Committee: To Chris O. Andrew, my chairman, for his help, patience, and encouragement not only during every phase of this research but throughout all these years of graduate work; to Ronald W. Ward for always being available to share his knowledge of Econometrics and for his valuable comments; to W.W. McPherson, who taught me the theoretical background of Economic Development, for providing his experience in the area through sound remarks; to Manuel J. Carvajal for his help in this dissertation and his availability during all these years; to Leo Polopolus, Department Chairman, for his support, his comments and the financial assistance of the Department.

My appreciation to the Institute of Agricultural Science and Technology (ICTA) of Guatemala, particularly to Mario Martínez and Astolfo Fumagalli, for the enthusiasm shown in approving the research topic. Special thanks to my friends in Socioeconomía-ICTA, starting with the Coordinator, Peter E. Hildebrand. His vast experience with the Guatemalan situation materialized in helpful comments and ideas during several reviews of the manuscript. To Pete and Joyce, his wife, thanks also for their hospitality and understanding.

I am grateful to the Rockefeller Foundation, especially to Joe D. Black, for willingness to finance the original project. And to International Programs-IFAS, University of Florida, for making some funds available at an early stage of the research.

The Consejo Nacional de Planificación Económica de Guatemala deserves credit for authorizing use of the Farm Policy Analysis data utilized in this study. Russell Misheloff, Daniel A. Chaij, Robert Bartram, and James Riordan, USAID-Washington, facilitated release of the tapes and Carl D. Koone, USAID-Guatemala, was a most valuable intermediary.

My appreciation to Sheriar Irani and Mario Ariet for writing and debugging so many computer programs. The facilities of the Northeast Regional Data Center of the State University System of Florida were used for making all computations.

Special thanks to Beth Davis and Ann Ritch for valuable assistance in typing so many drafts and to Beth Davis again for typing the final copy.

Finally, and above all, I want to thank my wife, Mercy, for her love and encouragement in both good and difficult times. She and I owe too much to Mario and Nini Ariet and want to thank them for being always there.

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Jose Alvarez

June, 1977

Chairman: Chris O. Andrew
Major Department: Food and Resource Economics

A growing population with about two-thirds employed in agriculture, a limited arable land base, and poverty stricken farmers experiencing unemployment and low levels of food production are characteristics that portray Guatemala as a developing country. The nation's development efforts focus on the implementation of programs designed to alleviate those detrimental characteristics.

Program objectives at the Institute of Agricultural Science and Technology (ICTA) of Guatemala intend to develop new technologies designed to generate productivity increases especially for basic grains in the traditional farm sector. These programs will enable the country to augment supply without expanding the area committed to production.

Two types of problems, however, may result from productivity advances. Small farmers could use the new technology to produce the

same or even a reduced quantity of grains on less land. Or, if land is fully utilized, "second generation" marketing problems are likely to appear.

To avoid either type of problem, the investigation of traditional and commercial supply response becomes of utmost importance. Accordingly, the objectives of this study were to estimate market supply functions for each basic grain or association (combined crops such as beans-corn) in the different regions of the country; to compute income, farm size, and price elasticities of market supply; and to delineate and quantify the corresponding production and distribution activities. A model conceptualizing the small farmer's basic economic system was developed. The surplus-output ratio was estimated as a function of the product's farmgate price , education of household head, total farm size, distance to the nearest market, quantity of the product demanded on the farm, a relative profitability ratio, and total family income. Data used came from a 1974 Small Farmer Credit Survey conducted by the Guatemalan government and the U.S. Agency for International Development.

Research results, from the input standpoint, show that basic grain production is most influenced by seed and fertilizer costs. While fertilizer use tends to be a generalized practice, with the level of application depending upon crops and regions, pesticides and soil additives are not commonly utilized. All enterprises present different levels of employment by region except for the associations where labor use per hectare is very similar.

Total production differs among enterprises with respect to yields and product distribution. Variations in cash sales are the result of differences in farm demand for production and consumption purposes; the more traditional the crop, the lower will be sales.

The results of the regression equations support the conceptual model; in general, the estimated coefficients behave as hypothesized. Traditional crops generally appear at near zero income and farm size levels while commercial crops are cultivated when higher levels of income and farm size have been attained. Elasticities of market supply for traditional and commercial crops are high at low levels of income and farm size. However, while commercial crops still show some responsiveness at higher income and farm size levels, the traditional crop response becomes almost perfectly inelastic. This behavior is the result of farmers becoming involved in the activities of the market economy once self-sufficiency has been secured, and shifting into commercial crop production at higher levels of income and farm size.

Thus, since traditional crops pervade the basic grains production system in Guatemalan agriculture, little hope prevails for the attainment of massive increases in supply of basic grains. Although corn in regions three and four and rice in regions four and five seem to have a slight potential for increased production, the resulting increases would fall far behind the goal of the Guatemalan government.

CHAPTER I

INTRODUCTION

This chapter presents the problematic situation and the environment within which this research project evolved. Some of the most important agricultural and development related characteristics of Guatemala are described, followed by the problem setting and the objectives of the study. The importance of the project is discussed briefly. The data source is explained, as are the important considerations concerning use of the data in the present study.

Setting of the Study[1]

Although a developing nation sharing certain characteristics with other Third World countries, Guatemala possesses unique characteristics to differentiate the country from other nations. To better understand the present study, some of Guatemala's most important physical, demographic, economic, and social characteristics are described in this section.

Physical Environment

Guatemala, with an area of approximately 42,000 square miles (excluding British Honduras or Belize, which Guatemala claims as its

[1]This section is based on [24].

territory), lies entirely within the tropics. It is bordered on the north and west by Mexico, by the Pacific Ocean on the south, by El Salvador on the southeast, on the east by Honduras and the Gulf of Honduras, and on the northeast by British Honduras.

The climate ranges from hot and humid in parts of the lowlands to very cold in the highlands. This wide range in climatic variation permits the cultivation of any crop grown in the Western Hemisphere. Landforms are also in great variety. The altitude varies from sea level to over 13,000 feet in the volcanic highlands.

Rainfall occurs mostly from May to November and varies geographically. The Caribbean coastal plain and adjacent areas receive the heaviest annual rainfall, which may reach 200 inches. On the Pacific side annual rainfall is less and diminishes toward the coast. Guatemala City, in the highlands, averages about 45 inches of rain per year.

Population

Guatemala is the most populous country in Central America--4.3 million inhabitants according to the 1964 Census. The Guatemalan population growth rate, one of the highest in the world, was approximately 3.1 percent per annum at the time of the 1964 Census. It is expected that by 1980 the population of Guatemala will reach 7 million people. Extremely high birth and death rates produce the consequent problems of a young population with over half under 18 years of age.

The population is predominantly rural (66 percent of the population according to the 1964 Census) and is concentrated in the highlands, where the population density has greatly reduced the available land. In 1964, the population density of the country, considered among the highest in the Western Hemisphere, was 102 inhabitants per square mile.

In the 1950 and 1964 censuses the population was divided into two groups: Indian and non-Indian or ladino. The first group encompasses those of pure Maya Indian descent who continue to live much as their ancestors lived several hundred years ago. The second group, in its broadest context, comprises those neither belonging to an Indian community nor wearing the traditional Indian dress and following Indian customs. Since ladino is a cultural term, it may be possible for someone who is accepted as a ladino in a rural environment to be classified as an Indian in the urban milieu.

According to the 1950 Census nearly 72 percent of the population over seven years of age was recorded as illiterate. This figure declined to 63 percent in the 1964 Census, with almost 79 percent of the rural and over 36 percent of the urban populations still illiterate.

Although Spanish is the official language and is spoken by a majority of the population, over 40 percent of the population speaks a native lanugage, with each township having its own dialect. Over 17 different Indian languages and hundreds of township dialects create special problems for the total integration of the population within the mainstream of national life.

Government and Political Subdivisions

Guatemala is a Republic with three branches of government: executive, legislative, and judicial. The Republic is comprised of 22 major political subdivisions (similar to states) called Departamentos (Figure 1), each Departamento being divided into a number of municipios (similar to

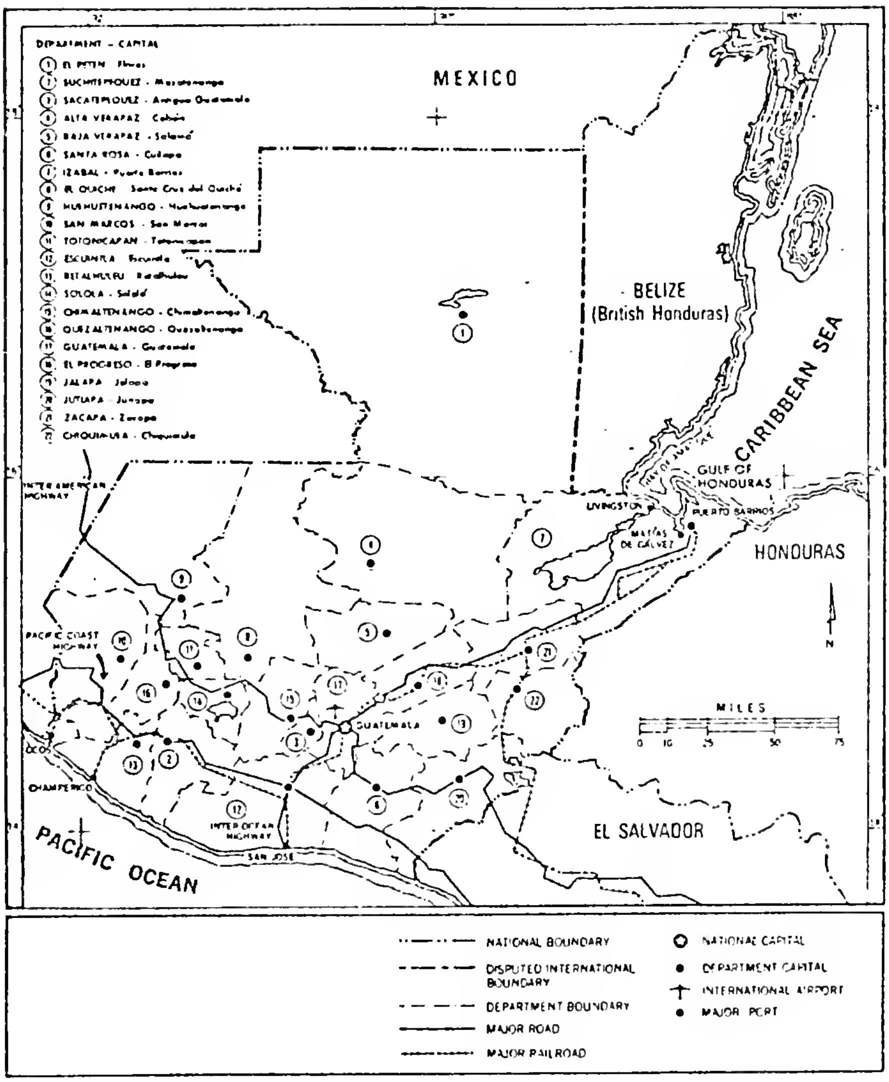

Figure 1.--Political divisions and transportation routes of Guatemala

Source: [24, p. xiv].

counties) of which there were 325 in 1964. The cabecera (capital of a municipio is called either a pueblo (village), or a villa (large village), or a ciudad (city) if it is also a Department capital. The municipio is made up of a number of aldeas (hamlets) and caseríos (small rural communities) and the cabecera of the municipio is divided into cantones (wards).

The Economy

Guatemala's Gross National Product (GNP) is the largest of the Central American countries, reaching 1.5 billion quetzales in 1967 (one dollar is equal to one quetzal). Although growing at an average rate of 5 percent annually since 1950, the economy's growth has been erratic with substantial fluctuations in the annual growth rate of Gross National Product. Per capita income has been growing at a rate of about 2.5 percent since 1957; it changed from less than Q170 in 1955 to Q314 in 1966. Traditional farmers' annual income is estimated at about Q85.

Guatemala's economy encompasses three major sectors: domestic food production, export crops, and industry. Construction and miscellaneous services supplement the three main sectors. The Indian economy, predominantly subsistence agriculture, is largely self-supporting and regional. The Indians are not completely integrated into the money economy and surplus production, when present, is usually bartered or sold in local markets. Items for which the Indians can not barter are purchased with money earned during the harvest season by working for wages on plantations. Domestic crop production is characterized by its low level of productivity as the result of primitive agricultural techniques and a rigid land tenure system all of which sometimes require the importation of food.

Much of commercial agriculture is managed by foreign firms, such as fruit companies, the ladino aristocracy, and also by the Government. The rapid development of export products such as coffee, cotton, sugar, and beef contrasts with the stagnant characteristics of the domestic food production sector, which has been unable to develop.

The industrial sector, although mainly concentrated in food processing, is rapidly expanding, having grown at an average annual rate of 10 percent between 1961 and 1967. This growth rate was stimulated by laws designed to grant tax benefits and by participation in the Central American Common Market.

Agriculture

Agriculture is the dominant sector of Guatemala's economy. The agricultural sector has accounted for more than 80 percent of all exports since 1953; it provides about 30 percent of all raw materials used by domestic industries; and the sector employs about two-thirds of the population. Agriculture also accounts for about one-third of GNP.

Major crops are corn, rice, wheat and beans and three major export crops--coffee, cotton, and bananas. Minor export crops include essential oils, tobacco, and honey. Crops primarily for domestic use include rubber, cacao, fruits and vegetables, sorghum, millet, sesame, potatoes, cassava, and hard fibers. Livestock and poultry are also important and have grown rapidly in the last decade.

Agricultural activities take place within a very rigid system of land tenure. Over 98 percent of the farms have an area under 100 acres and occupy 28 percent of the land being farmed. On the other hand, only 0.1 percent of the total number of farms are larger than 5,000 acres, but they occupy 41 percent of the farm land. In the 1950 Census, 1.3 million people lived on landholdings averaging 3.5 acres, the minimum amount considered sufficient to satisfy the basic needs of one family. In 1965, the situation was even worse; the Guatemalan National Planning Council estimated that the number of landless families had increased by 140,000 and that over 90 percent of all rural families were either landless or possessed insufficient land for subsistence.

Markets and Marketing

Markets and fairs occupy a very important place in the life of rural Guatemala. Each community holds at least one special market day per week, which is a socio-economic institution. Although these markets are the traditional response to the economic conditions of Indian life, pricing is determined not by customs but by supply and demand conditions. Sellers are mainly Indian women; buyers are both Indians and *ladinos*. Products, ranging from food to handicrafts and clothing, are displayed by type and origin. Each township is known for a particular commodity being less expensive than in other markets. They may continue for several days and attract people from all over the country.

Besides markets and fairs, marketing activities in the countryside take place in small general or neighborhood stores. These stores are often located in the onwer's home. In larger towns, stores are of a permanent structure and owners are professional merchants.

Guatemala City, the capital, possesses a large number of retail stores, one large plaza market for each of 15 zones, a central market, and a number of well-stocked supermarkets. The capital is also the principal marketing and distribution center for all imports.

Marketing activities are severely handicapped by the bad quality or lack of communication. Certain regions of the country still remain relatively isolated (Figure 1). Much of the produce for domestic trade is carried to the local market on the backs of men and mules over dirt trails and footpaths.

Foreign Trade

Guatemala's foreign trade is characterized by a large number of trading partners, a short list of commodities traded and for most years an unfavorable balance of trade. Guatemala maintains commercial relations with about 76 countries and is signatory to several international agreements. The United States is Guatemala's primary trading partner, although this share has been slowly decreasing. Coffee, cotton, sugar, beef, and bananas are the main exports. Nickel and flowers are new promising export products. Consumption goods are the primary imports. In each year between 1957 and 1969, with the exception of 1966, Guatemala experienced unfavorable trade balances which had to be financed by credits and loans.

Agricultural products are the most important items of foreign trade. Very low levels of grain production in Guatemala have forced the importation of cereals and the consequent annual deficit in cereal trade (Table 1). From 1963 to 1972, agricultural imports represented 13.4 to

Table 1.--Guatemala's imports and exports of cereals, 1963-72

	Year									
	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
	Millions of U.S. Dollars									
Imports	7.6	8.0	7.8	7.0	8.6	8.7	7.0	10.2	9.9	10.8
Exports	0.1	0.2	0.6	0.8	1.0	1.1	1.2	1.8	1.3	2.5
Deficit	7.5	7.8	7.2	6.2	7.6	7.6	5.8	8.4	8.6	8.3

Source: [117, p. 84].

9.2 percent of total imports. Agricultural exports, on the other hand, have represented between 69 and 88 percent of total exports during the same time period (Table 2). For both imports and exports, agriculture's share of trade had declined. Yet it is important to note the extremely important role played by the agricultural sector's export surplus in the overall trade balance situation for Guatemala. Over the 1963-72 period this role increased as the share of agricultural imports of total agricultural trade declined from about 14 percent to 11 percent.

Setting of the Problem

Introduction

The above description portrays Guatemala as a developing country. Most of the characteristics described are common in other Third World countries. First, the country's population, especially the rural population, is growing rapidly. The Guatemalan population growth rate at approximately 3.1 percent *per annum* is high. When the population of Guatemala reaches a projected seven million people in 1980, 63 percent of the economically active population will be employed in the agricultural sector. Compared with 65 percent in 1964, this represents an insignificant decrease. Although employing 65 percent of the labor force, agriculture only contributes about 30 percent to the Gross National Product [35].

Another characteristic common to Third World countries is that Guatemala has a limited arable land base. Yet a large percentage of privately owned land is idle as a result of the prevailing land tenure

Table 2.--Guatemala's agricultural imports and exports, total imports and exports, and agricultural percentage of total, 1963-72

Year	IMPORTS			EXPORTS		
	Agriculture	Total	Agricultural percent of total	Agriculture	Total	Agricultural percent of total
	---Millions of U.S. Dollars---					
1963	22.9	171.1	13.4	135.2	154.0	87.8
1964	24.0	202.1	11.9	140.1	166.8	84.0
1965	25.2	229.0	11.0	156.6	185.8	84.3
1966	24.4	206.9	11.8	185.4	226.1	82.0
1967	30.1	247.3	12.2	140.6	203.9	69.0
1968	29.1	249.4	11.7	164.4	222.2	74.0
1969	24.3	250.2	9.7	186.3	255.4	72.9
1970	31.5	284.3	11.1	200.9	290.2	69.2
1971	31.3	303.3	10.3	198.5	283.1	70.1
1972	30.0	327.7	9.2	234.8	328.1	71.6

Source: [117, pp. 52-9].

system [24, p. 260]. Nearly all arable land in the highlands is presently under production. Government policies prohibiting tree removal to bring new land into production in regions such as El Peten contribute to a land scarcity condition that is further aggravated by the population situation.

A third characteristic, common to other Third World countries, is that many Guatemalan farmers live in poverty conditions, are often unemployed and unemployable, and have very low levels of food production. For example, net income per capita in the central highland region has been estimated recently to be Q117 per annum [26, p. 43]. In the same area, real product per capita went from Q77 in 1951 to Q51 in 1966 [35, p. 23]. A recent study conducted by the Institute of Agricultural Science and Technology (ICTA) in the community of Santo Domingo Xenacoj supports these figures [17]. The community, where family income averages from Q90 to Q200 per year, is plagued by such a high unemployment rate that part of its population is forced to migrate to cities and the coast in search of new employment opportunities.

Successful efforts directed to solving population, employment, land use, and income problems will benefit Guatemalan development. The implementation of programs leading to more intensive land use, the reduction of unemployment, and the increase in production and productivity in rural areas ought to receive top priority among the country's development efforts.

Agriculture, especially small farm agriculture, can play an important role in Guatemala's march towards economic and social development. In 1951 a mission sponsored by the International Bank for Reconstruction and

Development reported that "it is clear that any appreciable rise in Guatemala's standard of living can come only through improvements in agriculture" [51, p. 27]. Several researchers have suggested that programs to improve agriculture should be oriented toward small rather than large farmers because small farmers utilize scarce resources more efficiently in food production [19, 35, 47]. Furthermore, the contribution of the traditional small farmer to overall production, especially basic grains production, is relatively large. Fifty-five percent of total basic grains production in the country comes from farms under seven hectares. Waugh states that it is evident that the small farmer's production is of first order of importance to the country. He goes on to say that this production results from a very limited percentage of the land in farms and that 67 percent of the total number of farms in the size group 1.7 to 7 hectares have only 18 percent of the total land in farms [118, p. 2]. Furthermore, it is in the small farm sector where economic and social development are most needed.

Certain characteristics of Guatemalan agriculture necessitate program formulation at the subsector level. Fletcher _et al_, [35, pp. 51, 53] identified three subsectors in Guatemalan agriculture: the traditional agriculture of the highlands (corn, beans, wheat) and other parts of the country; export crops (coffee, cotton, and bananas); and commercial agriculture mainly for domestic consumption (the majority of the remaining crops). Since these subsectors face different produce demand schedules and marketing problems, agricultural development programs will be most successful when formulated at the subsectoral level. Accurate problem identification leading to specific solutions for each subsector would then be easier. This study is mainly concerned with the traditional (subsistence) and commercial subsectors of Guatemalan agriculture. A distinction ought to be made between traditional and commercial farmers, and between traditional and commercial crops.[2] The term traditional farmer does not necessarily include only Indian pre-Colombian types of agriculture; it is also used to signal farmers who historically ignore market stimuli and are not prepared to shift from one crop to another; they can not respond easily (neither economically, culturally, nor technologically) to stimuli. In general, the term traditional means any system which has been used for "a long time" and has not been "modernized" particularly in the use of petroleum based products. Although these farmers may use some fertilizer in some regions (where water is available), they apply almost no insecticides (ownership of a sprayer means an additional investment). The commercial farmer is price responsive and has the means to shift between crops; his farming is a business and he responds to market stimuli.

The difference between traditional and commercial crops is based on the destination of the product and the utilization of labor in its production. In traditional crops, farmers tend to use about 80 percent family labor and 20 percent contract or hired labor, and, although some output may be sold when a surplus occurs, production is mainly devoted to family consumption. In commercial crops the characteristics are

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[2]The discussion is based on personal communication with Peter E. Hildebrand, Coordinator, Socioeconomics Program, ICTA-Guatemala.

almost exactly the reverse. These sharp distinctions among subsectors validate the assertion concerning the necessity of formulating programs at the subsectoral level.

Work at the Institute of Agricultural Science and Technology (ICTA) of Guatemala is focused on subsectoral problems. On January 20, 1976, the Minister of Agriculture of Guatemala announced that the government was launching a program to increase agricultural production with special emphasis on basic grains [22, p. 1]. Accordingly, ICTA's 1976 plan comprises production programs for different agricultural products (corn, beans, rice, wheat, sorghum, vegetables, and hogs) with the support of disciplines such as Soil Management and Rural Socioeconomics. The creation of the Program of Rural Socioeconomics is the result of ICTA's policy based

> ... in the belief that an appropriate technology can only be developed through the study of the causes conditioning the application of new technologies and this is achieved by means of agro-socioeconomic studies at the farm level in continuous contact with the farmer who will be its principal usufructuary. Therefore, the contribution of the social sciences (Economics, Sociology, Anthropology), is the key which will enable us to know these causes and will permit the recommendations to be based on the agronomic research and correspond to the requirements of the environment to which they are intended...[53, p. 217].

Problem Statement

ICTA's subsectoral programs are intended to develop a new technology based on the environment in which farmers live, to generate productivity increase that make it possible for Guatemala to supply its growing population with more agricultural products per capita without an increase in the area used in production. For example, several diseases and weeds affecting corn have been controlled and, by utilizing a new seed variety, yield per acre in La Máquina, located in the Suchitepéquez Department, can be doubled and even trebled. Another example pertains to research on interplanting beans with corn and on insecticides and new seed varieties that will eventually lead to larger bean yields. Research on wheat is seeking new seed varieties with high productivity and resistance to primary diseases and adapted to different regions of the country and small farmer use. The new wheat variety, "Gloria", introduced in the Cooperative Santa Lucía, R.L., has doubled wheat production and has been accepted by the farmers of the area [52]. Since the new technology is being developed considering the conditions and limitations that farmers face, farmers are making full and best use of the technology.

The adoption of the new technology, it is hoped, will foment increases in production and productivity. In Guatemala, as in most developing countries, a large portion of agricultural production is consumed on the farm. Thus, the adoption of new production techniques may arise from the desire to sell the extra production for cash. Very little is known, however, about the intensity of marketing and consumption problems that must be faced if farmers market most of the increase in output.

An increase in marketed output may intensify the strong tendency towards price instability inherent in the marketing of agricultural products. Abbott attributes instability to the seasonal concentration of output, great difficulties in adjusting production closely to demand in view of the uncertainties of weather and yields, and to the relatively low price elasticities of demand for the basic food products [2, p. 6].

Productivity advances can also show how rapidly the so called "second generation marketing problems" can arise. Falcon, when writing about the Green Revolution, expressed his hope that decision makers in the future will heed the warnings earlier of marketing specialists and will react before critical product distribution situations develop [32]. Such problems range from the early identifiable problems related to drying, storing, transportation, etc., to the less identifiable, but not less important, problems of pricing and markets. It is extremely important to face these problems on a timely basis, avoiding the erroneous belief that marketing is an accomodating, spontaneously generated activity that can be somehow performed once production has been increased. The following research is addressed to more fully understanding the differences in supply response in the traditional and commercial subsectors due to changes in agricultural technology.

Market problems in the future will combine with those at present such as unstable agricultural prices, the absence of adequate marketing channels for both inputs and outputs, and the lack of knowledge concerning demand and supply relationships. The vast importance of corn to the national economy and, in particular, to small farmers in the highlands has been documented [98], yet it is surprising how little information related to corn marketing is available. For example, there are no complete and reliable data for corn moving through the different marketing channels. The lack of drying and storing facilities causes concern to government officials, wholesalers, and farmers. Surveys conducted by the Agricultural Marketing Board reveal substantial differences in losses during marketing among the different zones of production due to differences in storage, transportation and processing. Fletcher, et al. say that the majority of the important problems prevailing in corn marketing are related to the lack of adequate facilities for drying and storing [35, p. 43], which causes substantial losses and produces considerable variation in the price of corn (Figure 2 and Table 3 to Table 5). The variability in the price of corn may benefit those who can store large amounts of corn for three to six months, but neither helps the small farmer who needs cash at the time of harvest nor the consumer who buys this product in small quantities. The same phenomenon prevails in bean marketing (Figure 3 and Table 3 to Table 5). Price stabilization for corn and beans, therefore, is an important objective of the Guatemalan government.

The need for conducting supply and demand studies in the rural areas is evident. An important aspect on the demand side is the quantity of basic grains that small farmers demand. Since much of their production is consumed on the farm, knowledge of their demand is needed to estimate the future amounts of basic grains they will send to the market as a result of increased production. Since the nature of the available data does not permit the identification of demand functions, this research will be focused mainly on supply.

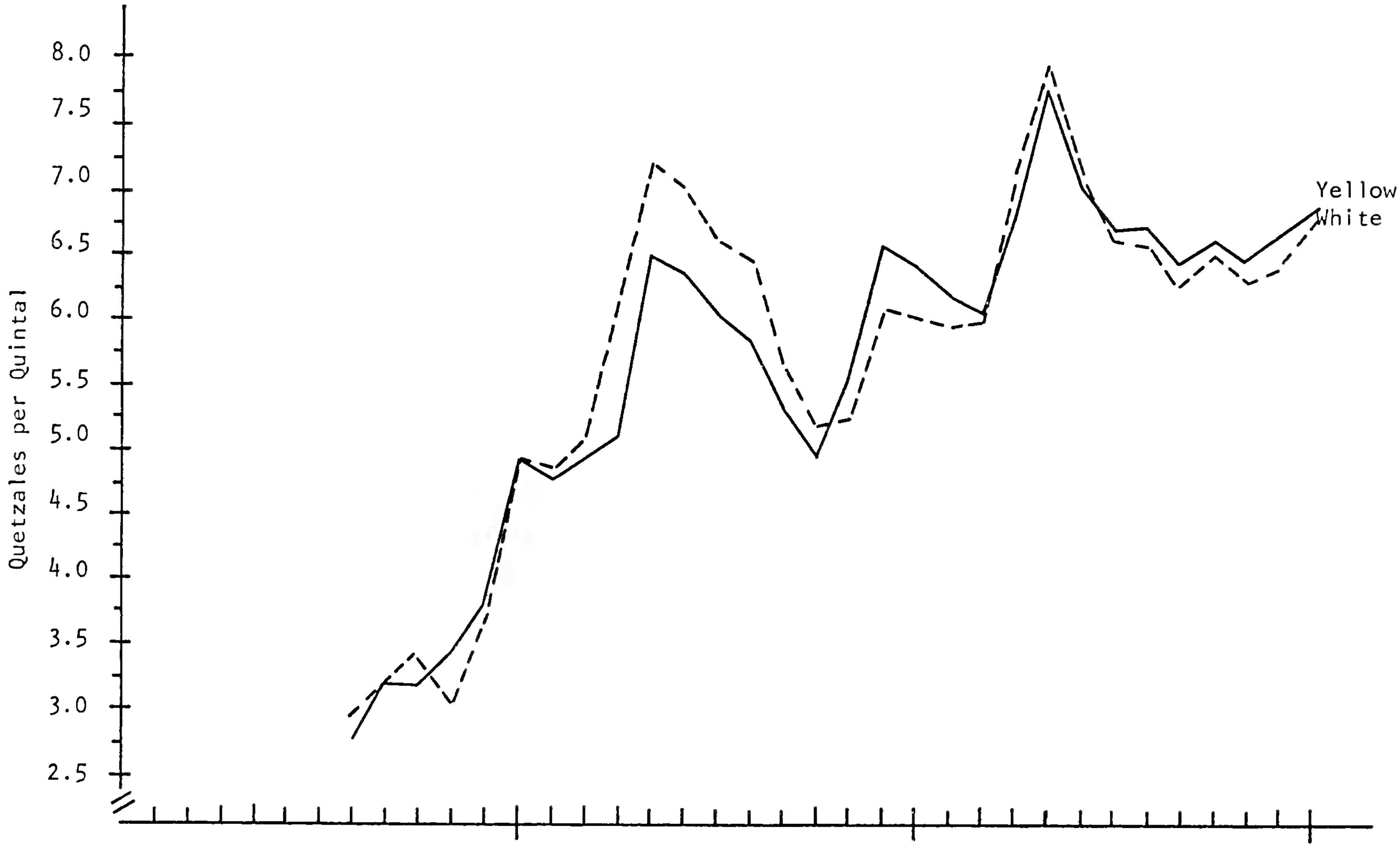

Figure 2.--Average wholesale prices for yellow and white corn in Guatemala City,1972-74

Source: [55, 56].

Table 3.--Average wholesale prices for beans and corn, in Guatemala City, 1972

Month	Black Bean	White Bean	Red Bean	Yellow Corn	White Corn
	----------------Quetzales per Quintal----------------				
January	7.77	10.08	7.47	2.90	2.73
February	----	----	----	----	----
March	7.85	10.14	7.65	2.82	2.64
April	7.50	9.96	7.58	2.74	2.89
May	----	----	----	----	----
June	----	----	----	----	----
July	7.18	11.00	7.58	2.80	2.90
August	9.12	12.01	9.06	3.22	3.22
September	9.10	12.44	9.92	3.22	3.33
October	9.16	12.14	10.30	3.42	3.07
November	10.75	12.69	11.31	3.83	3.77
December	13.35	11.86	14.98	4.95	4.95

Source: [55, 56].

Table 4.--Average wholesale prices for beans and corn, in Guatemala City, 1973

Month	Black Bean	White Bean	Red Bean	Yellow Corn	White Corn
	----------------Quetzales per Quintal----------------				
January	11.15	13.08	11.73	4.79	4.80
February	12.08	13.53	12.73	4.91	4.94
March	13.75	14.23	13.48	5.14	6.07
April	12.47	14.56	13.46	6.50	7.23
May	12.35	14.67	13.73	6.42	7.02
June	14.85	17.84	15.88	6.07	6.61
July	14.33	19.35	16.80	5.87	6.46
August	10.60	15.93	11.97	5.29	5.62
September	12.36	15.00	12.99	4.92	5.18
October	15.48	15.19	14.05	5.59	5.25
November	18.24	15.03	14.63	6.55	6.16
December	17.08	15.20	15.34	6.46	6.08

Source: [55]

Table 5.--Average wholesale prices for beans and corn, in Guatemala City, 1974

Month	Black Bean	White Bean	Red Bean	Yellow Corn	White Corn
	Quetzales per Quintal				
January	16.39	14.90	15.35	6.22	5.98
February	16.13	15.00	15.38	6.13	6.01
March	16.61	16.44	16.83	6.90	7.07
April	15.53	15.58	15.91	7.77	7.97
May	16.09	15.90	16.80	7.03	7.09
June	16.86	16.72	17.53	6.70	6.60
July	17.88	17.79	18.44	6.72	6.56
August	14.87	15.54	14.76	6.46	6.25
September	15.21	15.33	15.03	6.62	6.51
October	17.77	16.06	16.03	6.48	6.30
November	19.78	18.02	17.82	6.65	6.44
December	19.04	18.33	18.33	6.88	6.78

Source: [55]

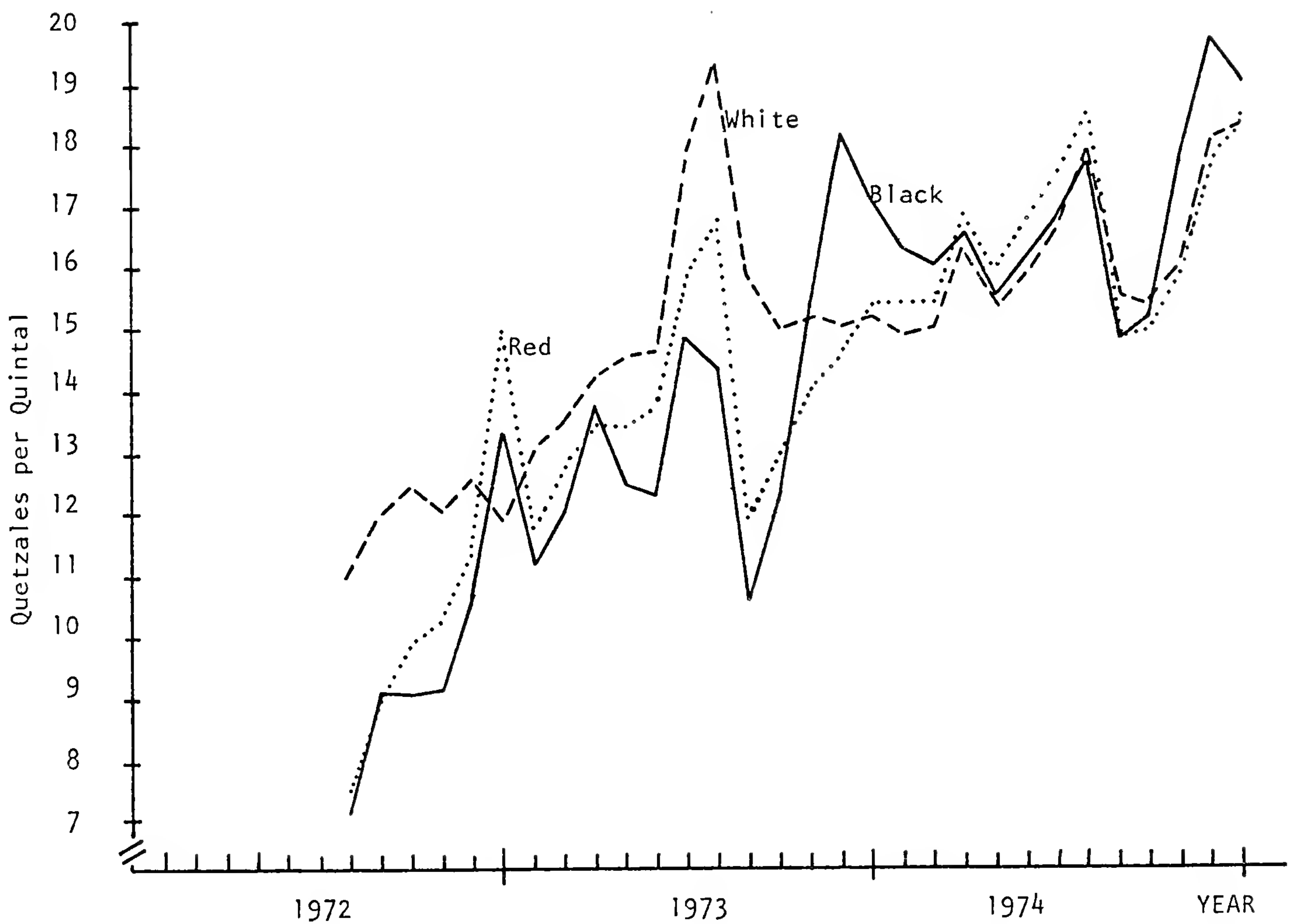

Figure 3.--Average wholesale prices for black, white, and red beans, in Guatemala City, 1972-74

Source: [55, 56].

On the supply side, detailed market knowledge and research on where, when and for what price products can be sold is essential in determining what to produce. Due to very large seasonal and cyclic fluctuations in the prices of agricultural products, farmers in developing countries rationally choose to grow sufficient food for home consumption. Market supply functions are important in determining how responsive farmers are to price, income and other variables for policy decisions aimed at securing adequate increases in the marketed supply of food crops. Since the responsiveness will be different in different milieus, elasticities of supply must be estimated separately for different regions. Market supply functions may also signal possible future changes in land utilization. It has been observed very recently in the communities of San Martin Jilotepeque and El Novillero that, as the small farmer obtains a better standard of living resulting from new corn technologies, there is a tendency to reduce the amount of land devoted to corn production since this is mainly cultivated for family consumption [107].

Knowledge of the characteristics of production and distribution activities is needed. Their description and quantification, especially in the market for inputs, will show cost and availability of inputs in each region. Comparing results with actual output in the region may provide a basis for identification of problems that can be solved by policy decisions. In a marketing study of basic grains, the Institute of Agricultural Marketing (INDECA) delineated the marketing channels for these products [54]. The study lacks, however, the corresponding data for each channel and therefore it is impossible to know the relative importance of each channel; it also contains no information about the movement of inputs to small farmers.

There is no doubt that the existing problems and those that will be generated by the increase in production and productivity of basic grains require careful study to avoid the imminent "Green Revolution" second generation problems. Knowledge of total supply and marketed supply functions, production and distribution activities, and the behavior of the surplus-output ratio as income and farm size change, is important in solving present problems and in trying to avoid major market problems in the future. It is in this context that the following objectives are undertaken.

Objectives of the Study

The objectives of the study are to:

1. Estimate market supply functions for basic grains in the different regions of the country and compute the corresponding income, farm size, and price elasticities of market supply.
2. Delineate and quantify input acquisition and product disposition for basic grains in the different regions of the country.

Data Source and Data Considerations

The data are derived from the Small Farmer Credit Survey conducted by the Government of Guatemala and the Agency for International Development (AID) in 1974 for agricultural activities during the 1973 calendar year. These cross section survey data contain necessary and valuable information for conducting this research since time series data are completely unavailable. The overall objective of the survey was to compare the performance of small farmers receiving credit from the government with non-recipients. A sample was selected by sub-region in order to have a minimum number of sample farms producing the designated main crop for each sub-region. Interviews were taken with 800 pairs of farms, from which a total of 1,548 questionnaires were completed.[3] Figure 4 shows the different regions with their respective important crops. Table 6 and Table 7 present the number of sampled farms and farm size by region, sub-region and department, respectively. By reviewing Figure 1, it becomes evident that the survey reached every Department in the nation, except El Peten (Region two) which is a semi-isolated area in the process of colonization.

A word of caution about the representativeness of the data is appropriate. The no-credit farmers were selected because of their similarity in age, size of farm, crops grown, etc., to the group of farmers receiving credit. Therefore, the former group would represent all farms in Guatemala only to the extent that the latter group does. Interest however falls in drawing conclusions about traditional and commercial agriculture at the regional level. In this case the sample does contain enough farms engaged in either or both types of agriculture such that conclusions by farm type at the regional and national levels are possible.

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[3]Complete descriptions of the sampling procedures are available in [19, 106]. More information about the survey's results is contained in [75, 92, 101].

Figure 4.--Important crops in the different regions of Guatemala

Source: [19, p. 14]

Table 6.--Number of sampled farms by region and farm size

Region	Farm Size					
	0-0.9 Ha.	1-2.9 Ha.	3-4.9 Ha.	5-9.9 Ha.	10+ Ha.	All Sizes
1 Central Highlands	64	145	75	56	40	380
3 South Coast (West)	5	10	14	14	59	102
4 South Coast (East)	7	68	49	75	89	288
5 Northeast	28	151	86	83	134	482
6 Southeast Highlands	9	77	75	59	76	296
National Totals	113	451	299	287	398	1548

Source: Computed from [19, p. 20]

Table 7.--Number of sampled farms by region, sub-region,and department

Region	Sub-Region	Department No.	Department Name	No. of Observations	
1	1	13	Huehuetenango	96	
	2	12	San Marcos	48	
	2	9	Quezaltenango	52	
	3	9	Quezaltenango	1	
	3	14	Quiché	40	
	3	8	Tontonicapán	23	
	3	7	Solalá	30	
	4	4	Chimaltenango	54	
	4	3	Sacatepéquez	36	
					380
3	5	12	San Marcos	32	
	5	11	Retalhuleu	49	
	5	10	Suchitepéquez	21	
					102
4	6	5	Escuintla	50	
	7	5	Escuintla	91	
	6	10	Suchitepéquez	45	
	6	3	Sacatepéquez	1	
	7	4	Chimaltenango	1	
	8	6	Santa Rosa	84	
	8	21	Jalapa	5	
	8	22	Jutiapa	11	
					288
5	9	16	Alta Vera Paz	89	
	9	6	Santa Rosa	1	
	9	15	Baja Vera Paz	4	
	10	15	Baja Vera Paz	78	
	10	14	Quiché	16	
	10	10	Suchitepéquez	4	
	11	19	Zacapa	81	
	11	2	El Progreso	19	
	12	2	El Progreso	30	
	12	1	Guatemala	64	
	13	18	Izabal	96	
					482
6	14	22	Jutiapa	98	
	15	21	Jalapa	77	
	15	6	Santa Rosa	19	
	16	20	Chiquimula	102	
					296
				Total	1548

Source: [19].

George and King's arguments in support of the use of cross-section data in their research [37] can be extended to the present study. First, time-series data are not available; but even if they were, more reliable (demand) parameters can be estimated with cross-section data. In static analysis, a (demand) relationship is specified for a particular period of time. In practice, as George and King point out, [37, pp. 28-9] each time an observation is made, we get one point on a (demand) curve and, by the time another observation is made, the curve might have shifted because one or more factors influencing (demand) may have changed. These shifts may influence the nature of functions obtained from time-series analysis and, at times, it will be difficult to isolate the effects of such shift variables from purely economic variables such as prices and income. Thus, wrong conclusions about the non-significance of economic variables in explaining (demand) could be drawn.

Second, since prices generally remain unchanged during a short period of time, cross-section data make it possible to estimate income elasticities free from price effects. George and King state that cross-section data primarily reflect the (demand) pattern in the sense of long-run income changes so that the income elasticities computed from these data can be interpreted as long-run elasticities. From the point of view of practical applications of (demand) analysis, these long-term elasticities are more relevant for many policy decisions than the short-term elasticities obtained from time-series data.

Relevance of the Project

Income and farm size elasticities of market supply are important determinants in signaling farmer behavior concerning potential increases in quantities produced and marketed and in land utilization. These elasticities permit the estimation of the effects that may result from future increases in productivity and production, if in fact they occur, and in income. Price elasticity may also be computed but would be less meaningful due to the nature of the data. Price observations from the cross-section data available do not capture seasonal prices because interviews were taken at one time due to research resource constraints. The aggregate prices taken can create price elasticity situations without easy interpretation and application. This drawback, however, appears to be less relevant as emphasis is given to the income and farm size elasticities and the income-quantity and farm size-quantity relationships as indicators of farmer supply responsiveness to factors that change his income and farm size.

One of the most important implications of testing the theory presented in this study is obtaining a better understanding of the basic economic system of small farmers and the relationships between this system and Green Revolution agriculture. The theory suggests that there is a built-in supply control mechanism for basic grains and low value-low risk crops in the small farm system. This mechanism, explaining why productivity increases yet production is stagnant, is a natural reaction to basic subsistence needs and avoids some of the second and third generation problems of the Green Revolution [32]. Overproduction may not usually result so prices would not decline sharply to create great income disparities and the usually disoriented market system itself would not be so forcefully challenged.

Should these hypotheses prove reasonably accurate, research and development programs might carefully consider the total small farm system. Basic research on basic grains alone will not serve the small farmer's developing needs entirely as he moves into higher value-higher risk crops. Meeting the risk element squarely in both agronomic and economic research programs might be most productive.

Organization of the Dissertation

The setting of the study, with its problematic situation and implications, has been presented in this chapter. The theoretical framework of the second chapter describes the role of agriculture and of marketing in economic development, with special emphasis on the theory of demand and supply in LDCs. After the theory and literature are reviewed, the methodology used in accomplishing the objectives is presented in the third chapter. The fourth chapter describes input acquisition and product disposition for basic grains in the different regions. Chapter five encompasses both the results and the corresponding analysis, and the sixth chapter contains a summary, the conclusions, and recommendations based on the results obtained. The final chapter, "Reflections on the Theory of Development," is an attempt at actualizing the current development literature of the second chapter in light of the findings in chapter five.

CHAPTER II

AN EVOLVING THEORY OF AGRICULTURAL DEVELOPMENT

That part of the development literature related to agricultural development and marketing is summarized in this chapter. The relationships between agriculture and economic development are the subject matter of the first section. The second section describes marketing activities and their role in the development process with special emphasis on the theory of demand and supply in developing countries.

Agriculture and Economic Development

Since World War II the literature has paid increasing attention to the process of economic development in the developing countries. There seems to be a consensus on the need for sustained growth to bridge the gap that separates LDCs from the industrialized nations. Though the problem of an overall development strategy is continually discussed, the key role that the agricultural sector has to play is today widely accepted. In this chapter, some of the most important viewpoints, especially those related to the problematic situation described above, are analyzed.

Agriculture in LDCs: A Changing Spectrum of Priorities

Arthur Gaitskell [36, pp. 46-50] has tried to explain why agriculture until recently has experienced a very low priority in developing countries. He enumerates the following reasons:

(a) Since the richest countries in the world are the industrial countries, it seemed logical that industry, rather than agriculture, was the means for development.

(b) Developing countries have been sources of raw materials for the industrialized nations and a market for their manufactured products, but their terms of trade have been deteriorating. Developing their own industries, therefore, seemed to be a correct goal.

(c) Private foreign investment was, for a long time, the pattern of development without any national participation.

(d) Traditional values ("not everybody gives development top priority in their lives"): Leisure, status, religious precepts, traditional methods of ancestors, etc., played an important role in hampering agricultural development.

(e) Decision makers in LDCs come from the educated-elite and they are fundamentally urban oriented.

(f) Other reasons favoring industrialization were: it has a greater appeal than agriculture to LDCs since it suggests the modern world. Machinery can be imported; it is easy to learn how to use it and see the results. Agriculture on the other hand is old and most people think they already know all about it. Industrial output is less uncertain than crops. Since a minority is engaged in agriculture in the industrial countries, industry seemed the obvious target for which to aim. Finally, since in the most developed countries, industry's surpluses have been used to pay for subsidies, a cause for technological success, the idea of developing industry first found greater appeal.

There has been, however, a recent shift to complementary growth of agriculture and industry. Gaitskell [36, pp. 50-6] attributes the attention given to agriculture to several facts:

(a) The existence of undernourishment and poverty is today a main purpose for encouraging development. Since the main areas affected are the rural areas, it follows that agriculture has to be developed.

(b) The "left-outs" from rural areas constitute a serious threat to existing political regimes.

(c) Industrialization alone can not solve the unemployment problem since it is capital intensive.

(d) Foreign exchange earnings from agriculture are necessary to buy the basic imports needed for industrialization.

(e) The increasing need for food as population increases and land becomes even more scarce.

The time has come for proper priority to be given to progress of the agricultural sector in developing countries where resources are favorable and population growth is pressing.

Agriculture versus Industry: A False Issue

The issue of establishing development priorities in LDCs is of utmost importance. In the process of making a choice, economists have embraced one of two opposing views: those recognizing that top priority should be given to increase food supply, and those advocating a "big push" industrialization program. Among the advocates for the first group are A.E. Kahn, J. Viner, Coale and Hoover, and others, while A.Hirschman, Liebenstein and Higgins, among others, belong in the second group. Heady [46, pp. 66-7], though recognizing that there is no univeral rule for making a choice between the two, outlines several cases in which a choice can be appropriately made in either direction according to specific circumstances. Nicholls [89, p. 16] believes that the choice is a matter of degree and not of kind, and states that there is probably no developing country in which it is feasible to concentrate all of its investment on either agriculture or industrial development, and it will be impossible to concentrate on industry until a reliable food surplus has been achieved and sustained. Since in most LDCs there is still a large agricultural majority coupled with large rates of population increase, Dovring [27, p. 95] wonders how large the rate of industrizalization must be to absorb the annual increments in the labor force and reduce the existing surplus in agriculture.

Meier's comments on the issue seem to summarize very well the current status of the debate:

> The attainment of a proper balance between the establishment of industries and the expansion of agriculture is a persistently troublesome problem for developing nations. In

> earlier discussions of development priorities, deliberate and rapid industrialization was often advocated. Experience, however, has shown the limitations of an overemphasis on industrialization, and it is increasingly recognized that agricultural progress is a strategic element in the development process. Industrial development versus agriculture has become a false issue, and the concern now is rather with the interrelationships between industry and agriculture and the contribution that each can make to the other. It has also become apparent that the relative emphasis to be given to industry and agriculture must vary according to the country and its phase of development [80, p. 285].

The Role of Agriculture in Economic Development

Papanek [93, pp. 289-91] advances several economic arguments for heavy emphasis on development of the agricultural sector. The arguments apply to the commercial and large scale (capital intensive) farms. First, it is necessary to free labor for industrial development. Second, agricultural production can be raised rapidly and with little capital (possibility of doubling crop production, or raising crops in previously uncultivated areas, fertilizer use, improved seeds, etc.), while industrialization requires time and capital, skilled workers, managers, social overhead capital and the like. Third, while the development of the agricultural sector is capital-saving in requiring minimum expenditures for overhead costs by obviating massive population movements, industrialization would require heavy expenditures to provide at least minimal facilities to the new city inhabitants. Fourth, development of agricultural production also is often the fastest method for decreasing needed imports or increasing saleable exports in countries needing and lacking foreign resources. Fifth, structural changes may be needed before technical improvements in agriculture can be carried out without prior industrialization. Finally, increased incomes will produce increased demand for food and clothing. Agricultural production or imports will have to be increased as part of the development process since reinvestment of all of the increased production can not be expected.

The five propositions stated by Johnston and Mellor [58, pp. 291-7] about the ways in which agricultural development, especially large scale agriculture, contributes to over-all economic development follow directly from the former arguments. First, economic development is characterized by a substantial increase in the demand for agricultural products, and failure to increase food production in pace with the increase in demand can seriously impede over-all economic development. Second, agricultural exports may provide foreign exchange earnings. Third, the labor force for the expansion of the industrial sector can contribute the capital required for overhead investment and expansion of secondary industry. And, finally, rising net cash incomes of the rural population may be important as a stimulus to industrial expansion.

There is no longer any doubt, according to Schultz [108, p. 5], whether agriculture can provide a tremendous stimulus for over-all economic development. It is only necessary to invest in agriculture and, above all, to provide farmers with incentives. Once there are investment opportunities and efficient incentives, as he puts it, farmers will turn sand into gold.

The role of agriculture in economic development according to Nicholls [89, pp. 11-3] depends heavily upon the particular historical circumstances of the country and upon the ratio of agricultural land to population. The relative emphasis which decision makers give to agriculture, and the consequent policies must therefore vary accordingly. But it is clear for him that, either for an open or closed economy, the agricultural sector can make tremendous contributions to over-all economic development and that, within considerable limits at least, the development of this sector is a sine qua non before a take-off into self-sustained economic growth can become a reality.

In many countries, however, agriculture has failed to respond for what Heady [46, pp. 63-4] calls obvious reasons. First, agriculture has not been given an appropriate priority. Second, there is a lack of a price structure conducive to the use of new and more capital resources such as insecticides, fertilizers, and improved seed varieties. Third, input prices have been kept too high and output prices have been kept too low. Fourth, capital has not been moved into the hands of subsistence farmers to incorporate them into the market economy. Fifth, frequently, the absolute supply of and the facilities to move and store inputs are lacking. To eliminate those adverse factors, several economists have suggested different prescriptions.

Some Prescriptions for Agricultural Development

Many sophisticated models have been provided for developing the agricultural sector in LDCs. Except for Heady and Lewis, all of the authors call for increasing employment on farms rather than replacing labor with mechanized technology.

For Heady [46, p. 61] there is no mystery in the process of explaining the development of agriculture. It is so simple that no new theory is required. He proposes the following "recipe":

> Lower prices and increase availability of resources, add certainty and greater quantity to product prices, blend with knowledge and a firm or tenure structure which relates input productivities appropriately with resource/product price ratios. This mixture can be brought to a developmental boil in a container of commercial farming, if not successfully in a purely subsistence environment which is outside the market economy. It will have a delayed or lagged maturity, depending upon the dosage of the above variables and the extent to which a very few specific cultural factors exist. These factors include (1) creating a new "state of mind" for cultivators who have previously been oriented to production best guaranteeing food for subsistence in the year ahead, and who must now look to expansion towards the market, and (2) acquainting families with the mysteries of managing credit and capital in order to convert them from subsistence operations.
>
> This recipe has been tested and proven successful over many parts of the world: so much that it is doubtful that anyone will ever come up with a better one. Hence, the creation of the conditions implied above is one of the priorities for bringing economic development to agriculture. There is no mystery to the process. If a mystery exists, it is to explain those exogenous conditions which prevent governments and planning agencies, which wish agricultural development, from manipulating the above instruments and going forward with the recipe [46, p. 63].

Lewis' well-known article on "Economic Development with Unlimited Supplies of Labour" [74] deserves special consideration. According to him, in most developing countries the supply of labor is perfectly elastic at current wage rates. The existence of disguised unemployment in the agricultural sector, with zero or even negative marginal productivity, provides the basis for economic development. As workers are absorbed by the industrial sector, capitalists earn a surplus, the surplus can be invested with the resulting increase in marginal productivity and, therefore, growth. Despite the controversy that followed publication of this position, the article exerted tremendous influence in the 1950's and 1960's.

Premature displacement of labor from agriculture, however, could hamper economic development. The demand for food (determined largely by population growth and by the income elasticity of demand for food) and the existing high rates of population growth with the difficulty experienced by the urban sector to absorb this growth, yields the Johnston and Mellor policy prescription of

> ...a labor-intensive approach with reliance on yield-increasing technical innovations in the earlier phases of agricultural development. This policy approach produces the required increases in agricultural production and avoids displacing labor prematurely from agriculture. It is a prescription for agricultural research, for large increases in the use of yield-increasing inputs such as fertilizer, improved seeds, insecticides and pesticides, for increases in irrigation facilities and for building service institutions in extension, marketing, and credit. It is also a prescription to minimize mechanization, especially when it serves to displace labor [26, p. 45].

Dorner [25, pp. 268-72] also points out important areas in which policy changes could strengthen economic development and the status of the small farm subsector. Of special interest to our case are: First, development and introduction of new technology to increase employment and production, with special emphasis on land saving technologies if both increased production and employment objectives are to be served. Second, modification of rural service structure to assure access by small farmers.

No matter the prescription followed, it is essential to remember, as Hirschman states, that "... development depends not so much on finding optimal combinations for given resources and factors of production as on calling forth and enlisting for development purposes resources and abilities that are hidden, scattered, or badly utilized"

[48, p. 5]. And that "there are always and everywhere potential surpluses available. What counts is the institutional means for bringing them to life...for calling forth the special effort, setting aside the extra amount, devising the surplus" [95, p. 339].

Marketing and Economic Development

A negative feature of pricing systems in developing countries is the existence of extremely high prices at the retail level restricting consumption along with extremely low prices at the producers' level which do not stimulate farmers to grow and market more products. There exists no doubt that inefficiency in the marketing of agricultural products is characteristic of most developing countries. Despite the importance of well organized and efficient distribution systems, the study of the role of marketing in LDCs began only two decades ago.[1] The purpose of this section is to profile the important role that marketing plays in economic development.

Marketing Defined

Marketing may be defined in several ways. In a broad sense, marketing can be identified as "part of the production process that assures market outlets for farm products and makes readily available supplies of production inputs which reduce price uncertainty and risk" [115, p. 1].

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[1]Abbott [2, p. 364] affirms that the first to point out specifically the importance of marketing in economic development was R.H. Holton in the beginning of the 1950's.

In a conference about marketing problems in LDCs [66, p. 6], agricultural marketing is considered to consist of four specialized areas or activities. The first area, "factor marketing", encompasses the functions of providing inputs for farming. The second is the movement of commodities to consumers. The third area is concerned with the activities performed by the processor converting the commodities into products. The fourth is related to the export of the commodity.

Marketing operates in a certain environment and is affected by different forces. Technology is, in our case, the most important factor to consider. "Technology puts pressure on a marketing system to which it must adjust, and similarly, technology has much to do with the products distributed and their eventual acceptance" [49, p. 2]. Reynolds [100, p. 154] says that marketing is affected by technological change in three ways: by change in goods and production methods, by changes in the ultimate consumer, and by changes in marketing itself.

The Role of Marketing in the Economy

An AID publication [67,pp. 27-8] lists three broad functions that the marketing system performs in the economy. First, it performs the reciprocal function of providing an outlet for producers and commodities for consumers (household and processing firms). Second, it provides a livelihood for those performing the different marketing activities, and should yield reasonable returns to the capital and managerial abilities devoted therein. Third, it signals those engaged in the production, distribution, and consumption of commodities the actions they should take in their own interest.

The importance of marketing can be appreciated in the triple functions enumerated by Drucker [28, p. 335]: the function of crystallizing and directing demand for maximum productive effectiveness and efficiency; the function of guiding production purposefully toward maximum consumer satisfaction and consumer value; and the function of discrimination, rewarding to those who really contribute excellence, and penalizing those who do not want to contribute or to risk.

The economic aspects of marketing, according to Holloway and Hancock [49, p. 1], are twofold in importance: First, consumer's behavior is influenced by their economic status which creates an environment for other influences to act upon the consumer. Second, firms act in the market in a competitive atmosphere with price serving as a signal to exchange transactions. "In this way the economic dimension is broadened, and the economic environment of the firm becomes a market force worthy of consideration" [49, p. 1].

The Role of Marketing in Economic Development

Marketing is an essential consideration when planning economic development. Moyer and Hollander [84, p. 2] attribute the importance of marketing in that process to the fact that it permits increased agricultural output to be moved into commercial markets, and since distribution systems link markets with markets and producers with markets, these systems equalize and distribute goods from surplus to deficit areas. Since producers and consumers are separated geographically, production and consumption cycles are different, food products though harvested intermittently are consumed at fairly regular intervals, and the necessity of marketing agents is evident to keep goods flowing both geographically and through time. The economic development process will suffer if this distributive function is not well performed.

King [64, pp. 78-9], in analyzing the importance of marketing in economic development, states that it is desirable that farmers respond to prices and income incentives for three goals: a nutritional goal, a price stability goal, and a growth goal. Inefficiencies in the production of marketing services and in the pricing system interfere with the achievement of such goals. Three basic conditions, according to Abbott [3, p. 5], are of special importance in assisting market demand to provide production incentives: reasonably stable prices for agricultural products at a remunerative level, adequate marketing facilities, and a satisfactory system of land tenure.

Despite its apparent importance in economic development, late emphasis on marketing may be due to the centuries-old belief in the unproductive nature of marketing and middlemen or possibly to the belief that marketing is an accomodating mechanism and that firms will appear to provide the necessary services once the need for such services has been felt. Collins and Holton [16, p. 360] have demonstrated the erroneous nature of the latter point. They emphasize the need for special attention in transforming the organization and operation of the distributive sector rather than the physical facilities.

Abbott [1, pp. 87-8] attributes the neglect of marketing in development plans to two possible causes. One is the belief that a _laisez faire_ attitude will better solve problems than if solutions are included in a plan. The other possibly is the ignorance of planners about the importance of marketing or their lack of interest in the subject. Going to the other extreme, there may exist the temptation of giving marketing an over emphasis and without sufficient attention to production. Heady and Mayer [45, p. 31] have already given warnings about this tendency when they state that both the producing and the marketing sectors should be considered and tackled together. Two opposite examples of imbalance are: (1) the case when increased food production is penalized in the market and the production potential is not realized because consumer preference places a low value on the commodity; and (2) the situation when large investments of effort and funds are made in marketing research and facilities without relating these investments properly to production conditions.

Times and attitudes about marketing and development are changing as stated by one author who writes..."countering the crude notion of the non-productivity of marketing is the growing realization that the activities performed in transforming farm products in space, form, and time are a useful and necessary part of the economy" [34, p. 132]. This growing consensus conveys the idea that changes are needed not only in the distributive sector to help the development process, but that this sector can actually play a leading role in that process. Collins and Holton [16, p. 360], in arguing against a passive role for marketing, state that the distributive sector can under certain circumstances play a very active role by changing demand and cost functions in such a way as to encourage the expansion of the agricultural and manufacturing sectors. Rising productivity, according to

Fletcher [34, p. 132], creates demand for services produced by different marketing firms and the strategic position of the distributive sector gives it a leading role in development. He further argues that in LDCs there is a need for a relatively heavy emphasis on technological efficiency as contrasted to economic efficiency (consumer satisfaction is more important than consumer sovereignty) and that the marketing system is the necessary connecting link between consumers and an increasing volume of food and fiber production.

There are many variables influencing the distributive sector in LDCs. An important publication [67, p. 5] lists the following: the stage of technology in its agricultural production system and in its overall economy (the rate of agricultural growth); how well the country's domestic production can meet the country's food needs (the extent of the dependence on external food aid) and the extent to which a few crops make up the bulk of the people's food supply; the extent of urbanization; the level and distribution of income, and the income elasticities of demand for food; the size of the country, the population distribution within it, and the rate of population growth; the country's socio-economic structure and its politico-economic ideology (the environment for private investment and the ease of entry into marketing enterprises).

Many authors have made important contributions about the role played by the variables that influence the distributive sector and the contribution of this sector to the process of economic development [1, 2, 3, 4, 5, 13, 14, 16, 18, 28, 31, 34, 40, 41, 42, 43, 44, 45, 49, 57, 64, 66, 67, 73, 79, 81, 83, 84, 86, 88, 90, 97, 100, 102, 103, 104, 105, 110, 112, 115]. Drucker [28, p. 344] assigns marketing such a critical role in the development process as to consider it to be the most important "multiplier" of such development. Though often neglected, market system development makes possible full utilization of existing assets and the productive capacity of an economy, mobilization of latent economic energy, and development of managerial talent.

Moyer [83, pp. 7-19], however, summarizes well the existing literature in several propositions about the role of the marketing system and marketing institutions. He suggests that they can provide the necessary means to coordinate production and consumption and provide consumers with the commodities they need and want. By making available new or improved products, improved marketing systems can increase the elasticities of supply and demand. Market systems can also reduce risk by providing more adequate information flows among participants in the system. Secondly, markets can incorporate subsistence producers into the exchange economy and also be an important channel for entrepreneurial talent and capital for other sectors of the economy. Third, as a result of market extension, market systems may generate pecuniary and technological economies, both internal and external, for producing firms. Efficient markets can lower consumer costs by improving distribution efficiency, more intensive resource use and less spoilage. They can also reduce transaction and exchange costs between producers and consumers.

Most important, and closely related to the problematic situation in this research, is the fact that marketing can "produce" just as farming does in the following senses: reducing losses to consumers is the same as increasing yield; storage augments production for the off season; providing timely inputs to farmers also increases yield; improving quality increases value (price) though often for marketing agents beyond the farm level.

Transplanting marketing strategies from the industrialized countries to the developing countries should be avoided. Currie [18] has shown that it is ill advised to assume a standard pattern of development for all countries and that trying to apply the marketing organizations and techniques of the developed countries to LDCs will not render satisfactory results. This is due to an array of differences in marketing efficiency between the two groups of countries according to Chaturvedi [14, pp. 118-23]. While in developed countries the producer is relatively prosperous, and is linked to and depends upon, the market, the self-subsistence farmer of LDCs is not. While in the advanced countries the main source of income of the middlemen in marketing is their turnover profits, in LDCs the often numerous and small middlemen generally depend on their margins for their incomes. Differences in transport and communications, information, storage, grades, and standards, etc., also prevail between the two types of countries. For these reasons it is clear that a transplant of techniques from advanced countries to developing countries will not necessarily produce satisfactory results. In traditional economies, on the other hand, marketing firms play a passive role by merely buying and selling. They can be positive and play a major entrepreneurial role. Development of the banana marketing industry in the United States started by a ship owner looking for products to haul back to the U.S. from Jamaica who was later joined by other food merchants, is a good example.

Marketing and the Theory of Demand in LDCs

A special consideration must be given to the relationship between marketing and the theory of demand in developing countries. The importance of the application of demand theory to developing country problems is accentuated by the introduction of new technologies coupled with a complete lack of knowledge about demand conditions for the different commodities. The excessive variability in the quality and volume of supply can be a tremendous problem for producers and market organizers in these countries.

The law of demand states that, *ceteris paribus*, quantity demanded of a commodity varies inversely with price. Chaturvedi [14, pp. 131-2] has pointed out several reasons why the law of demand can present special characteristics in LDCs. The law of demand assumes that conditions regarding the means of transport and communications are similar everywhere. Nevertheless, it sometimes happens that in LDCs, when transport difficulties occur, price increases are present when demand in a region has risen even though supplies of the commodity are adequate. Another characteristic present in LDCs is the fact that, particularly for foodgrains, movements of some commodities follow the directions of the profit trends or the expectations of the middlemen without considering consumer needs. This may result in surplus in one area while there is a need for the commodity in another area which lacks the necessary purchasing power.

Knowledge of demand conditions are of foremost importance for planning in developing countries. Abbott believes that

> ...the first stage at which market considerations enter the planning process is forecasting probable demand as a basis for fixing production targets. While looking for potential resources to exploit is one of the first elements in any plan to accelerate economic growth, decisions on how to use these resources and at what pace to put their products on the market must depend on an appraisal of the demand. This includes both the demands of a growing domestic population and the demands of international markets in which a country hopes to sell as a means of earning the foreign exchange it needs for development...Where less familiar or more specialized crops enter a plan, careful attention to consumer tastes, preferences and habits is essential. Examples of misjudgement on such grounds are common [1, p. 94].

It is necessary, however, that the market demand provide production incentives. Of special importance are, according to Abbott [1, p. 102; 2, p. 365], first, reasonably stable prices (without discontinuous intra or interseasonal changes) at a remunerative level. Farmers will hesitate before incurring additional work or expense to increase production unless they have confidence that prices will be higher than costs. Second, adequate marketing channels and facilities must be provided at the proper time. Farmers will be disappointed if they see that their increased ouput cannot be sold due to the lack of a proper channel. Finally, a satisfactory system of land tenure avoids large share of the returns from increased output going to the hands of the landlords.

To avoid marketing problems in the future, research on demand conditions must be conducted. This should include both domestic and foreign demand. Knowledge of price and income elasticities of demand can be used to signal producers where, when, and what products they should produce.

Marketing and the Theory of Supply in LDCs

Of special interest to our concern about traditional and commercial farms and crops' response to improved technology is the relationship between marketing and the theory of supply in developing countries. The law of supply states that, ceteris paribus, quantity supplied of a commodity varies directly with price.

Developing countries often emphasize increasing production of food crops by relying on modern yield-increasing technology. Adoption of the new technology is supposed to foment increased productivity and production [26].

Technological advance, however, may bring about productivity increases yet the same level or declines in aggregate production. Due to major seasonal and cyclic price fluctuations mainly in basic grains and to small farm income limitations, small farmers in LDCs choose, quite rationally, to grow only enough of some food crops for home consumption. Policy makers often desire to secure for the country adequate increases in the marketed supply of food crops and to determine necessary future changes in land utilization to meet that objective.[2] Knowledge of

[2]The impact and implications of foreign surplus disposal in developing countries are voluntarily ignored. The interested reader is referred to some of the relevant literature [33, 62, 63, 91, 109, 111, 121].

total and market supply response by traditional and commercial farms to changes in production, price and income under different regional conditions has concerned numerous development economists. Major contributions to an understanding of the forces governing supply response in "subsistence agriculture" are provided by Wharton [119], Behrman [11], and Krishna [68, pp. 497-547].[3] The latter has provided a comprehensive analysis about agricultural price policy and economic development, mainly concerned with supply response and price determination in developing countries.

The behavior of farmers in developing countries relative to a marketable surplus has been the main focus of several recent more general studies. Included in this research are the relationships between marketable surplus and dual development [23], marketable surplus and economic growth [29], and marketable surplus, dual development, and economic growth [122]. The relationships between marketable surplus and price [60, 72, 114], size of landholdings [87] and stages in the process of development [78] have also gained special attention.

Numerous specific studies related to production and supply of traditional and commercial crops, annual as well as perennial, mostly concerned with estimating the sign and magnitude of the price elasticity of the marketable surplus, have been conducted [6, 7, 8, 9, 10, 15, 20, 21, 38, 39, 50, 60, 61, 69, 70, 71, 76, 77, 85, 99, 113, 116]. The results generally suggest that the inverse relationship between surplus and

[3]The author does not want to discuss the acceptability of using the concept of "subsistence agriculture" so broadly. Miracle [82] considers the use of the term erroneous since agriculture in LDCs, according to him, is not homogeneous.

price found in some cases can be attributed to two possible causes. One is tied to the relatively fixed demand for money by traditional farmers which calls for sales only to the level of money needed. The second cause is that increasing traditional crop prices may stimulate an increase in the farmer's income such that the income effect on his demand for consumption of the crop outweighs the substitution effect in production and consumption [78]. For either cause, marketable surplus may be inversely related to price.

A very important recent contribution by Wiens [120] adds risk to the picture. Wiens, using quadratic programming to examine the impact of yield uncertainty on peasant allocation of land among crops and their use of hired factor services, shows that optimization qualified by risk aversion proves superior to risk neutrality or credit constraints in explaining peasant allocative behavior.

Despite the growing interest on small farm agriculture [12, 94, 82] the research on supply response in traditional agriculture seems incomplete. A definite explanation of the two causal phenomena producing a possible negative relationship between surplus and price has not been provided. Nor has there been an explanation of why the response situation happens in some but not all regions of a country, or how one can predict and measure the effects of that behavior. To complicate the situation even further, after contemplating their research results on the subject, Manghas, *et al*. state that price may not be very effective in increasing aggregate agricultural output, which implies "a much less optimistic outlook for the role of price as a development tool, at present levels of technology, than if price changes induced yield as well as area changes" [76, p. 685].

The need for a theoretical and analytical framework to enable economists to analyze the total small farmer basic economic system is evident. Such a framework would be an important contribution to the development theory. This research attempts to provide a basis for more fully understanding supply response criteria inherent to traditional and commercial agriculture in developing countries.

CHAPTER III

THEORETICAL AND METHODOLOGICAL FRAMEWORK FOR INVESTIGATING TRADITIONAL AND COMMERCIAL FARM SUPPLY RESPONSE

The basic economic system of the Guatemalan small farmer is described in the first section of this chapter. A second section contains the method of estimation with the corresponding hypotheses and equations and the description of how the model has been adapted to the different regions of the country and the different cropping patterns. The third section explains the methodology used for computing input acquisition and product disposition. Finally, data used and implications are briefly discussed.

Basic Economic System of the Guatemalan Small Farmer

The environment in which a Guatemalan small farmer lives determines his consumption and selling decisions. A small farmer grows basic grains mainly for home consumption. At harvest time he disposes of his production in several ways. A large share is kept for family consumption and other noncash purposes such as feed, seed, payments in kind, etc. If cash is needed, part of the output may be sold at the time of the harvest. In good years some production may also be saved to be sold throughout the year whenever the farmer needs cash or when high prices make selling worthwhile.

The hypothetical price-income-consumption (PIC) path developed in Figure 5 (A) illustrates the small farmer's consumption and selling decisions and is used to develop his market supply curve for a product. Due to his subsistence needs, the small farmer's demand and supply situation for items produced on his farm is somewhat unique. Figure 5 (A) shows a hypothetical price-income-consumption (PIC) path for a commodity produced and consumed at the farm level. Assume the farmer is at point Z, where price is P_a and increases to P_b. The farmer's income will increase. The income effect created by the price increase will make him move up and along the PIC path. Most food crops produced on the farm can be considered as inferior goods; since small farmers usually have so little income, a small price increase may produce a significant change in his income position such that he is willing to consume less of the product. Since he is his own supplier, he can cut back on his consumption. If the process is repeated, the hypothetical price-income-consumption (PIC) path shown in the figure can be drawn. Total output is fixed at OB and the amount OC is the minimum necessary for family subsistence and seed for the coming season. If quantity OB is desired for home consumption and other noncash purposes, the farmer will not sell any output. However, cash needs or higher prices throughout the year might induce him to sell some of his product and forego some consumption. For example, if the price is P_1, the farmer keeps OA and sells AB.

The decision process at harvest time and for the short-run, depicted in Figure 5 (B), is dependent primarily on product price, home consumption needs, and cash needs to purchase other goods. At harvest total supply is Q_1^T. If the price is P_1, the farmer expects to consume OA_1

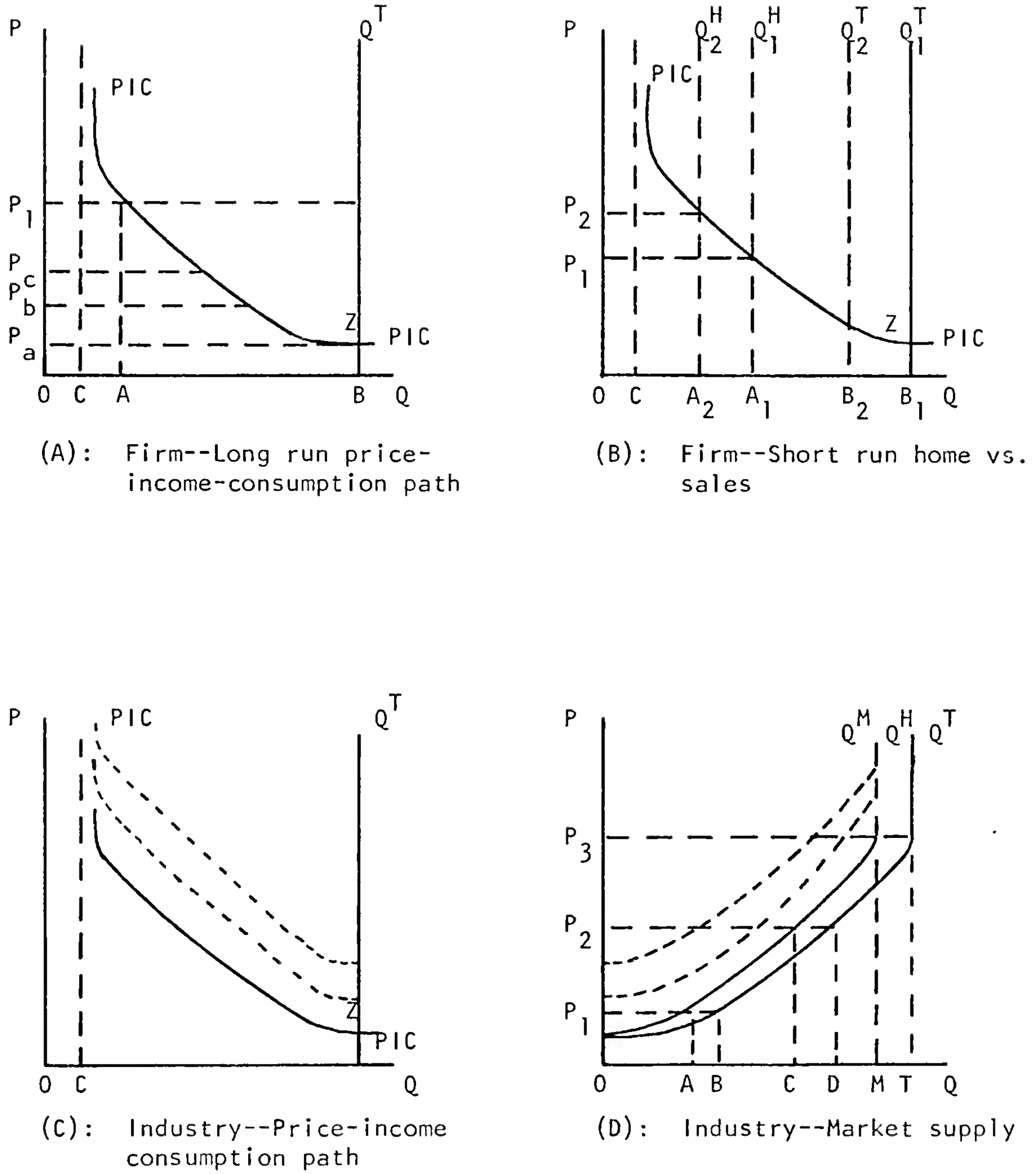

Figure 5.--Guatemalan small farmer consumption and selling decisions

(Q_1^H - quantity used at home) and to sell A_1B_1 (Q^M - quantity marketed). This decision at harvest time establishes OA_1 and A_1B_1 as supply and demand proportions for the year if price stays at P_1. When all of the output is sold at harvest, no further decisions are possible. If the farmer did not sell everything at harvest, Q_2^T becomes the new fixed total supply curve since B_2B_1 was sold or consumed. At P_1 expected home use would remain at Q_1^H. However, as price rises to P_2, home use declines to Q_2^H or OA_2 and sales are A_2B_2 thus reestablishing demand and supply proportions. The process, when induced by increasing prices, may continue until Q^T reaches the amount where the hypothetical price-income-consumption path becomes asymptotic to the Y axis at OC, the minimum needed for family subsistence and seed. It may happen that, as Q^T shifts to the left during the marketing period, prices above P_2 result in decreasing quantities marketed. Little or no surplus available when prices keep rising may bring about indirect relationships between prices and quantities marketed. For price declines, the process is also operative and illustrates greater home use relative to sales for the short run or one season.

From the hypothetical price-income-consumption path for each small farmer, as illustrated in Figure 5 (A), a community of price-income-consumption paths can be developed as in Figure 5 (C). The effects of price and income changes, (e.g., constrained variables) result in movements along the path. Other variables exert an influence in the position of the PIC path. While increases in farm size and in the level of education with other things remaining equal, make the path shift downward, the opposite occurs as distance to the market and quantity demanded on the farm increase. If the profitability of other grains goes up, the PIC path also shifts upward. As the PIC path approaches the total production constraint (Q^T) it becomes more elastic. At point Z, the elasticity of the PIC path is infinite; price is so low at this point that farmers decide to consume everything they produce since there is no incentive to forego consumption through sales in the market.

The hypothetical PIC path is used to derive the market supply (Q^M) shown in Figure 5 (D). By starting at point Z and moving up and along the PIC path, quantities marketed at different prices can be read to establish Q^M. If the quantities used on the farm (Q^H) are added to Q^M, the total quantity produced (Q^T) is identified.[1] At this point, Q^T does not present the completely vertical shape that the fixed total supply curve shows in sections (A), (B), and (C) of Figure 5. Although Q^T is a fixed amount until the next harvest, it does decrease during the marketing period as the farmer alters his consumption and selling decisions due to changes in his income situation produced by price changes. For that reason, when Q^H (OC or MT) is added to Q^M, Q^T slopes upward. At P_3, however, both annual supply functions (Q^T and Q^M) are perfectly inelastic and will not be affected by further price increases. Here the basic identity $Q^M \equiv Q^T - Q^H$ will not be subjected to further alterations until the following harvest. Since there is an infinite number of hypothetical

[1] Income level and farm area devoted to the crop in question provide offsetting influences on Q^H which are not measured in this research. As income rises with an income inelastic demand for a basic grain, consumption per capita at the farm level may decline while demand for seed may expand until the income supply response function Q^M becomes perfectly inelastic. For this reason a fixed Q^H is assumed.

price-income-consumption paths, representing numerous farm families, and of combinations that can be made between Q^H and Q^M, and since Q^T shifts over the marketing period, there is an infinite number of possible Q^M curves as shown by Q_1^M to Q_n^M in Figure 5 (D). Since Figure 5 (D) is derived from Figure 5 (C), the starting points of all industry supply functions are completely elastic; such a low price does not induce farmers to market any output.

Assuming that Q^M and Q^T in Figure 5 (D) are two observable supply functions, small farm market behavior can be further investigated. At price P_1, OT is total quantity produced (Q^T), AB is the quantity kept at home (Q^H) and OT minus AB is the quantity marketed (Q^M). As price goes up, Q^H will fall until it reaches the minimum amount MT. At P_2, for example, OT is again total quantity produced (Q^T), CD is the quantity kept at home (Q^H), and OT minus CD is the quantity sold in the market (Q^M). Q^M is therefore not a fixed amount but becomes a function of price throughout the marketing period. Thus, knowledge of those conditions that induce changes in Q^T and Q^M are necessary to identify both curves and the implications of their relative locations and shapes.

Since the levels of Q^H observed are not actually purchased in the market at different prices, we cannot obtain farm family demand functions, final equilibrium points, and demand elasticities. Interest, however, is in determining supply responsiveness to changes in farm size and level of income.

Enterprise combinations utilized by small farmers at different income levels are closely related to the theory of small farm demand and supply of basic foods. More specifically, the impact of income changes on the relative quantities that are produced and marketed from the crop mix as well as land use patterns support the demand and supply theory. This subsistence, land use and crop mix environment of the Guatemalan small farmer is characterized by varied levels of risk aversion as relative incomes change. With few, small and divided plots of land at his disposal, the small farmer grows primarily traditional crops although he may also produce some commercial crops where risk is minimal relative to that of other high value crops. As opposed to low risk traditional crops grown mainly for subsistence, low risk commercial crops are a source of income where adversity would not extend beyond normal weather fluctuations. Low risk commercial crops may also include crops whose prices are supported by the government. Wheat is a good example for Guatemala.

The small farmer's behavior within his basic economic system is one of carefully balanced risk aversion, income maintenance and risk taking. As depicted in Figure 6, at very low levels of income or farm size the farmer grows basic grains for subsistence though he may also sell part of his production. The difference between total quantity produced (Q_t^T) and quantity marketed (Q_t^M) of a traditional crop depicts home use requirements for consumption, seed and other purposes (Q_t^H). Since crop t is mainly intended for subsistence, the curves show some income responsiveness at very low levels of income and almost none at high income levels. Because some grains will always be grown due to cultural values, (corn and beans are good examples), the curves will be similar in shape and, once the home use requirement is reached, the curves will tend to become perfectly inelastic (or vertical) regardless of income level.

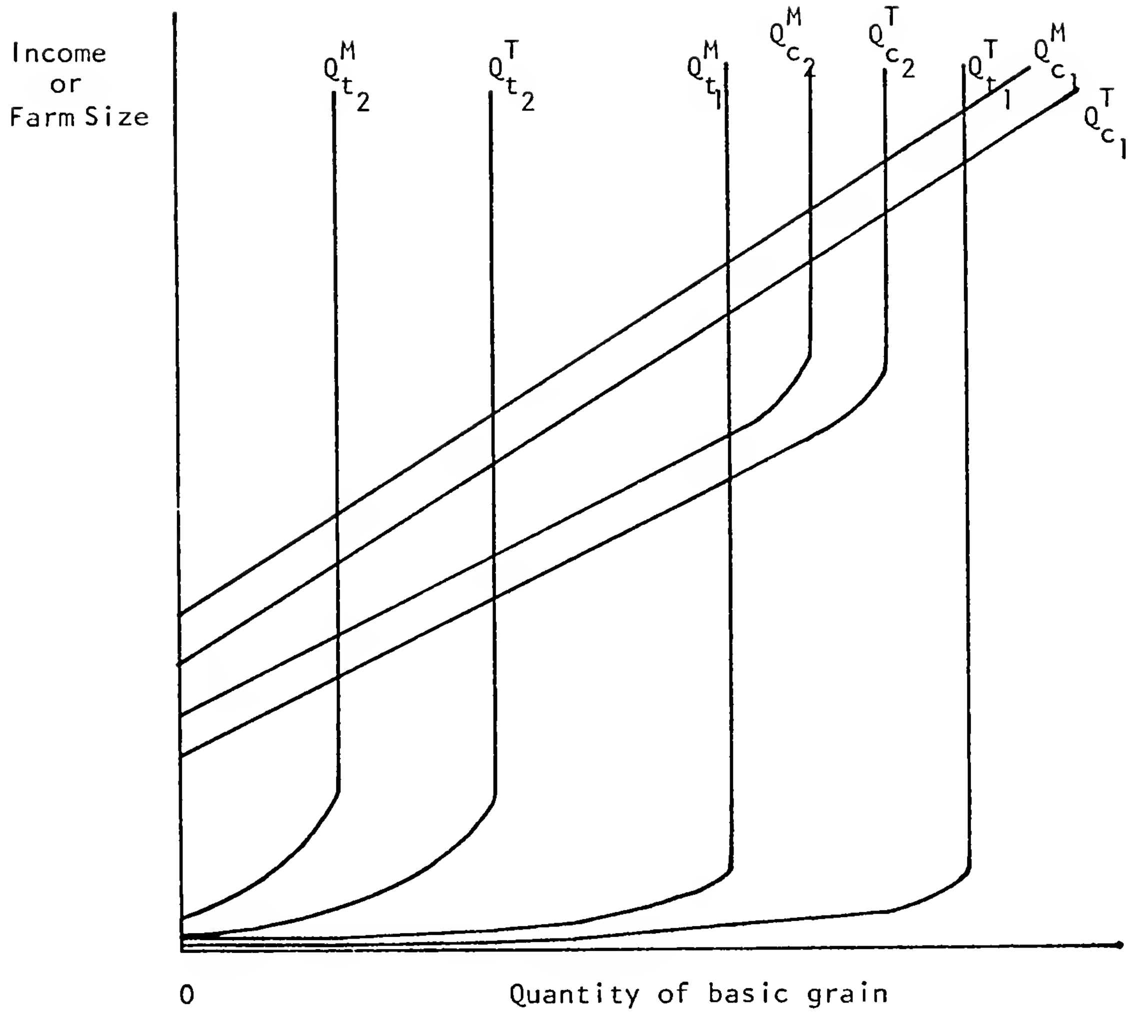

Figure 6.--Income-quantity or farm size-quantity relationships for the Guatemalan small farmer, given his land constraint

As income rises, due to productivity and/or price reasons, the farmer will divert some of his land into other commercial crops (Q_c) while maintaining his self-sufficiency production on less land. In this case, the response will increase with income up to the point where the farmer has no more land available for crop production or it is feasible to introduce another commercial crop.

Thus, as income rises, small farmers with their self-sufficiency guaranteed, will tend to diversify production by growing high value crops until the land constraint is reached. Q_c in Figure 6 is not produced until a certain minimum consumption and income level is attained with the basic and low risk crops. Income responsiveness of the higher value and higher risk crops is greater than for the traditional crops. At higher income levels farmers venture into higher risk crops and combine their production according to income level and land availability. Figure 6 is also operative to determine land use patterns when the vertical axis is labeled with different levels of farm size.

Method of Estimation

This section presents the methodology used in this study. The hypotheses to be tested with the corresponding functions and the adaptation of the model to the different regions and to varied cropping patterns are also explained.

Hypotheses

Since income-supply relationships are the main focus of this research, the primary set of hypotheses relates to the respective elasticities. The hypotheses are formulated broadly since it may be the case that a traditional crop in one region may be a commercial crop in another region. The functions, and corresponding elasticities, will behave differently in each case.

Concerning income elasticities of market supply it is hypothesized that:

(1) When crops are grown for subsistence, at very low levels of income, small farmers will market very little. As income rises small farmers will market more but only up to a certain amount where they have their self-sufficiency secured.

(2) If the income of small farmers rises, they will produce and market successively higher value crops in combination with subsistence crops and within their land constraint.

Concerning the productivity of basic grains and of competing or alternative commodities, it is further hypothesized that:

(3) If the productivity of basic grains grown for subsistence increases due to yield-increasing technologies, then small farmers will produce up to the point where they would have their self-sufficiency secured with less land.

(4) At low income levels, as alternative crops become more profitable, small farmers will produce and market wheat up to a certain amount after which they will shift to other commercial crops since their income cannot be increased much more due to the wheat price support limit.

Concerning farm size elasticities of market supply, it is hypothesized that:

(5) When farmers are at the very subsistence level, all available land is devoted to traditional crops. As technology or farm size continues to increase, small farmers will grow other crops while maintaining their self-sufficiency.

Concerning price elasticities of market supply, it is hypothesized that:

(6) As the price of basic grains rises, small farmers will market more output but the percentage increase in supply will be less than the percentage increase in price.

Concerning production and distribution activities of traditional and commercial basic grains, it is hypothesized that:

(7) If the productivity of basic grains can increase, and production gains are obtained at the same time, production and distribution activities can still be performed adequately.

The Model[2]

Based on the small farm decision process just described, the following market supply function can be estimated:

$$(1)\quad Q_i^M / Q_i^T = \beta_o + \beta_1 \frac{1}{P_i} + \beta_2 E + \beta_3 \frac{1}{A_i} + \beta_4 D_i + \beta_5 I_i + \beta_6 W_i + \beta_7 \frac{1}{Y_i} + \varepsilon_i$$

[2]The Appendix contains a complete specification and discussion of the mathematical and statistical models.

where,

Q_i^M / Q_i^T = percent of grain production that is marketed (kg);

P_i = farm price of basic grain i (quetzales/kg), and estimated in reciprocal form;

E_i = education of household head (number of years of formal education);

A_i = total farm size (ha) and estimated in reciprocal form;

D_i = distance to the nearest market (km);

I_i = quantity of basic grain i demanded at the farm level for all purposes (kg);

W_i = return per hectare in all basic grains except basic grain i divided by return per hectare in basic grain i; and,

Y_i = total family income (quetzales/year) and estimated in reciprocal form.

The reciprocal is chosen for P_i, Y_i, and A_i because in the theoretical presentation the function is hypothesized to slope upward and to become perfectly vertical at a certain point. Complete inelasticity occurs in the case of price, when the farmer does not want to sell any part of the quantity saved for home consumption and seed; in the case of income, when the subsistence level has been achieved; and in the case of total farm size, when other crops enter the production system. The rest of the variables are estimated in direct form.

The ratio of marketed output to total output (Q_i^M / Q_i^T) is estimated instead of Q_i^M alone because Q_i^T becomes a different constraint, based on farm size, for each farmer. The quantity retained for home use varies considerably among farmers and crops and only a certain maximum percentage of total supply can be marketed. In a totally commercialized farm, the ratio equals one, while in a totally traditional farm it equals zero. A positive sign indicates that the crop becomes more commercial as independent variables increase while a negative sign indicates a tendency to more traditional, or less commercial crops for the direct variables (E_i, D_i, I_i, W_i) and the opposite for the reciprocal variables (P_i, A_i, Y_i). The ratio also becomes smaller or larger at different price levels due to the total production constraint.

Total farm size (A_i) is included instead of area producing each crop (A_i) to account for the differences in farm size and to illustrate variations in quantities marketed at different levels of farm size. Therefore, the same observation (A_i) per farm is used in the equations for each basic grain regardless of the amount of land devoted to its production. The weight (W_i) should account for the different basic grains grown by the farmer and, therefore, any possible substitution among them. The rest of the variables are self-explanatory.

Price (P_i), income (Y_i), and total farm size (A_i) will carry negative signs if the function behaves as postulated. Quantity demanded at the farm level (I_i) is also expected to carry a negative sign. Distance to the nearest market (D_i) and education (E_i) are expected to carry negative and positive signs, respectively. The relative profitability ratio (W_i) will carry a positive or a negative sign according to the traditional or commercial nature of the crops in the region.

Once Q_i^M / Q_i^T is estimated, both Q_i^M and Q_i^T can be obtained.

From the theoretical presentation we know that

$$(2) \quad Q_i^T = Q_i^M + I_i$$

From (1) we can write

$$(3) \quad Q_i^M = Q_i^T \cdot Q_i^M / Q_i^T, \text{ or}$$

$$(4) \quad Q_i^M = Q_i^M \cdot (Q_i^M / Q_i^T) + I_i \cdot (Q_i^M / Q_i^T)$$

Solving for Q_i^M,

$$(5) \quad (1 - Q_i^M / Q_i^T)\, Q_i^M = I_i \cdot Q_i^M / Q_i^T$$

Finally,

$$(6) \quad Q_i^M = I_i\, (Q_i^M / Q_i^T) / (1 - Q_i^M / Q_i^T)$$

Once (6) is obtained, it can be substituted in (2) and, after adding I_i, Q_i^T can also be obtained.

Adaptation of the Model

The model is adapted to specific circumstances in different regions. For example, when two crops are associated, Q_i^M / Q_i^T for both crops must be estimated. Price and quantity variables must be converted to weighted values to permit realistic comparisons and derive realistic conclusions. In the case of two or more associated crops the following weight is used: Let TR_i and TQ_i be total revenue and total quantity of crop i, respectively, and TR_j and TQ_j total revenue and total quantity of crop j associated with crop i in one region.

Then,

$\Sigma TR_i / \Sigma TQ_i = P_{wi}$, a weighted price for crop i in the region, and,

$\Sigma TR_j / \Sigma TQ_j = P_{wj}$, a weighted price for crop j in the region. Then Q_{ij}^M / Q_{ij}^T may be estimated as the sume of $P_{wi} \cdot [Q_i^M / Q_i^T]$ and

$P_{wj} \cdot [Q_j^M / Q_j^T]$, and Q_{ij}^M / Q_{ij}^T will have been given a value figure. In the case of price on the right-hand side of the equation, $(P_i \cdot Q_i^T + P_j \cdot Q_j^T) / (Q_i^M + Q_j^M) = P_{ij}$, a new enterprise price for an association.

Production and Distribution Activities

Description and quantification of production and distribution activities is illustrated in Figure 7. These activities are explained for every enterprise in the different regions of the country.

The figure contains amount (kgs) and cost (quetzales/kg) of the different inputs utilized in the production process and the different ways for disposing of total production. Since figures in each cell take into account the weight given to each questionnaire, they are intended to represent good approximations of totals in the region.

Data Used and Implications

Not all farms contained in the sample are used in each of the estimated equations. Q_i^M / Q_i^T picks up only those farmers selling some of their output; or in terms of the theoretical presentation, those producing more than OC in Figure 5. Furthermore, it seems that the sample failed to include a considerable number of these farmers, and, since the sample was intended for a small farm study, only very few of the large farmers were included. For those reasons, the estimates are conservative. Responses will therefore be stronger than shown in the results since both ends of the spectrum are not considered. In Chapter six, a special section is devoted to the discussion of the descriptive statistics of each independent variable, and generalizations and implications of the results.

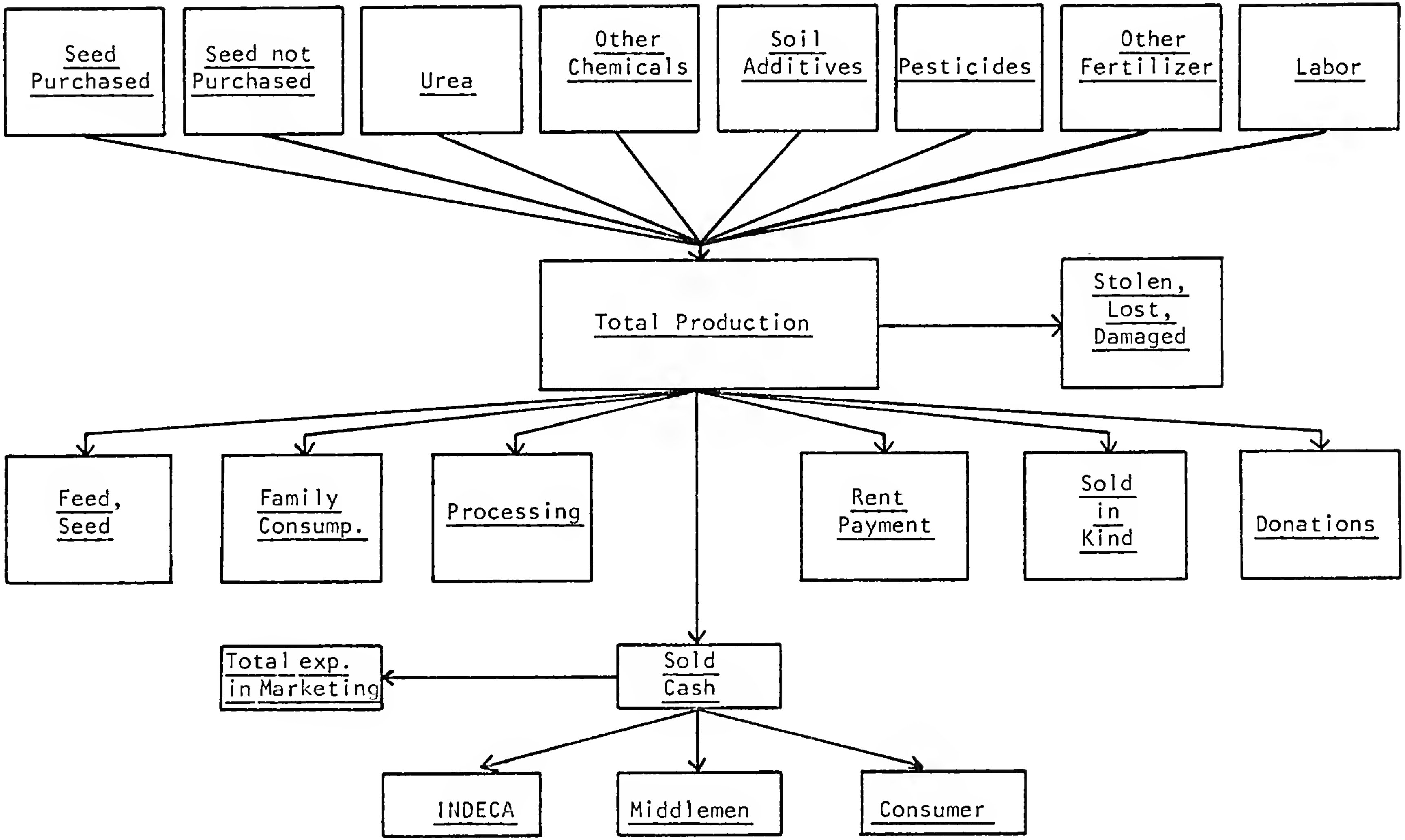

Figure 7.--Hypothetical production and distribution activities for basic grains produced in the different regions of Guatemala

The computations of the production and distribution activites do encompass all farmers in the sample size. For that reason, averages in the activities, especially total quantities produced, may not coincide with those in the estimated equations.

Summary

This chapter has described the theoretical framework which explains the Guatemalan small farmer's behavior within his basic economic system; a sytem in which his subsistence needs, the land constraint, and his income level are the most important variables. The production and distribution activities to be described and the equations to be estimated attempt to quantify that behavior by considering the variables that may be relevant to his decision making process. The degree of success achieved in quantifying that behavior is the subject matter of the following chapters.

CHAPTER IV

PRODUCTION AND DISTRIBUTION ACTIVITIES

Production and distribution activites for each basic grain or association produced in the different regions of Guatemala are described and quantified in this chapter. The description by crop, or association, follows the pattern of analysis utilized in Chapter five. Characteristics or each crop or association are identified for each region to facilitate interpretation of the results presented in the remainder of the dissertation.

The Input Market

Input use in basic grain production is presented in Table 8. After briefly defining each production activity, the description focuses on the relative importance of each activity across enterprises and regions (Table 9).

Seed Utilization

The activity of seed utilization relates to the total amount of seed purchased at planting time or stored from a previous harvest. Some differences in seed management across regions and crops are present. Of all the associated enterprises, corn-beans in R_5 and R_6

Table 8.--Total inputs used in basic grain production by regions of Guatemala

Input Activities	CROP[a]									
	C-B	C-B	C-B	C-S	C-B-S	C	C	C	C	C
	REGION									
	1	5	6	6	6	1	3	4	5	6
Seed:										
Amount not purchased	45,924	55,952	99,579	36,312	64,017	95,200	68,440	92,460	60,192	49,818
Amount purchased	18,286	5,670	84,582	21,720	33,712	1,773	3,470	92,460	42,127	25,599
Cost	5,248	2,010	24,753	5,875	9,306	288	755	38,350	13,493	9,672
Modern inputs:										
Amount urea	110,676	28,749	29,029	30,810	13,750	108,680	98,031	124,921	61,427	205,856
Cost	12,006	3,885	3,641	4,017	1,760	13,884	12,885	19,504	8,109	28,560
Amount soil additives	470	0	0	0	0	0	238	2,143	0	0
Cost	28	0	0	0	0	0	28	835	0	0
Amount other chemicals	280,973	30,647	414,700	176,698	157,420	667,818	157,860	594,336	309,582	450,368
Cost	33,300	3,724	47,900	21,794	18,760	81,480	19,746	68,973	40,278	58,032
Cost other fertilizers	38	78	809	0	0	720	73	1,824	475	22
Cost Pesticides	930	1,501	3,124	1,740	1,218	1,551	14,848	39,184	11,088	5,220
Labor:	106,808	38,664	193,697	127,981	109,844	247,679	213,988	446,472	206,346	183,638

Input Activities	CROP									
	B	B	B	B	S	R	R	R	W	W
	REGION									
	1	4	5	6	4	4	5	6	1	6
Seed:										
Amount not purchased	13,024	3,773	12,040	85,842	11,448	32,328	9,681	57,760	263,676	5,210

Table 8.--continued

Input Activities	B	B	B	B	S	R	R	R	W	W
	REGION									
	1	4	5	6	4	4	5	6	1	6
Seed:										
Amount purchased	2,256	19,728	7,520	39,804	13,692	34,896	34,204	43,605	311,922	51,048
Cost	805	7,200	1,755	13,423	3,416	8,027	8,262	11,088	50,998	9,552
Modern inputs:										
Amount urea	4,449	0	894	16,780	355	37,296	21,740	44,460	251,187	8,562
Cost	636	0	144	2,136	55	5,992	3,290	5,265	31,209	944
Amount soil additives	0	0	0	0	0	0	0	0	7,154	0
Cost	0	0	0	0	0	0	0	0	747	0
Amount other chemicals	54,993	7,856	13,508	237,363	29,310	63,468	13,572	196,940	1304,256	117,461
Cost	6,325	928	2,068	31,150	3,200	7,824	1,690	23,120	137,280	14,760
Cost other fertilizers	6	0	42	145	55	824	80	425	565	0
Cost pesticides	630	574	1,456	1,995	2,416	15,221	1,444	5,222	11,970	910
Labor:	16,872	21,080	25,944	109,020	108,664	65,760	55,977	83,810	247,044	26,125

[a] C,B,S,R, and W represent corn, beans, sorghum, rice, and wheat, respectively. Amounts are given in kgs., except labor which is given in man days; costs are given in quetzales.

Table 9.--Relative importance of inputs used in basic grain production by regions of Guatemala

Input Activities	C-B	C-B	C-B	C-S	C-B-S	C	C	C	C	C	B	B	B	B	S	R	R	R	W	W
REGION	1	5	6	6	6	1	3	4	5	6	1	4	5	6	4	4	5	6	1	6
Seed purchased:																				
Average use per hectare	12	14	26	13	19	27	11	17	20	18	67	67	56	53	14	46	66	104	148	131
Average cost per hectare	3	4	8	4	5	4	3	7	6	7	25	24	15	17	4	9	15	17	22	25
Percent of total seed used	28	9	46	37	35	2	5	50	41	34	15	84	38	32	55	52	78	43	54	91
Seed not purchased:																				
Average use per hectare	22	36	27	10	19	38	16	21	26	22	52	47	58	61	11	51	51	78	163	154
Percent of total seed used	72	91	54	63	65	98	95	50	59	66	85	16	62	68	45	48	22	57	46	9
Urea:																				
Average use per hectare	77	58	41	36	25	127	179	74	79	128	270	0	32	169	16	170	105	129	116	195
Average cost per heactare	9	8	4	5	2	16	23	11	11	17	43	0	5	23	3	26	15	16	14	22
Soil additives:																				
Average use per hectare	32	0	0	0	0	0	3	65	0	0	0	0	0	0	0	0	0	0	172	0
Average cost per hectare	2	0	0	0	0	0	3	6	0	0	0	0	0	0	0	0	0	0	12	0
Other chemicals:																				
Average cost per hectare	15	7	10	9	7	36	15	18	25	23	37	17	21	21	19	26	11	25	40	41

Column heading: CROP[a]

Table 9.--continued

Input Activities	C-B	C-B	C-B	C-S	C-B-S	C	C	C	C	C	B	B	B	B	S	R	R	R	W	W
REGION	1	5	6	6	6	1	3	4	5	6	1	4	5	6	4	4	5	6	1	6
Other fertilizers:																				
Average cost per hectare	1	1	7	0	0	11	2	2	16	4	1	0	3	5	2	11	1	2	3	0
Pesticides:																				
Average cost per hectare	4	3	2	1	1	4	4	6	8	6	12	6	13	7	5	15	4	6	4	7
Labor:																				
Average use per hectare	45	43	42	54	37	101	100	56	57	62	92	66	79	74	60	59	92	85	88	66

The header "CROP[a]" spans all crop columns.

[a]C, B, S, R, and W represent corn, beans, sorghum, rice, and wheat, respectively. Amounts (average use) are given in kgs., except labor which is given in man days per hectare, average costs are given in quetzales/kg./ha.

is the heaviest user of seed per hectare. Corn-beans in R_1 and R_5 is most dependent upon stored seed.

Land scarcity in R_1 calls forth more intensive production of corn and beans as single crops, evidenced by the highest application of seed per unit of land. This region also depends more on stored corn and bean seed than the remaining regions.

In rice production, average seed use per hectare is higher in R_6 than in R_5 and R_4 while R_5 depends more on purchased seed. The main difference found in wheat production is an almost complete dependence on seed purchased in R_6, as opposed to an even distribution in R_1, the latter being a more subsistence region that the former. Also, less wheat seed is used per hectare when it is purchased than when it has been stored.

In general, seed becomes linked to product sales, seed storage, and seed purchase decisions. Thus, variation does prevail in the percentage of total production retained to be used as animal feed and seed and that percentage of seed which is purchased (Table 10).

Urea Application

Average amounts and cost of urea per hectare suggest that usage of this input is fairly common. Although urea application appears for all crops, except for beans in R_4, some of the crops contain only a small number of observations; these crops are wheat in R_6, corn in R_3, beans and rice in all three regions, sorghum in R_4, and corn-beans-sorghum in R_6. For the remaining crops, no major differences in either average use or average cost of urea per hectare are found.

Table 10.--Seed purchase and sale proportions relative to total production and total seed use

CROP[a]	REGION 1		3		4		5		6	
	Percent									
	b	c	b	c	b	c	b	c	b	c
C-B	4.8	28.0	---	---	---	---	5.0	9.0	5.6	46.0
C-S	---	---	---	---	---	---	---	---	13.4	37.0
C-B-S	---	---	---	---	---	---	---	---	12.8	35.0
C	6.6	2.0	3.5	5.0	1.8	50.0	4.4	41.0	5.4	34.0
B	9.8	15.0	---	---	5.0	84.0	5.4	38.0	5.8	32.0
S	---	---	---	1.6	55.0	---	---	---	---	---
R	---	---	---	---	2.2	52.0	1.8	78.0	5.3	43.0
W	8.7	54.0	---	---	---	---	---	---	0.9	91.0

[a]C, B, S, R, and W represent corn, beans, sorghum, rice, and wheat, respectively.

[b]Feed and seed retained as a percent of total production.

[c]Seed purchased as a percent of total seed used.

Use levels do differ between associated crops and single crops where rates per hectare average 47.4 kgs and 119.3 kgs., respectively.

Soil Additives

This activity, with use limited to only four crops, contains amounts of calcium oxide and other soil correctives applied. The appearance of only three or less observations in every case signals the extremely limited use of this chemical input in basic grain production.

Other Chemicals

Application of chemical fertilizers other than urea is heavier than that for any single input as evidenced by the use of chemicals in all enterprises. Average costs per hectare are the highest in wheat production in both R_1 and R_6, and the lowest in all associations and in rice in R_5. The remaining crops utilize similar amounts per hectare. Again associated crops utilize only Q9.6 worth of chemical fertilizers per hectare compared with Q25 for single crop enterprises.

Other Fertilizers

This activity encompasses the utilization of other fertilizers, sprays, etc., which are recorded as an average cost per hectare. Very limited observations of use for each enterprise confirms the minor role of other fertilizers in basic grain production.

Pesticides

Under this activity, average cost per hectare of applying insecticides, herbicides, and other chemicals utilized in pest control are recorded. Although used on every enterprise, pesticide application is not very generalized among farmers. Average cost per hectare for pesticide use varies substantially but is particularly high at Q12 or more for rice in R_4 and beans in R_1 and R_5. Most enterprises and regions display pesticide costs at less than Q5 per hectare. Pesticide costs per hectare for single crops average Q7.1 compared to Q2.2 for associations.

Labor

Labor utilization encompasses all phases of agricultural activities, from soil preparation to harvesting and marketing the final product. Since it contemplates cash payments as well as family labor, the word jornal used in the questionnaire is assumed to mean man day. Except for the associations, where employment per hectare is very similar, all enterprises show different levels of employment by region.

In corn production, R_1 and R_3 employ more workers per hectare than R_4, R_5, and R_6. For beans, R_1 is the largest employer, while R_5 and R_6 use more labor per unit of land than R_4 in rice production. Wheat production requires more labor in R_1 than in R_6.

For all of the crops present, R_1 is the largest employer. Perhaps this is a result of the subsistence nature of the region. In general, however, associated crops utilize substantially less labor (44.2 man days per hectare) than do single crops (75.8).

The Product Market

Distribution of total basic grain production is presented in Table 11. Emphasis is given to the relative importance of the distribution activities and the major differences encountered across crops and regions (Table 12). A brief definition of each activity is also presented at the beginning of each sub-section.

Total Production

Average production per hectare, differing among enterprises, is very similar for each particular crop grown in different regions. Yield differences, of course, are correlated with the nature of the crop.

For the associations average production per unit of land is very similar across regions. However, when the same crops are grown alone, corn and sorghum exceed the association yield levels while bean yields fall below those of the associations.

Rice production shows no major differences in average production per hectare across regions. In wheat yields are somewhat higher in R_1 than in R_6 probably resulting from heavier chemical input usage.

Animal Feed and Seed

This item pertains to that part of total production set aside by the farmer to be used as seed in the future or as animal feed. The activity is a fairly generalized practice as evidenced by a large number of observations obtained in each crop, with the exception of wheat in R_6.

Table 11.--Distribution of total basic grain production by regions of Guatemala

Distribution Activities	C-B	C-B	C-B	C-S	C-B-S	C	C	C	C	C
	CROP[a]									
	REGION									
	1	5	6	6	6	1	3	4	5	6
Total Production	2,776,974	1,366,778	5,332,982	4,682,233	3,701,922	5,176,481	8,432,820	20,590,494	6,830,277	7,309,947
Feed, Seed	134,400 (4.8)	68,794 (5.0)	297,183 (5.6)	629,004 (13:4)	473,904 (12.8)	341,850 (6.6)	298,870 (3.5)	363.392 (1.8)	300,362 (4.4)	397,761 (5.4)
Family Consumption	898,562 (32.4)	238,606 (17.5)	1,425,747 (26.7)	1,046,061 (22.3)	723,168 (19.5)	2,550,702 (49.3)	900,144 (10.7)	2,422,728 (11.8)	1,382,814 (20.2)	1,838,688 (25.0)
Processing	0	0	0	0	0	0	0	0	0	14,284 (0.2)
Rent Payments	20,089 (0.7)	0	49,845 (1.0)	33,930 (0.7)	35,770 (1.0)	6,528 (0.1)	14,141 (0.2)	0	32,168 (0.5)	537,040 (7.6)
Sales "in kind"	0	2,922 (0.2)	99,300 (1.9)	105,710 (2.3)	99,300 (2.7)	26,296 (0.5)	115,182 (1.4)	3,578 (0.02)	16,920 (0.25)	90,228 (1.2)
Donations	16,192 (0.6)	27.090 (2.0)	11,970 (0.2)	1,500 (0.03)	1,820 (0.05)	12,470 (0.2)	4,240 (0.05)	18,984 (0.09)	55,330 (0.8)	4,820 (0.07)
Stolen, Damaged, Lost	37,750 (1.4)	73,984 (5.3)	15,656 (0.3)	14,920 (0.3)	0	50,193 (1.0)	29,705 (0.35)	97,860 (0.5)	27,183 (0.4)	45,432 (0.6)
Total Sold for Cash	1,669,981 (60.1)	955,202 (70.0)	3,433,281 (64.3)	2,851,108 (60.97)	2,367,960 (63.95)	2,188,442 (42.3)	7,070,538 (83.8)	17,638,952 (85.79)	5,015,500 (73.4)	4,361,694 (59.93)
Indeca	0	0	0	b	0	0	0	0	b	0
Middleman	b	b	b	b	2,367,960	b	b	b	b	b
Consumer	b	b	b	0	0	b	b	b	b	b
Total Expend. in Mkting.	8,352	9,063	13,344	9,560	8,616	11,025	8,555	54,285	19,488	12,192

Table 11.--continued

Distribution Activities	CROP[a]									
	B	B	B	B	S	R	R	R	W	W
	REGION									
	1	4	5	6	4	4	5	6	1	6
Total Production	173,800	271,040	320,809	1,788,263	2,751,904	2,379,488	1,380,544	2,496,655	4,967,966	448,722
Feed, Seed	16,962 (9.8)	13,596 (5.0)	17,024 (5.3)	103,008 (5.8)	44,760 (1.6)	52,948 (2.2)	25,083 (1.8)	132,768 (5.3)	430,650 (8.7)	3,927 (0.9)
Family Consumption	64,085 (37.0)	54,211 (20.0)	35,608 (17.3)	323,963 (18.0)	73,552 (2.7)	18,468 (0.8)	11,737 (0.85)	53,225 (2.1)	215,016 (4.3)	0
Processing	0	0	375 (0.12)	0	0	0	0	0	942 (0.02)	0
Rent Payments	0	717 (0.3)	0	58,208 (3.3)	0	0	0	89,246 (3.6)	0	0
Sales "in kind"	0	0	0	0	0	0	0	0	4,026 (0.08)	0
Donations	274 (0.16)	0	0	548 (0.03)	0	0	0	0	13,140 (0.27)	0
Stolen, Damaged, Lost	940 (0.54)	1,135 (0.4)	122 (0.04)	4,380 (0.25)	5,358 (0.2)	0	1,824 (0.13)	2,948 (0.1)	101,384 (2.0)	1,070 (0.2)
Total Sold for Cash	91,539 (52.5)	201,381 (74.3)	247,680 (77.24)	1,298,156 (72.62)	2,628,234 (95.5)	2,308,072 (97.0)	1,341,900 (97.22)	2,218,468 (88.9)	4,202,808 (84.63)	443,725 (98.9)
Indeca	0	0	0	b	0	0	b	0	b	b
Middleman	b	b	b	b	2,628,234	2,308,072	b	2,218,468	b	b
Consumer	b	b	b	b	0	0	b	0	b	b
Total Expend. in Mkting.	900	780	884	4,725	12,581	3,690	5,820	3,510	26,690	4,209

[a]C, B, S, R, and W represent corn, beans, sorghum, rice, and wheat, respectively. Amounts are given in kgs; marketing expenditures are given in quetzales. Figures in parentheses are percents of production going to that activitity.

[b]Impossible to determine due to the coding procedure used.

Table 12.--Relative importance of the distribution of total basic grain production by regions of Guatemala

Distribution Activities	CROP[a] C-B	C-B	C-B	C-S	C-B-S	C	C	C	C	C
REGION	1	5	6	6	6	1	3	4	5	6
Production (average kgs. per ha.)	1054	999	1007	1143	1000	1636	1737	1889	1575	1678
Product Disposition:										
Feed, seed (average kgs. per ha.)	64	50	76	183	134	124	143	89	113	132
Family consumption (average kgs per family)	1520	790	1269	1529	1370	1090	1579	1485	1156	1164
Processing (average kgs. per ha.)	0	0	0	0	0	0	0	0	0	1296
Rent payments (average kgs. per ha.)	592	0	232	221	172	927	208	0	872	1160
Sales "in kind" (average kgs. per ha.)	0	58	308	352	208	367	268	163	196	606
Donations (average kgs. per ha.)	34	64	80	14	7	168	25	61	533	76
Stolen, Damaged, Lost (average kgs. per ha.)	34	50	56	80	0	195	69	148	142	157
Cash sales (average kgs. per ha.)	685	791	639	697	637	1057	1425	1555	1297	1158
Marketing Expenditures: Average per kg.	.005	.01	.004	.003	.004	.005	.001	.003	.004	.003
Percent of price received by farmers in the region	3.9	7.1	2.2	2.8	2.7	8.3	1.2	2.8	3.9	2.7

Table 12.--continued

Distribution Activities	CROP B	B	B	B	S	R	R	R	W	W
	REGION 1	4	5	6	4	4	5	6	1	6
Production (average kgs. per ha.)	732	757	862	907	1380	1848	2040	1959	1442	1181
Product Disposition:										
Feed, seed (average kgs. per ha.)	79	59	70	75	116	80	80	132	174	179
Family consumption (average kgs. per ha.)	224	310	191	267	575	131	267	134	346	0
Processing (average kgs. per ha.)	0	0	161	0	0	0	0	0	62	0
Rent Payments (average kgs. per ha.)	0	65	0	472	0	0	0	1622	0	0
Sales "in kind" (average kgs. per ha.)	0	0	0	0	0	0	0	0	78	0
Donations (average kgs. per ha.)	129	0	0	29	0	0	0	0	92	0
Stolen, Damaged, Lost (average kgs. per ha.)	202	81	43	44	70	0	648	90	150	108
Cash Sales (average kgs. per ha.)	576	658	767	675	1451	1781	1966	1741	1205	1169
Marketing Expenditures: Average per kg.	.01	.004	.004	.004	.005	.002	.004	.002	.006	.01
Percent of price received by farmers in the region	3.7	1.2	1.7	1.5	4.6	1.2	4.2	10.2	3.7	6.1

[a]C, B, S, R, and W represent corn, beans, sorghum, rice, and wheat, respectively.

The average amount of rice production per hectare saved for seed and animal feed purposes shows some regional variation among enterprises. The corn-sorghum and corn-beans-sorghum associations of R_6 save more than twice the amount saved from corn-beans of R_1, R_5, and R_6. In corn production, R_4 saves the least for seed and feed purposes, while all regions keep a similar amount for bean production. Concerning rice, R_4 and R_5 save an identical amount, while that stored in R_6 is somewhat higher.

Family Consumption

The amount set aside at harvest time for the sole purpose of family consumption is contained in this activity. Average family consumption of basic grains, with the exceptions of wheat and rice, is relatively large and does not show major regional differences.

Average family consumption along with total production is lower in the corn-beans enterprise of R_5 than in the rest of the associations. In corn production, R_3 and R_4 show a somewhat higher consumption than R_1, R_5, and R_6, while in beans, R_1 and R_5 save less for future home consumption than R_4 and R_6.

Rice consumption is higher in R_5 and lower and nearly equal in R_4 and R_6. Wheat is not consumed in R_6 and very few observations appear in R_1.

Processing

Throughout Guatemala a very minor amount of basic grains is set aside at the farm level for processing. Only one observation, each in corn of R_6 and in beans of R_5, and two observations in wheat of R_1, appeared in the sample.

Rent Payments

The product distribution activity of rent payments includes not only payments made for the use of the land but also payments for equipment and house rentals. Although this practice is found throughout the country, the small number of observations in the sample leads one to believe that it is not a very common practice. Corn is, by far, the most important crop in this activity.

Sales "in Kind"

That part of production exchanged for goods and services other than cash or rent payments is included in this activity. Corn is again the crop most commonly used for this purpose. The small number of observations per crop again suggests that this is not a very generalized practice.

Donations

Included in donations is the amount of total production given to relatives and friends for which no renumeration was received. This practice is more common than rent payments and sales "in kind". Corn again is the crop most used for donations.

Total Losses

Production damaged, lost, or stolen after harvest appears in all crops with the exception of rice in R_4 and corn-beans-sorghum in R_6.

However, failure of interviewers to consistently record losses makes it difficult to assess the relative variation of losses among crops and by regions within crops.

Cash Sales

Sales for cash cover all production disposed of in exchange for currency. Variations depend on farm demand for production and consumption purposes.

Average sales per hectare, among the associations are higher in the corn-beans enterprise of R_5 than in the remaining associations. Being the basic subsistence cropping pattern, with high levels of home demand, associations present lower average sales than the rest of the crops. Corn sales are similar in all regions except for R_1 where they are somewhat lower. Average cash sales of beans per hectare do not present sharp variations, excluding a lower amount in R_1.

Rice sales are very close in R_4 and R_6 but somewhat higher in R_5. Average cash sales of wheat per hectare do not vary substantially between R_1 and R_6.

Marketing Expenditures

Expenses incurred by the farmer in marketing his products include the cost of containers (boxes, bags, etc.) and the cost of transporting the product, either by truck or animal, from his farm to the market. Although marketing expenditures per kilogram of product sold are generally one cent or less, differences are observed when these expenditures are expressed as a percentage of the average price received by the farmers in the region. Enterprise variation in marketing costs from greatest to least are wheat, rice, sorghum, corn, followed by the associations and, finally, beans. R_1 tends to experience the highest marketing costs followed by R_6 and R_5, while R_6 displays the greatest amount of variation ranging from 1.5 percent for beans to 10.2 percent for rice (Table 13).

Summary

Production and distribution activities of basic grains reveal major differences among crops and regions. Some of these findings are used in the analyses and implications in the chapters to follow.

Production of basic grains from the input standpoint is most influenced by seed and fertilizer costs. While fertilizer tends to be universally utilized, but at different levels depending upon crops and regions, soil additives and pesticides are used to a minor degree. Seed becomes closely linked to product sales, seed storage, and seed purchase decisions.

Corn, rice, and wheat are the crops employing more workers per hectare, followed by beans and the associations. Except for the associations, where employment per unit of land is very similar, all enterprises show different levels of employment by region.

Total production also presents differences among crops relative to yields and product distribution. Average production per hectare is very similar for each crop grown in different regions. However, when the crops of the associations are grown alone, yield rises above the average for the associations for corn and sorghum while bean yields are below those of the associations.

Table 13.--Marketing expenditures as a percent of average price received by enterprises and regions

CROP[a]	REGION 1	3	4	5	6
	----------------------	----------Percent----------	----------------------		
C-B	3.9	---	---	7.1	2.2
C-S	---	---	---	---	2.8
C-B-S	---	---	---	---	2.7
C	8.3	1.2	2.8	3.9	2.7
B	3.7	---	1.2	1.7	1.5
S	---	---	4.6	---	---
R	---	---	1.2	4.2	10.2
W	3.7	---	---	---	6.1

[a]C, B, S, R, and W, represent corn, beans, sorghum, rice, and wheat, respectively.

Average family consumption, excluding wheat and rice, is relatively large and does not show major regional differences. Production set aside for processing, sales "in kind", and donations are rarely present with corn being the most important crop used for these activities.

Variations found in cash distribution category depend on farm demand for production and consumption purposes. For example, being the basic subsistence enterprises, the associations present high levels of home demand and, therefore, lower average sales than the rest of the crops. Expenditures per kilogram of product marketed are generally one cent or less but, when expressed as a percentage of the average regional price, from highest to lowest, the ranking is wheat, rice, sorghum, corn, the associations, and beans.

CHAPTER V

TRADITIONAL AND COMMERCIAL FARM SUPPLY RESPONSE

To explain and analyze the results obtained from the empirical model is the objective of this chapter. Regression coefficients are interpreted, the computed elasticities are explained, and income, farm size, and price-quantity relationships are discussed for each basic grain or association grown in each region of Guatemala. A summary of the results at the end of the chapter serves an an introduction for the discussion of the implications in the following chapter.

Associations

The corn-beans association is found in R_1, R_5, and R_6, while the corn-sorghum and the corn-beans-sorghum associations are only present in R_6. The regression coefficients obtained for each of these associations (Table 14 and Table 15), the income, farm size, and price elasticities (Table 16 to Table 18), and the income, farm size, and price-quantity relationships (Figure 8 to Figure 10) strongly support the conceptual model by illustrating the typical behavior of traditional enterprises.

Table 14.--Regression coefficients for each basic grain or association by regions of Guatemala[a]

Region	Crop	Constant	P_i	E_i	A_i	D_i	I_i	W_i	Y_i	d.f.	R^2
1	C-B	0.27392	-0.00524[f] (0.00419)	0.00482[f] (0.00541)	-0.08943[b] (0.01974)	0.00024 (0.00040)	-0.00001[b] (0)	0.00144[d] (0.00099)	-10.61613[b] (4.25824)	55	.33
5	C-B	0.28718	-0.00415[g] (0.00500)	0.00364 (0.01175)	-0.05829[f] (0.05218)	0.00126[d] (0.00093)	-0.00001[f] (0.00001)	0 (0)	-6.04527 (9.61876)	26	.02
6	C-B	0.34978	-0.00388 (0.00642)	0.00647[d] (0.00481)	-0.08192[d] (0.05403)	-0.00049 (0.00082)	-0.00003[b] (0.00001)	-0.00412 (0.00753)	-16.55984[b] (7.64936)	37	.44
6	C-S	0.19378	-0.00112 (0.00267)	0.00540[g] (0.00665)	-0.05217[f] (0.05855)	-0.00074[f] (0.00076)	-0.00001[b] (0)	0.01147[b] (0.00428)	- 7.57932[f] (7.34657)	30	.34
6	C-B-S	0.51144	-0.01083[g] (0.01299)	0.00509 (0.01283)	-0.36586[c] (0.14030)	-0.00335[f] (0.00326)	-0.00002[c] (0.00001)	-0.02748 (0.05376)	20.90172[d] (14.82739)	8	.50
1	C	0.44802	0.02884[b] (0.01312)	0.01116 (0.01686)	-0.14456[c] (0.07254)	0.00176[d] (0.00113)	-0.00011[b] (0.00003)	0.00129[f] (0.00148)	-20.41058[b] (7.41719)	78	.28
3	C	1.03937	-0.00049 (0.00162)	0.00699 (0.01321)	-0.37019[b] (0.13443)	0.00019 (0.00092)	-0.00006[b] (0.00001)	-0.05028[b] (0.01877)	-105.81248[b] (16.74541)	43	.70
4	C	1.01516	-0.00193 (0.00502)	-0.00305 (0.01266)	-0.20645[b] (0.07638)	0.00035 (0.00063)	-0.00007[b] (0.00001)	0.01868[b] (0.00524)	- 75.78100[b] (8.82157)	200	.44
5	C	0.76560	0.00881[b] (0.00380)	0.01286[b] (0.00528)	-0.08178[c] (0.04451)	-0.00129[d] (0.00099)	-0.00008[b] (0.00001)	-0.00029 (0.00126)	- 39.90728[b] (4.50239)	242	.38
6	C	0.46929	0.02270[b] (0.00897)	0.01256[f] (0.01301)	-0.00962 (0.7740)	-0.00052 (0.00171)	-0.00001[f] (0.00001)	0.00352[c] (0.00178)	- 32.85251[b] (9.40590)	133	.12
1	B	0.33231	0.07544[b] (0.02915)	-0.02071[g] (0.02981)	0.31937[b] (0.11896)	0.00010 (0.00139)	-0.00004 (0.00006)	-0.00071 (0.00367)	- 16.94399[b] (5.60921)	13	.48
5	B	0.76875	0.00532[g] (0.00665)	0.00880 (0.02105)	-0.02692[c] (0.01234)	-0.00188[g] (0.00261)	-0.00013[f] (0.00012)	0.00014 (0.00151)	- 11.58908[d] (8.50285)	55	.01

Table 14.--continued

Region	Crop	Constant	P_i	E_i	A_i	D_i	I_i	W_i	Y_i	d.f.	R^2
6	B	0.63009	0.03663[b] (0.01099)	0.01075[f] (0.01149)	0.09483[d] (0.06430)	0.00046 (0.00082)	-0.00020[b] (0.00003)	-0.00067[b] (0.00026)	-32.08327[b] (7.48973)	116	.34
4	S	1.04221	0.00095 (0.00953)	-0.01663[f] (0.01608)	0.03633 (0.06260)	0.00087[f] (0.00069)	-0.00015[b] (0.00004)	0.00807[b] (0.00320)	-27.06131[d] (16.50459)	34	.40
4	R	0.94006	0.00730[b] (0.00238)	0.00957[c] (0.00542)	0.01260 (0.02230)	-0.00049[c] (0.00027)	-0.00012[b] (0.00003)	0.00669[b] (0.00147)	- 7.14182[d] (5.18718)	44	.45
5	R	0.98878	0.00063[g] (0.00090)	0.00077 (0.00227)	-0.12806[d] (0.07980)	0.00017 (0.00037)	-0.00004[b] (0.00001)	-0.00032 (0.00218)	-10.63218[b] (4.37460)	42	.23
6	R	0.88339	-0.00581 (0.01153)	0.01630[f] (0.01713)	-0.02060 (0.19699)	0.00520[g] (0.00678)	-0.00004[b] (0.00001)	0.00172[g] (0.00223)	-76.41856[c] (31.31350)	20	.46
1	W	0.92030	-0.00893[f] (0.00871)	0.01989[b] (0.00509)	-0.03073[c] (0.01631)	0.00019 (0.00049)	-0.00020[b] (0.00002)	0.01076[c] (0.00648)	- 3.37986[b] (0.96901)	196	.37
6	W	1.02771	-0.00331[d] (0.00225)	-0.00206[f] (0.00188)	-0.02066[f] (0.01798)	-0.00012 (0.00028)	-0.00031[b] (0.00001)	-0.01455[c] (0.00580)	0.01958 (0.92662)	17	.96

[a]Figures in parentheses are standard errors. C, B, S, R, and W represent corn, beans, sorghum, rice, and wheat, respectively.

[b]Significant at the 99 percent level.

[c]Significant at the 95 percent level.

[d]Significant at the 90 percent level.

[e]Significant at the 80 percent level.

[f]Significant at the 60 percent level.

[g]Significant at the 50 percent level.

Table 15.--Sign and significance level of the regression coefficients for each basic grain or association by regions of Guatemala

Region	Crop[a]	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
1	C-B	-.60	+.60	-.99	+.00	-.99	+.90	-.99
5	C-B	-.50	+.00	-.60	+.90	-.60	+.00	-.00
6	C-B	-.00	+.90	-.90	+.00	-.99	-.00	-.99
6	C-S	-.00	+.50	-.60	-.60	-.99	-.99	-.60
6	C-B-S	-.50	+.00	-.95	-.60	-.95	-.00	+.90
1	C	+.99	+.00	-.95	+.90	-.99	+.60	-.99
3	C	-.00	+.00	-.99	+.00	-.99	-.99	-.99
4	C	-.00	-.00	-.99	+.00	-.99	+.99	-.99
5	C	+.99	+.99	-.95	-.90	-.99	-.00	-.99
6	C	+.99	+.60	-.00	-.00	-.60	+.95	-.99
1	B	+.99	-.50	+.99	+.00	-.00	-.00	-.99
5	B	+.50	+.00	-.95	-.50	-.60	+.00	-.90
6	B	+.99	+.60	+.90	+.00	-.99	-.99	-.99
4	S	+.00	-.60	+.00	+.60	-.99	+.99	-.90
4	R	+.99	+.95	+.00	-.95	-.99	+.99	-.90
5	R	+.50	+.00	-.90	+.00	-.99	-.00	-.99
6	R	-.00	+.60	-.00	+.50	-.99	+.50	-.95
1	W	-.60	+.99	-.95	+.00	-.99	+.95	-.99
6	W	-.90	-.60	-.60	-.00	-.99	-.95	+.00

[a]C, B, S, R, and W represent corn, beans, sorghum, rice, and wheat, respectively.

Table 16.--Income elasticities of market supply for each basic grain or association by regions of Guatemala

Income[b]	CROP[a]									
	C-B	C-B	C-B	C-S	C-B-S	C	C	C	C	C
	REGION									
	1	5	6	6	6	1	3	4	5	6
50	12.56720	5.89896	22.43350	16.71250	16.71130	6.08591	49.41400	34.97740	12.03280	10.25430
100	3.14180	1.47468	5.60810	4.17796	4.17770	1.52148	12.35350	8.74437	3.00820	2.56353
150	1.39636	0.65525	2.49230	1.85663	1.85669	0.67621	5.49045	3.88633	1.33694	1.13936
200	0.78545	0.36861	1.40209	1.04453	1.04446	0.38037	3.08837	2.18609	0.75205	0.64089
400	0.19636	0.09197	0.35052	0.26113	0.26112	0.09509	0.77209	0.54652	0.18801	0.16022
600	0.08727	0.04074	0.15579	0.11606	0.11605	0.04226	0.34315	0.24290	0.08356	0.07121
800	0.04909	0.02293	0.08763	0.06528	0.06528	0.02377	0.19302	0.13663	0.04700	0.04006
1000	0.03142	0.01464	0.05608	0.04178	0.04178	0.01522	0.12354	0.08744	0.03008	0.02564
1200	0.02182	0.01000	0.03895	0.02902	0.02901	0.01057	0.08579	0.06073	0.02089	0.01780
1400	0.01603	0.00732	0.02861	0.02132	0.02132	0.00776	0.06303	0.04461	0.01535	0.01308
1600	0.01227	0.00561	0.02191	0.01632	0.01632	0.00594	0.04826	0.03416	0.01175	0.01001
1800	0.00970	0.00439	0.01731	0.01290	0.01290	0.00470	0.03813	0.02699	0.00929	0.00791
2000	0.00786	0.00366	0.01402	0.01045	0.01045	0.00380	0.03088	0.02186	0.00752	0.00641
2200	0.00649	0.00293	0.01159	0.00863	0.00863	0.00314	0.02552	0.01807	0.00622	0.00530
2400	0.00546	0.00244	0.00974	0.00725	0.00725	0.00264	0.02145	0.01518	0.00522	0.00445

Income[b]	CROP[a]								
	B	B	B	S	R	R	R	W	W
	REGION								
	1	5	6	4	4	5	6	1	6
50	2.88532	2.86616	9.69734	12.96830	3.31305	2.95055	44.35290	0.11281	0.00360
100	0.72133	0.71654	2.42432	3.24206	0.82826	0.68178	11.08822	0.02820	0.00087
150	0.32055	0.31842	1.07746	1.44084	0.36809	0.30300	4.92803	0.01253	0.00037

Table 16.--continued

Income[b]	CROP[a] B	B	B	S	R	R	R	W	W
	REGION 1	5	6	4	4	5	6	1	6
200	0.18033	0.17914	0.60608	0.81052	0.20707	0.18441	2.77205	0.00705	0.00022
400	0.04508	0.04478	0.15152	0.20263	0.05177	0.04610	0.69301	0.00176	0.00006
600	0.02004	0.01990	0.06734	0.09006	0.02301	0.02049	0.30801	0.00078	0.00003
800	0.01127	0.01112	0.03788	0.05066	0.01294	0.01153	0.17325	0.00044	0.00001
1000	0.00721	0.00717	0.02424	0.03242	0.00828	0.00738	0.11088	0.00028	0.00000
1200	0.00501	0.00498	0.01684	0.02551	0.00575	0.00512	0.07700	0.00020	0.00000
1400	0.00368	0.00366	0.01237	0.01654	0.00423	0.00376	0.05658	0.00014	0.00000
1600	0.00282	0.00280	0.00947	0.01266	0.00324	0.00288	0.04331	0.00011	0.00000
1800	0.00223	0.00221	0.00748	0.01001	0.00256	0.00228	0.03422	0.00009	0.00000
2000	0.00180	0.00179	0.00606	0.00811	0.00207	0.00184	0.02772	0.00007	0.00000
2200	0.00149	0.00148	0.00501	0.00670	0.00171	0.00152	0.02291	0.00006	0.00000
2400	0.00125	0.00124	0.00421	0.00563	0.00144	0.00128	0.01925	0.00005	0.00000

[a]C, B, S, R, and W represent corn, beans, sorghum, rice, and wheat, respectively.

[b]In quetzales per year.

Table 17.--Area elasticities of market supply for each basic grain or association by regions of Guatemala

Area[b]	C-B	C-B	C-B	C-S	C-B-S	C	C	C	C	C
	REGION									
	1	5	6	6	6	1	3	4	5	6
0.25	26.6378	11.5033	20.1198	37.2782	82.7982	11.7845	51.5516	23.2446	6.6568	0.9286
0.50	6.6595	2.8758	5.0300	9.3195	20.6995	2.9461	12.8879	5.8111	1.6642	0.2321
0.75	2.9598	1.2781	2.2354	4.1420	9.1998	1.3094	5.7280	2.5827	0.7396	0.1032
1.00	1.6649	0.7190	1.2575	2.3299	5.1749	0.7365	3.2220	1.4528	0.4161	0.0580
1.25	1.0655	0.4601	0.8048	1.4911	3.3119	0.4714	2.0621	0.9298	0.2663	0.0371
1.50	0.7399	0.3195	0.5589	1.0355	2.3000	0.3274	1.4320	0.6457	0.1849	0.0258
1.75	0.5436	0.2348	0.4106	0.7608	1.6898	0.2405	0.0521	0.4744	0.1359	0.0190
2.00	0.4162	0.1797	0.3144	0.5825	0.2937	0.1841	0.8055	0.3632	0.1040	0.0145
2.25	0.3289	0.1420	0.2484	0.4602	1.0222	0.1455	0.6364	0.2870	0.0822	0.0115
2.50	0.2664	0.1150	0.2012	0.3728	0.8280	0.1179	0.5155	0.2325	0.0666	0.0093
2.75	0.2202	0.0951	0.1663	0.3081	0.6843	0.0974	0.4261	0.1921	0.0550	0.0077
3.00	0.1850	0.0799	0.1397	0.2589	0.5750	0.0818	0.3580	0.1614	0.0462	0.0065
3.25	0.1576	0.0681	0.1191	0.2206	0.4900	0.0697	0.3050	0.1375	0.0394	0.0055
3.50	0.1359	0.0587	0.1027	0.1902	0.4224	0.0601	0.2630	0.1186	0.0340	0.0047
3.75	0.1184	0.0511	0.0894	0.1657	0.3680	0.0524	0.2291	0.1033	0.0296	0.0041
4.00	0.1041	0.0449	0.0786	0.1456	0.3234	0.0460	0.2014	0.0908	0.0260	0.0036

CROP[a]

Area[b]	B	B	B	S	R	R	R	W	W
	REGION								
	1	5	6	4	4	5	6	1	6
0.25	21.0788	1.0243	8.3482	3.5793	1.2037	18.6695	2.7164	1.0725	1.5142
0.50	5.2696	0.2561	2.0871	0.8948	0.3009	4.6674	0.6791	0.2681	0.3786
0.75	2.3421	0.1138	0.9276	0.3997	0.1338	2.0744	0.3018	0.1192	0.1683

Table 17.--continued

Area[b]	CROP[a] B	B	B	S	R	R	R	W	W
	REGION 1	5	6	4	4	5	6	1	6
1.00	1.3174	0.0640	0.5218	0.2237	0.0752	1.1669	0.1698	0.0670	0.0946
1.25	0.8432	0.0410	0.3339	0.1432	0.0482	0.7468	0.1087	0.0429	0.0606
1.50	0.5885	0.0285	0.2319	0.0994	0.0334	0.5186	0.0755	0.0298	0.0421
1.75	0.4302	0.0209	0.1704	0.0731	0.0246	0.3810	0.0554	0.0219	0.0309
2.00	0.3294	0.0160	0.1304	0.0559	0.0188	0.2917	0.0424	0.0168	0.0237
2.25	0.2602	0.0127	0.1031	0.0442	0.0149	0.2305	0.0335	0.0132	0.0187
2.50	0.2108	0.0102	0.0835	0.0358	0.0120	0.1867	0.0272	0.0107	0.0151
2.75	0.1742	0.0085	0.0690	0.0296	0.0099	0.1543	0.0225	0.0089	0.0125
3.00	0.1464	0.0071	0.0580	0.0249	0.0084	0.1297	0.0189	0.0075	0.0105
3.25	0.1247	0.0061	0.0494	0.0212	0.0071	0.1105	0.0161	0.0064	0.0090
3.50	0.1076	0.0052	0.0426	0.0183	0.0061	0.0953	0.0139	0.0055	0.0077
3.75	0.0937	0.0046	0.0371	0.0159	0.0054	0.0830	0.0121	0.0048	0.0067
4.00	0.0823	0.0040	0.0326	0.0140	0.0047	0.0729	0.0106	0.0042	0.0059

[a]C, B, S, R, and W represent corn, beans, sorghum, rice, and wheat, respectively.

[b]In hectares.

Table 18.--Price elasticities of market supply for each basic grain or association by regions of Guatemala

Price[b]	C-B	C-B	C-B	C-S	C-B-S	C	C	C	C	C
	1	5	6	6	6	1	3	4	5	6
0.03	4.1456	2.5377	2.9683	0.9518	5.2576	8.0228	0.0652	0.3143	1.4617	4.5938
0.06	1.0364	0.6344	0.7421	0.2380	1.3144	2.0057	0.0163	0.0786	0.3654	0.1484
0.09	0.4606	0.2820	0.3298	0.1058	0.5842	0.8914	0.0073	0.0349	0.1624	0.5104
0.12	0.2591	0.1586	0.1855	0.0595	0.3286	0.5014	0.0041	0.0196	0.0914	0.2871
0.15	0.1658	0.1015	0.1187	0.0381	0.2103	0.3209	0.0026	0.0126	0.0585	0.1838
0.18	0.1152	0.0705	0.0825	0.0264	0.1460	0.2229	0.0018	0.0087	0.0406	0.1276
0.21	0.0846	0.0518	0.0606	0.0194	0.1073	0.1637	0.0013	0.0064	0.0298	0.0938
0.24	0.0648	0.0397	0.0464	0.0149	0.0822	0.1254	0.0010	0.0049	0.0228	0.0718
0.27	0.0512	0.0313	0.0367	0.0118	0.0649	0.0991	0.0008	0.0039	0.0181	0.0567
0.30	0.0415	0.0254	0.0297	0.0095	0.0526	0.0802	0.0007	0.0031	0.0146	0.0459
0.33	0.0343	0.0210	0.0245	0.0079	0.0435	0.0663	0.0005	0.0026	0.0121	0.0380
0.36	0.0289	0.0176	0.0206	0.0066	0.0365	0.0557	0.0005	0.0022	0.0102	0.0319
0.39	0.0245	0.0150	0.0176	0.0056	0.0311	0.0475	0.0004	0.0019	0.0087	0.0272
0.42	0.0212	0.0130	0.0151	0.0049	0.0268	0.0409	0.0003	0.0016	0.0075	0.0234

CROP[a] / REGION

Price[b]	B	B	B	S	R	R	R	W	W
	1	5	6	4	4	5	6	1	6
0.03	38.2024	1.8852	15.3889	0.1224	1.3742	0.0693	1.4777	1.9397	0.6075
0.06	9.5506	0.4713	3.8472	0.0306	0.3435	0.0173	0.3694	0.4849	0.1519
0.09	4.2447	0.2095	1.7099	0.0136	0.1527	0.0077	0.1642	0.2155	0.0675
0.12	2.3877	0.1178	0.9618	0.0077	0.0859	0.0043	0.0924	0.1212	0.0380

Table 18.--continued

Price[b]	CROP[a] B	B	B	S	R	R	R	W	W
	REGION 1	5	6	4	4	5	6	1	6
0.15	1.5281	0.0754	0.6156	0.0049	0.0550	0.0028	0.0591	0.0776	0.0243
0.18	1.0612	0.0524	0.4275	0.0034	0.0382	0.0019	0.0411	0.0539	0.0169
0.21	0.7796	0.0385	0.3141	0.0025	0.0280	0.0014	0.0302	0.0396	0.0124
0.24	0.5969	0.0295	0.2405	0.0019	0.0215	0.0011	0.0231	0.0303	0.0095
0.27	0.4716	0.0233	0.1900	0.0015	0.0170	0.0009	0.0182	0.0240	0.0075
0.30	0.3820	0.0189	0.1539	0.0012	0.0137	0.0007	0.0148	0.0194	0.0061
0.33	0.3157	0.0156	0.1272	0.0010	0.0114	0.0006	0.0122	0.0160	0.0050
0.36	0.2653	0.0131	0.1069	0.0009	0.0095	0.0005	0.0103	0.0135	0.0042
0.39	0.2261	0.0112	0.0911	0.0007	0.0081	0.0004	0.0087	0.0115	0.0036
0.42	0.1949	0.0096	0.0785	0.0006	0.0070	0.0004	0.0075	0.0099	0.0031

[a]C, B, S, R, and W, represent corn, beans, sorghum, rice, and wheat, respectively.

[b]In quetzales per kilogram.

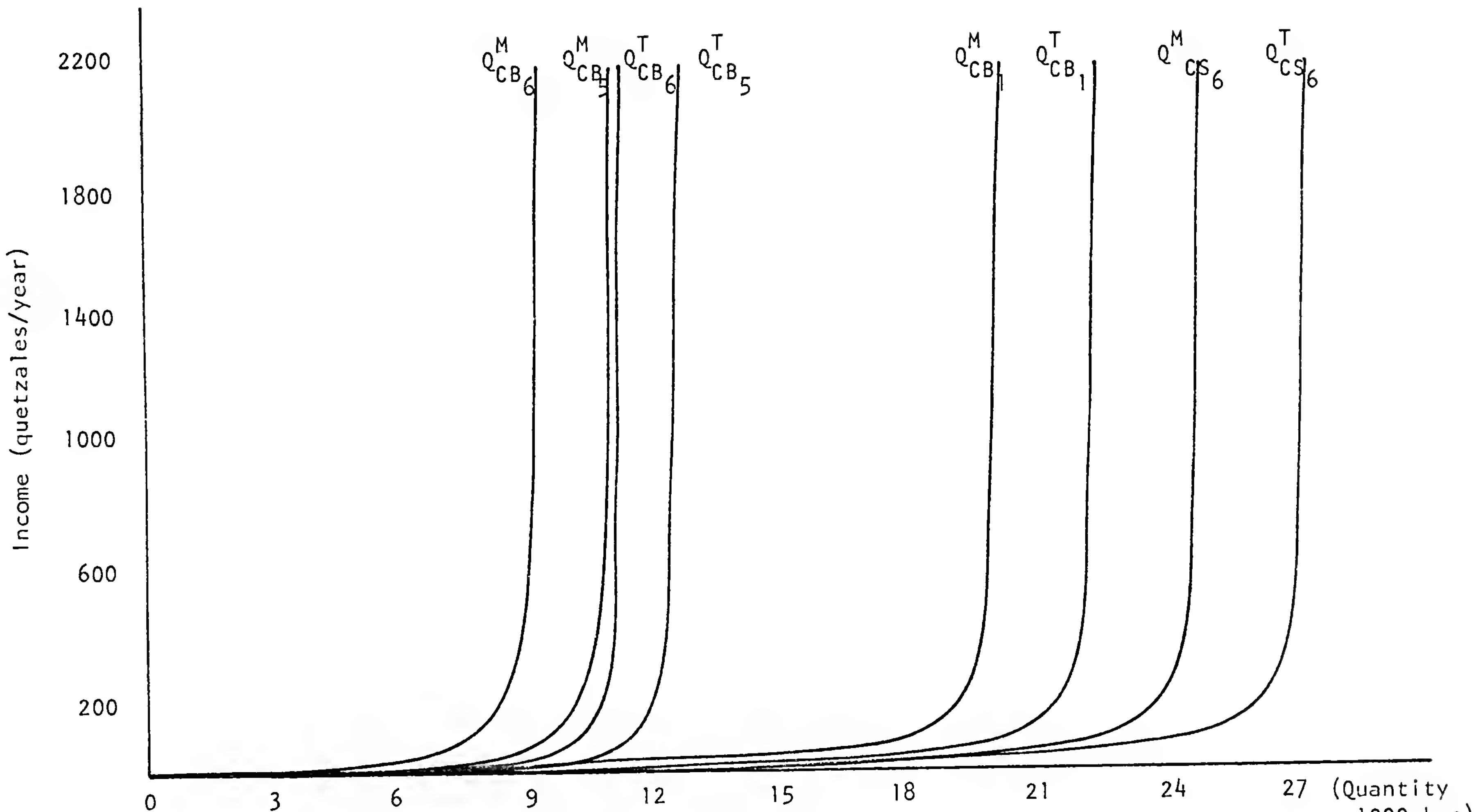

Figure 8.--Income-quantity relationships for the associations by regions of Guatemala

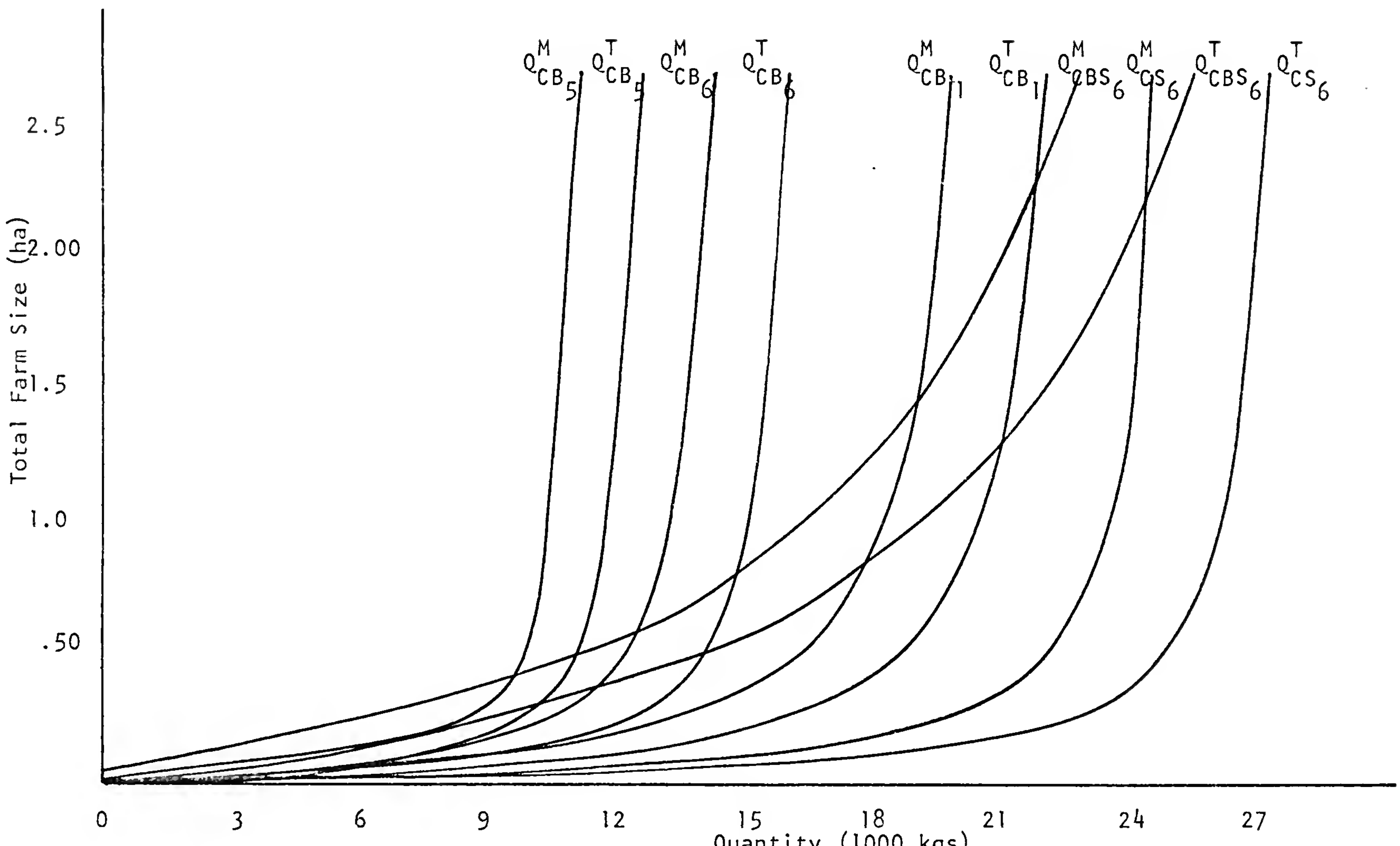

Figure 9.--Farm size-quantity relationships for the associations by regions of Guatemala

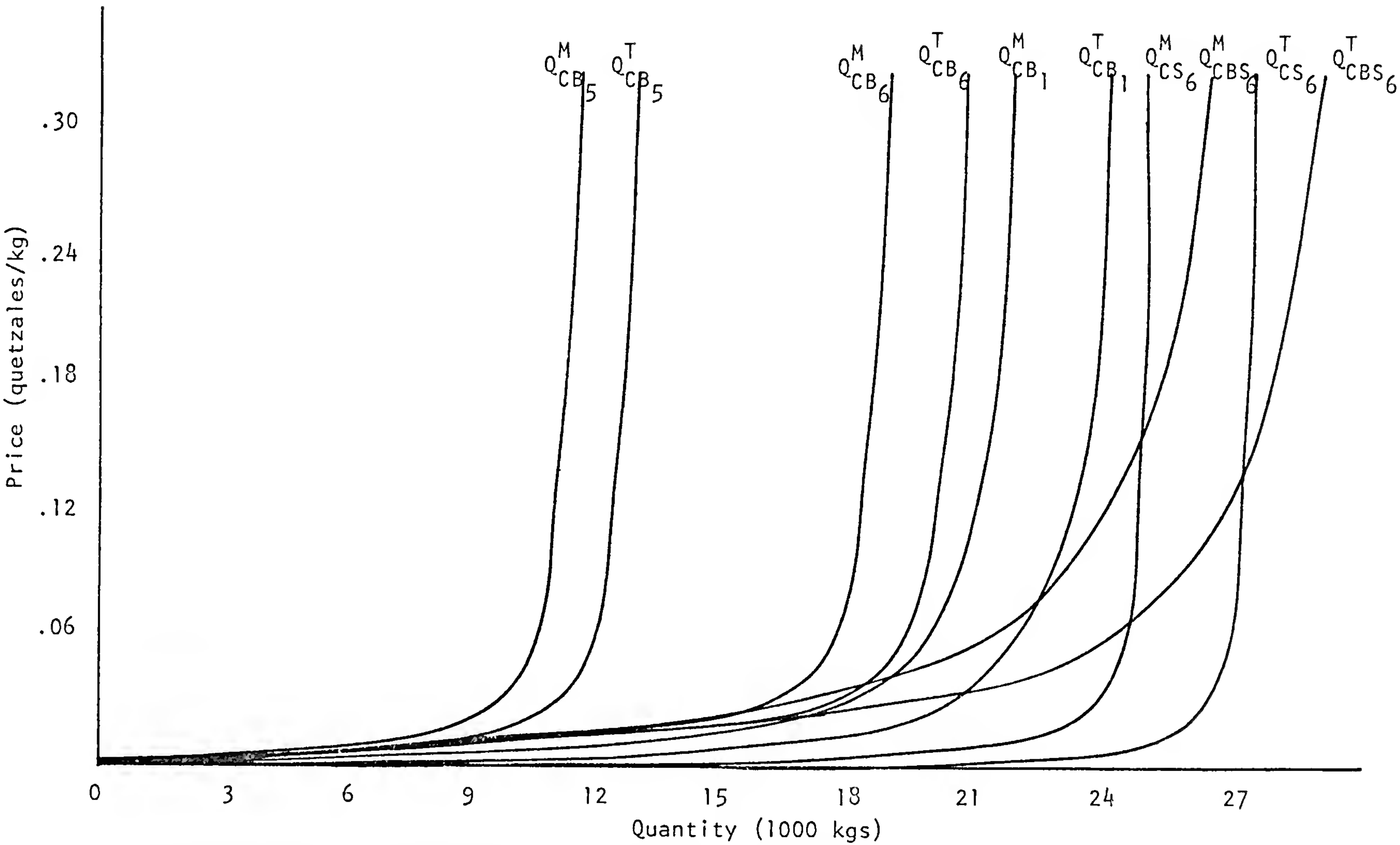

Figure 10.--Price-quantity relationships for the assocations by regions of Guatemala

Regression Coefficients

The regression coefficients of the five equations empirically tested for the associations, behave in general as hypothesized. Total family income (Y_i), except for corn-sorghum in R_6 and for corn-beans in R_5, presents high levels of statistical significance. Total farm size (A_i) is less significant for corn-beans in R_5 and corn-sorghum in R_6 than for the remaining associations. Quantity demanded on the farm (I_i) shows marginal statistical significance for corn-beans in R_5 and high significance for the remaining enterprises. Price (P_i), as expected for traditional crops, appears with the lowest level to no statistical significance.

Due to the reciprocal nature of the specification, the negative sign for total family income (Y_i), farm size (A_i) and price (P_i) signals the presence of a direct relationship between each of these variables and the dependent variable. Only total income in the corn-beans-sorghum equation of R_6 has an unexpected sign. Of the three associations in R_6, corn-beans-sorghum seems to be the most traditional, which may explain the unexpected sign. Surplus in this case may be in fact inversely related to total income because higher-income farmers do not cultivate this association.

The three remaining variables, education (E_i), distance to the nearest market (D_i), and the relative profitability ratio (W_i) provide minor contributions to the model. All education coefficients are positive; it is expected that as the level of education increases farmers become more involved in the activities of the monetary economy and, as a result, market more of their output. Levels of statistical significance for education, when present, are very low except for corn-beans in R_6.

Distance to the market (D_i) presents no statistical significance in the corn-beans equations of R_1 and R_6, minor levels of significance in the corn-sorghum and corn-bean-sorghum equations of R_6, and a high level of statistical significance in the corn-beans equation of R_5. Distance coefficients alternate with positive and negative signs. Although a negative sign is expected, it is possible that the numerous middlemen arriving with their trucks several times a month at different places in rural Guatemala tend to eliminate a negative relationship between surplus and distance. Distance in the data used for this research, however, was defined as the distance to the place where the family most commonly buys and sells, which may or may not refer to the place where they sell the specific grain.

In the relative profitability ratio (W_i), high levels of statistical significance are found in the corn-beans equation of R_1 and in the corn-sorghum equation of R_6, and none in the remaining equations. A positive sign for the corn-beans association in both R_1 and R_5 is expected. Since corn-beans is the basic subsistence cropping pattern in R_1 and R_5 with only one commercial crop in the numerator of the ratio for each region, the ratio and the surplus should move in the same direction. Wheat and rice, respectively, are the commercial crops in R_1 and R_5. In R_6 three associations with both commercial and traditional crops in the numerator of the ratio provide confusing results evidenced by a positive sign for corn-sorghum and negative signs for (W_i) in the remaining two associations.

Income-Quantity Relationships

As expected, the income elasticities of market supply indicate that all of the associations are quite responsive at very low levels of income (Table 16). The responsiveness, however, decreases sharply as income rises, which is an easily explained phenomenon. Farmers at subsistence experiencing an income increase devote new resources to production and react by marketing the newly created surplus. At higher income levels, however, responsiveness tends to decrease abruptly for traditional crops and once the home use requirement is met, commercial crops enter the production system. Figure 8 illustrates that process and corroborates the conceptual model by displaying the same pattern of behavior for all the associations in the different regions of the country. That is, their appearance at almost zero income, their elastic portions at low income levels, and their almost vertical shapes at higher levels of income, are characteristics that were hypothesized in chapter three for those crops belonging in the traditional category.

Farm Size-Quantity Relationships

Farm size elasticities (Table 17) and farm size-quantity relationships (Figure 9) for the associations parallel the income elasticities and income-quantity relationships except for the corn-beans-sorghum enterprise in R_6. In the case of farm size elasticities, as hypothesized, responsiveness is more accentuated for traditional crops than for commercial crops at low levels of farm size. The corn-beans-sorghum association of R_6 presents an elastic portion up to 2.25 hectares, a level much higher than the remaining enterprises, perhaps due to the importance of sorghum as part of the human diet in R_6. The vertical nature of the functions beyond low levels of farm size, further corroborates the traditional presentation of chapter three.

Price-Quantity Relationships

Associated enterprises, being the traditional subsistence cropping pattern, present very little price responsiveness (Table 18 and Figure 10). All associations show a higher response at low price levels than at higher prices and this finding is most accentuated in R_6 with corn-beans-sorghum. No available surplus at the end of the season when prices are high may contribute to this result as illustrated in Figure 5 (A) where Q^T shifts to the left during the marketing period.

Corn

In terms of acreage, corn is the most important basic grain in Guatemalan agriculture. Besdies appearing in all associations, corn is cultivated as a single crop in all regions of the country. The dual character of this enterprise, being both traditional and commercial, is shown by the regression coefficients (Table 14 and Table 15), and the income, farm size, and price elasticities of market supply (Table 16 to Table 18). The income-quantity (Figure 11), farm size-quantity (Figure 12), and price-quantity relationships (Figure 13) uphold the former finding and support the basic theory of chapter three.

Regression Coefficients

Total income,total farm size, and quantity demanded on the farm carry the expected signs in all of the corn equations. Except for farm size in R_6 and for quantity demanded on the farm, all of the coefficients present high levels of statistical significance. The price variable, however, displays the highest levels of significance in R_1, R_5, and R_6 but also unexpected signs. The opposite occurs in R_3 and R_4 where price carries the expected sign along with no statistical significance.

Education shows the expected positive sign in all corn producing regions with the exception of R_4 but marginal significance in R_6 and the highest level of statistical significance in R_5. Distance to the market is only significant in R_1 and R_5 but carry opposite signs, possibly for the same reasons as given for the associations. The relative profitability ratio shows no significance in R_5, low in R_1, and high levels of statistical signifiance in the remaining three regions. The signs of the ratio vary according to the traditional or commercial nature of the crop and to the nature of the remaining crops grown in the region. In R_1 corn is traditional and in R_4 both traditional and commercial, both having basically only commercial crops in the numerator of the ratio. Given these characteristics it is anticipated that the ratio and the dependent variable move in the same direction because self-sufficiency is not secured. Corn, being both traditional and commercial in R_3 and basically the only crop in the region (only a few observations of commercial crops are in the numerator) carries a negative sign possibly signaling that farmers, as

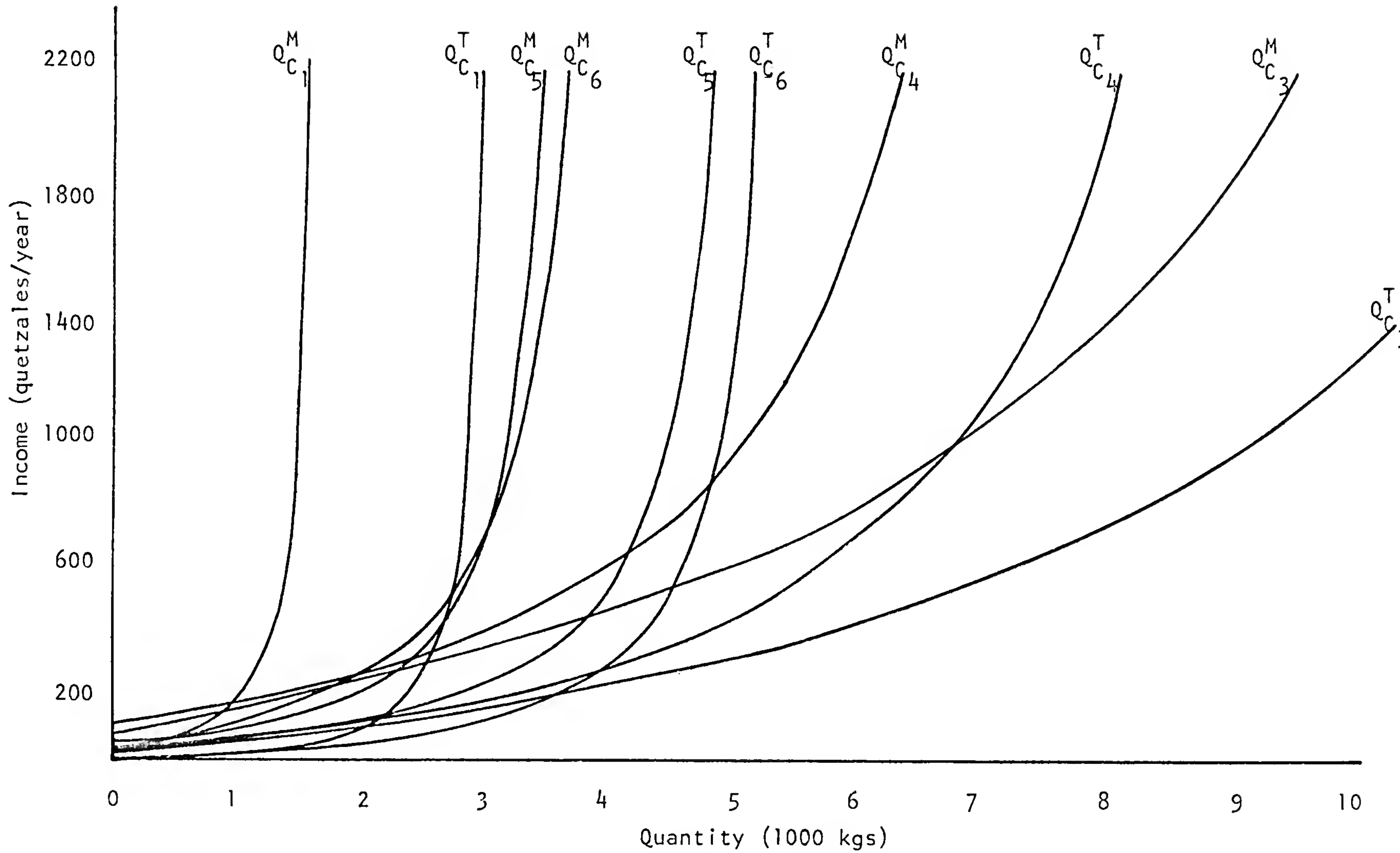

Figure 11.--Income-quantity relationships for corn by regions of Guatemala

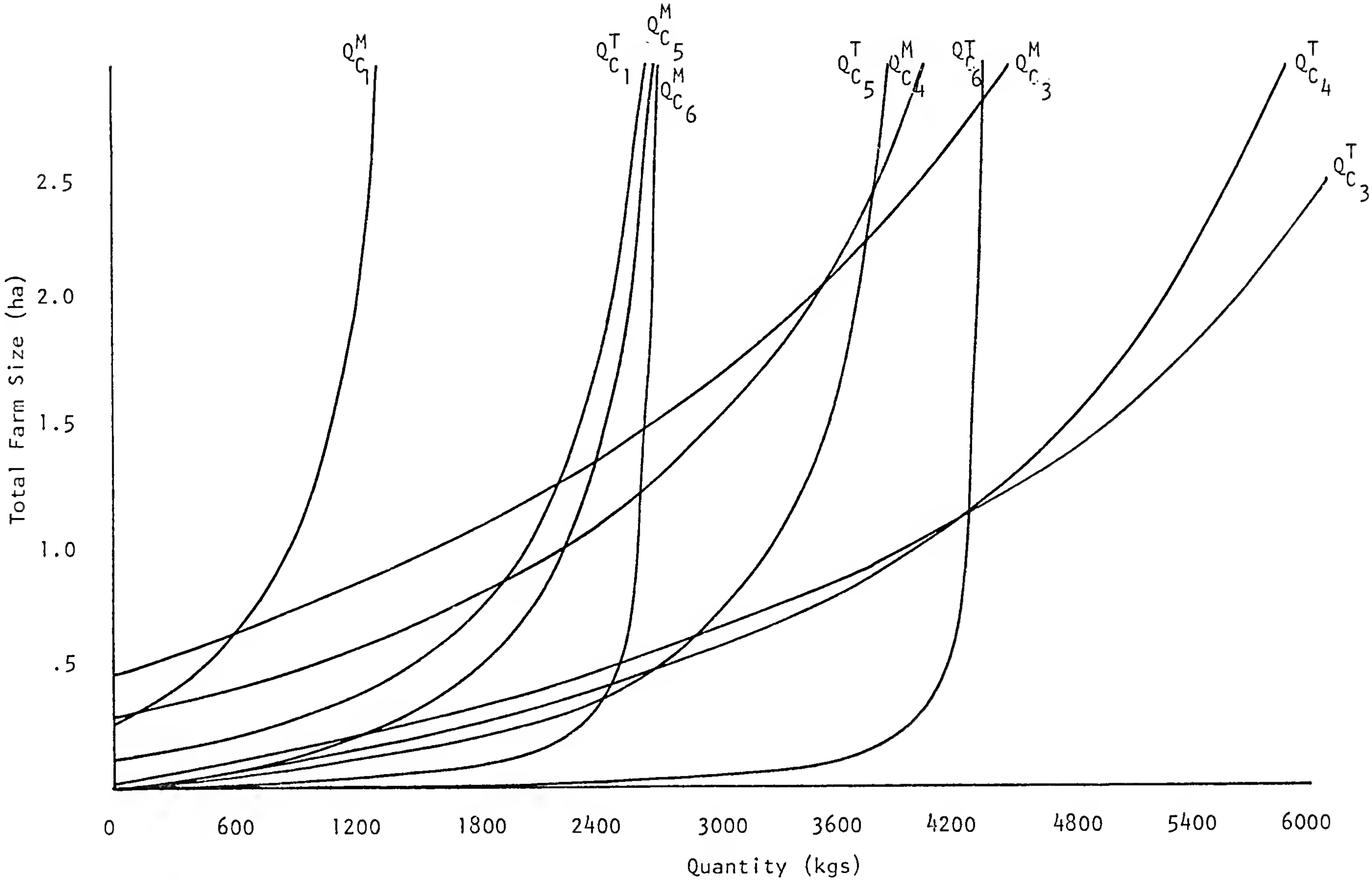

Figure 12.--Farm size-quantity relationships for corn by regions of Guatemala

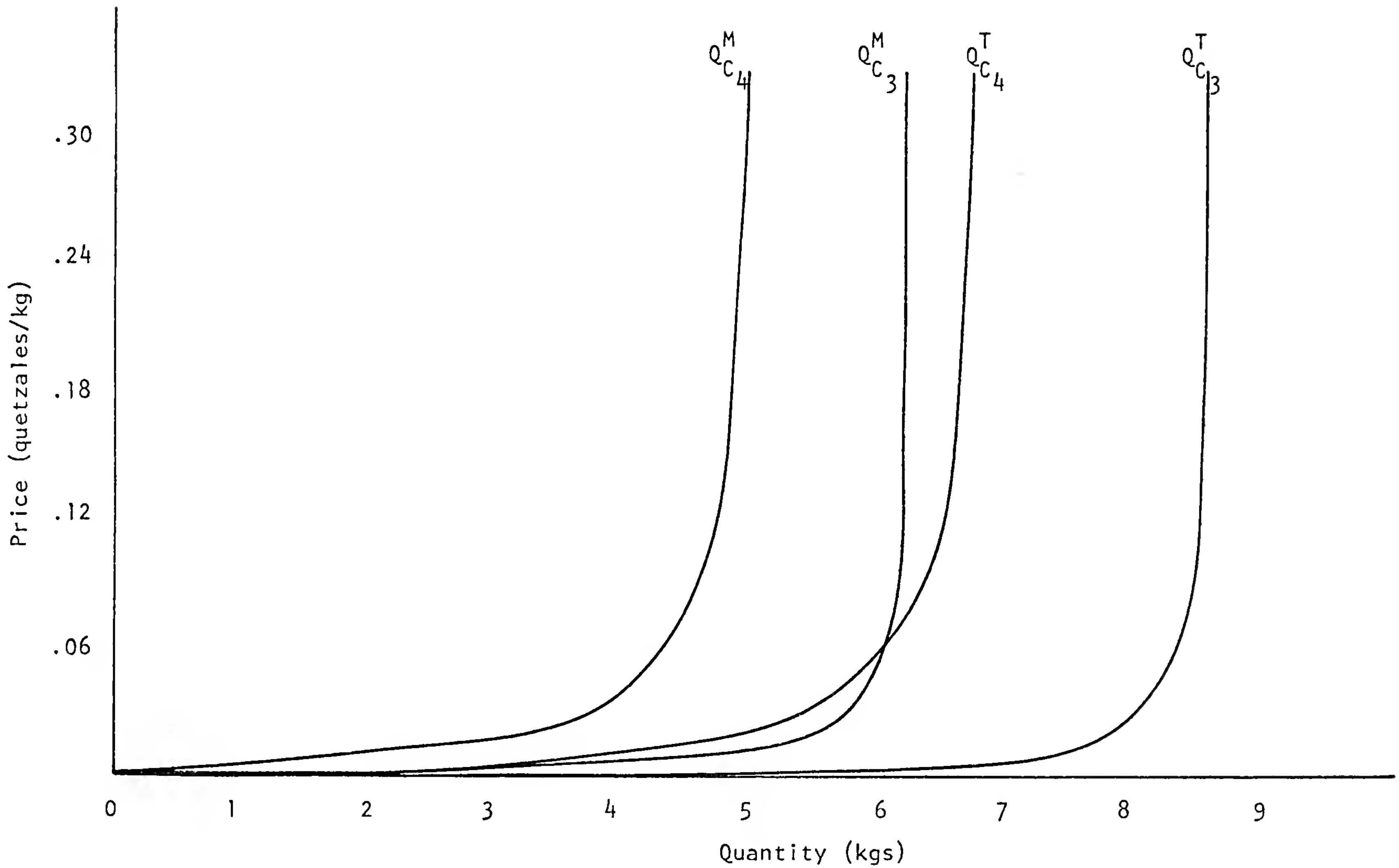

Figure 13.--Price-quantity relationships for corn by regions of Guatemala

self-sufficiency is secured, decrease corn marketing and shift into more profitable crops. In R_5, both commercial and traditional crops appear in the numerator; for that reason, an inverse relationship is present. Finally, R_6 presents an unexpected sign compared to R_5 where the crop has the very similar characteristics.

Income-Quantity Relationships

The income elasticities (Table 16) and the income-quantity relationships illustrated in Figure 11 reveal the traditional nature of corn in R_1, R_5, and R_6, and an accentuated tendency toward commercialization in R_3 and R_4. At very low income levels, corn is quite income responsive. The responsiveness tends to decrease more rapidly in R_1, R_5, and R_6 as a result of the traditional nature of the crop in these regions. In R_3 and R_4 though becoming inelastic beyond the Q200 per year level, corn still shows some responsiveness at higher income levels. This responsiveness may be due to the diversity of chemical input usage, a situation only possible at high income levels, as identified in the production and distribution activities in chapter four. Furthermore, the fact that commercial sales (Q_i^M) begin around the Q150 income level denotes the subsistence character of this crop in these two regions at very low income levels.

The dual role of corn in R_3 and R_4 is corroborated by a higher level of home use relative to the other regions. In these two regions, corn is cultivated as a single crop only, as opposed to the other regions where it also appears in all of the basic grain associations.

Farm-Size Quantity Relationships

Findings from the farm size elasticities (Table 17) and the farm size-surplus relationships (Figure 12) closely parallel those of income. R_3 and R_4 again display the traditional and commercial nature of corn.

R_1, R_5, and R_6 grow corn mainly for subsistence. At low levels of farm size, all crops are highly responsive, with the responsiveness decreasing faster in R_1, R_5, and R_6 than in R_3 and R_4. The vertical shape of the functions in the former three regions means that subsistence may be secured and, since the crop is not commercialized, production and marketing decrease.

The subsistence character of corn in R_3 is given by its production at near zero farm size but sales of corn commence beyond the 0.45 hectare size. The same reasoning applies to R_4, where production takes place at almost zero farm size but marketing occurs only when farm size exceeds 0.25 hectare. These findings closely parallel the theoretical presentation of chapter three.

Price-Quantity Relationships

Though price elasticities for all regions are computed (Table 18), only price-quantity relationships for R_3 and R_4 are graphed (Figure 13) because unexpected signs appear in the remaining regions. In R_3 and R_4, corn is minimally price responsive despite its commercial nature. Being less responsive in R_3 than in R_4 may result from prices being relatively lower than expected as evidenced by the heavy dependence on stored seed (95 percent of total seed used). Low prices may induce farmers to withhold more production than anticipated.

The unexpected price sign for corn in R_1, R_5, and R_6 can be explained with the conceptual model of chapter three. Available output decreases throughout the marketing period as prices increase. Near to the asymptotic section of the price-income-consumption (PIC) path, higher prices may have resulted in decreasing quantities marketed, thereby leading to the indirect relationships observed between price and the surplus-output ratio.

Beans

Beans are cultivated as single crops in R_1, R_5, and R_6, where they also appear associated with other basic grains. This crop shows the behavior of a traditional enterprise, as given by the regression coefficients (Table 14 and Table 15), the income, farm size, and price elasticities (Table 16 to Table 18), and the income-quantity relationships (Figure 14).

Regression Coefficients

All income coefficients in the three bean equations present the expected negative sign and high levels of statistical significance. Regression coefficients for the total farm size variable are also significant at high levels but present the expected sign only in R_5. Unexpected signs in R_1 and R_6 may be the result of omissions committed at the time of data collection, as has been recognized by AID officials (see chapter six), when interviews failed to specify some crops that were interplanted. Quantity demanded on the farm shows the expected sign in all equations, with a high level of statistical significance in R_6, less significance in R_5 and none in R_1. The price variable, showing different levels of statistical significance, carries unexpected signs in all three equations.

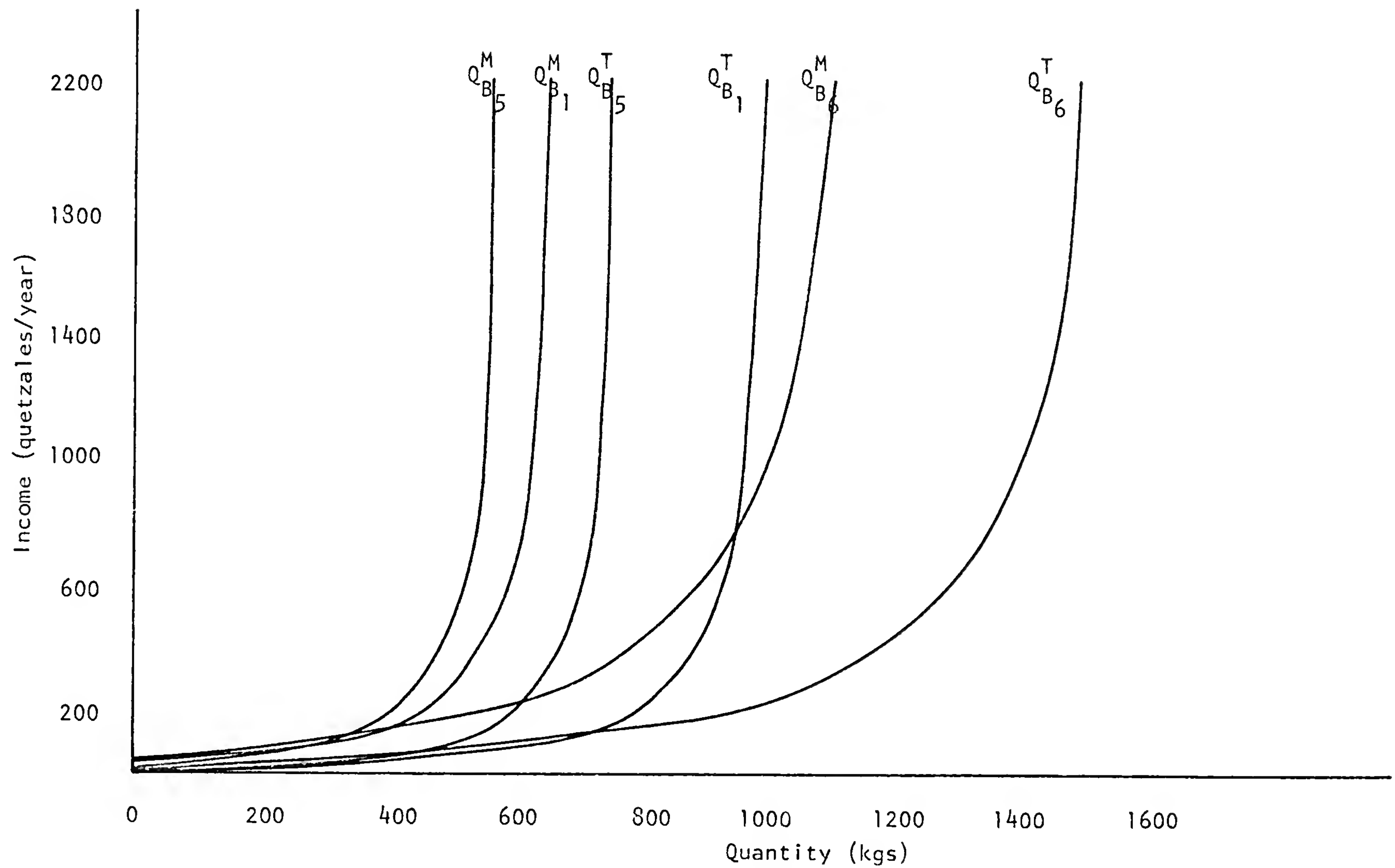

Figure 14.--Income-quantity relationships for beans by regions of Guatemala

Education carries an unexpected sign in R_1, low levels of statistical significance in R_1 and R_6 and none in R_5. Distance being barely statistically significant in R_5, carries an unexpected positive sign in R_1 and R_6, possibly due to the role of truckers and middlemen explained in the discussion of the associations.

The relative profitability ratio is only statistically significant in R_6 and expected negative signs are present in R_1 and R_6. Since beans are traditional crops and both traditional and commercial crops appear in the numerator, an inverse relationship between the ratio and the dependent variable is correct. For the same reasons, the positive sign in R_5 can be regarded as unexpected.

Income-Quantity Relationships

The income elasticities (Table 16) and the income-quantity relationships (Figure 14) for beans show the traditional character of this enterprise. Beans present some income responsiveness at very low income levels, but as income increases the functions become almost perfectly inelastic as in R_1 and R_5 above the Q50 level, and in R_6 above the Q150 level.

Farm Size-Quantity Relationships

No farm size-quantity relationships are depicted for beans since comparisons are not possible because only one correct sign is present. Farm size elasticities for R_5 illustrate very little responsiveness (Table 17). Unitary elasticity is found at the 0.25 hectare farm size level and thereafter, elasticities decrease sharply. At that point, other crops may enter the production system.

Price-Quantity Relationships

Price elasticities of market supply (Table 18) for beans are discussed without a graphical presentation because the price signs are negative in all three equations. The unexpected price sign can be explained as in the case of corn. A wide price range for beans prices, possessing the highest prices of all basic grains in the sample, strongly corroborates the reasoning behind the conceptual model. Increasing prices during the marketing period up to the asymptotic section of the PIC path may have resulted in marketed output reductions.

Sorghum

Sorghum is only grown as a single crop in R_4. Regression coefficients (Table 14 and Table 15) and income, farm size, and price elasticities of market supply (Table 16 to Table 18) reveal a traditional crop with some degree of commercialization. Income, farm size, and price relationships are not depicted since no comparisons are possible.

Regression Coefficients

Total family income and quantity demanded on the farm conform to expectations regarding sign and level of statistical significance. Total farm size and price present neither the expected sign nor a level of significance. Education and distance, with minor statistical significance, carry unexpected signs. The relative profitability ratio presents the highest level of significance relative to the other variables in the sorghum equation and the correct sign; since sorghum is both a traditional and a commercial crop, with other crops of both types in the numerator, a direct relationship is expected.

Income-Quantity Relationships

Income elasticities (Table 16) reveal that sorghum is a very income responsive crop at low income levels, with the responsiveness decreasing as income increases. Since sorghum in this region is mostly sold to livestock feed processors, becoming a highly commercial crop, the elastic portion of the curves, located at very low levels of income, may reveal that farmers with low income levels are the main suppliers.

Farm Size-Quantity Relationships

The total farm size coefficient presents an unexpected sign, a condition possibly related to the income responsiveness situation. If farmers at low income levels are the main suppliers to feed processors in the region, it is natural that, as the size of the farm and income increase, there is a tendency to reduce production thereby providing a basis for the indirect relationship between farm size and market supply.

Price-Quantity Relationships

The likely presence of traditional and commercial farmers in the sample may have produced the unexpected price sign. The limited number of observations for low quantities at high price levels might have caused the discrepancy by making the function slope in the opposite direction.

Rice

This basic grain is cultivated mainly in R_4, R_5, and R_6. The regression coefficients (Table 14 and Table 15), the income, farm size, and price elasticities of market supply (Table 16 to Table 18), and the income-quantity (Figure 15) and farm size-quantity relationships (Figure 16) give strong support to the conceptual model of traditional and commercial supply response. In the case of rice, the land constraint plays an important role in shaping the appropriate characteristics for the crop.

Regression Coefficients

All coefficients of total family income and quantity of rice demanded on the farm present the expected sign and high levels of statistical significance. Total farm size shows the expected sign in R_5 and R_6, and is statistically significant only in R_5. The price coefficient is statistically significant in R_4 and R_5, with unexpected signs, and is not significant in R_6 where it carries the expected sign.

Education shows the expected positive sign in all three equations but is not statistically significant in R_5. Distance to the market for rice producers carries positive signs in R_5 and R_6 and a negative sign in R_4 while statistical significance varies from none in R_5 and low in R_6 to high in R_4.

The relative profitability ratio for rice shows more statistical significance in R_4 than in R_6 and none in R_5. Positive signs in R_4 and R_6 are expected. Since this is a commercial crop with subsistence crops in the numerator of the ratio, a direct relationship is normal.

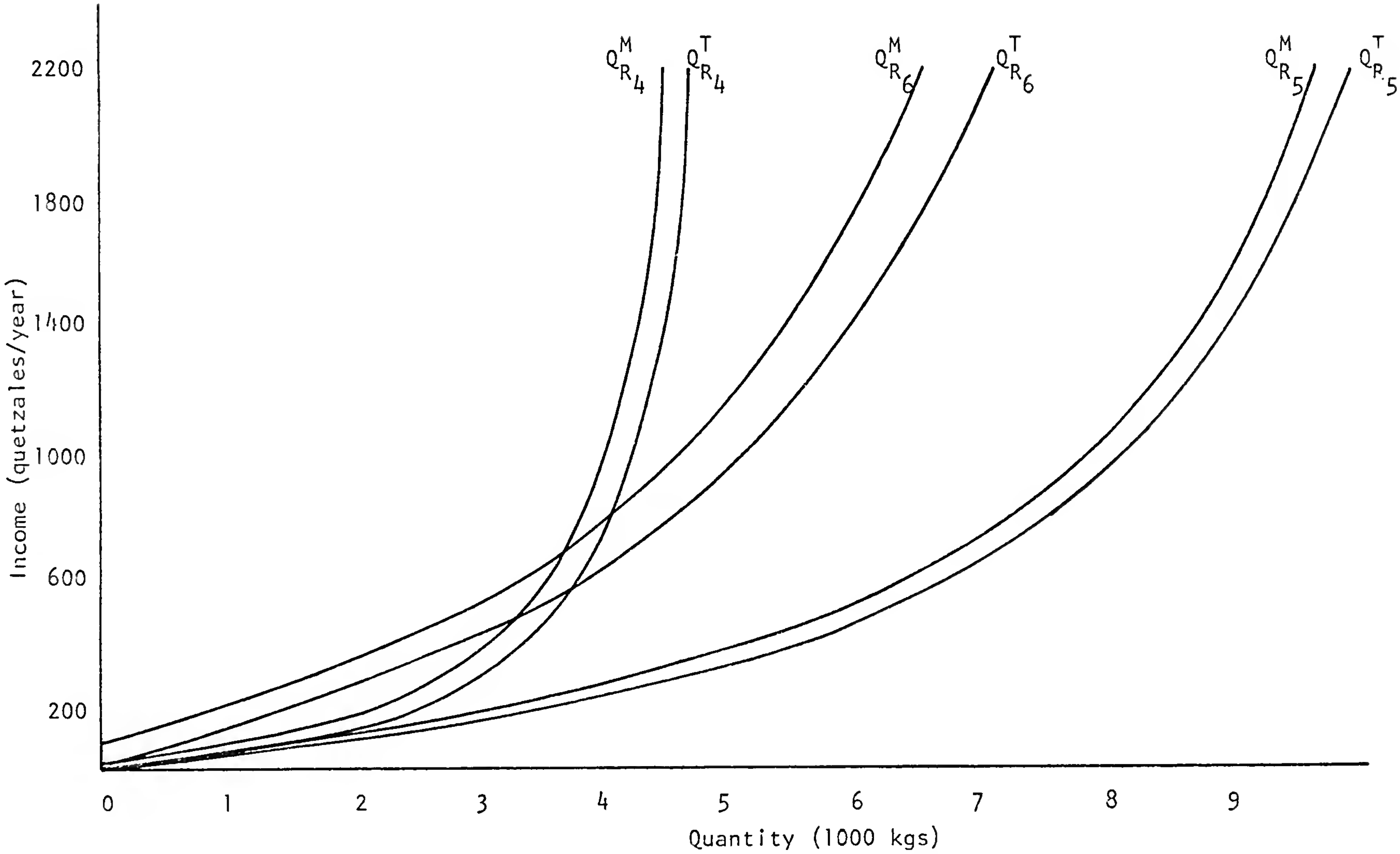

Figure 15.--Income-quantity relationships for rice by regions of Guatemala

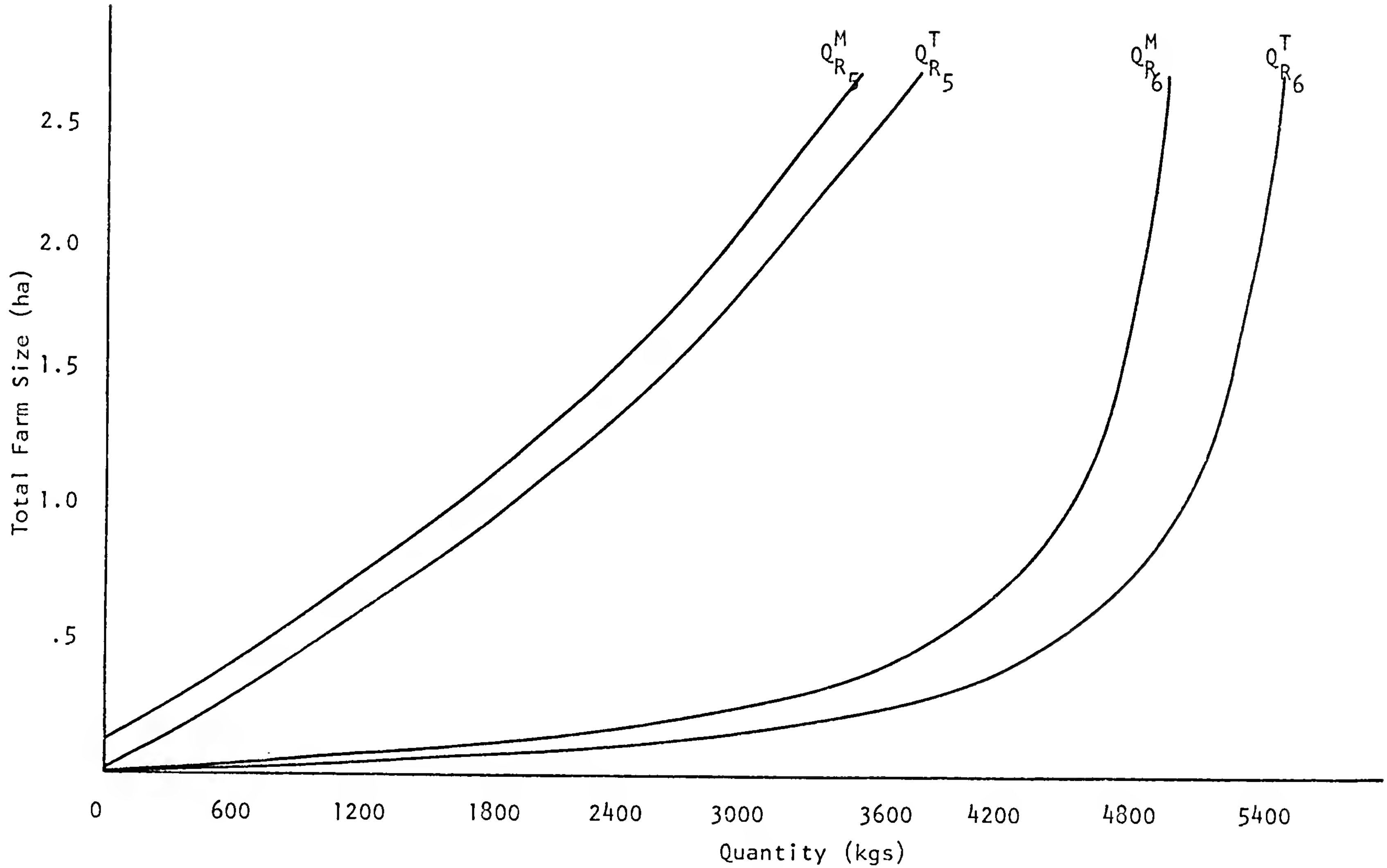

Figure 16.--Farm size-quantity relationships for rice by regions of Guatemala

With self-sufficiency secured, farmers can move into commercial-crop production. Having the same characteristics in R_5, the ratio presents a negative and unexpected sign.

Income-Quantity Relationships

Appearing when basic income levels have been attained, rice shows some income repsonsiveness at low income levels with the response decreasing less rapidly than for traditional crops. This behavior is substantiated by the income elasticities of market supply (Table 16) and the income-quantity relationships (Figure 15). The former characteristics follow exactly the description of commercial crops in the conceptual model. Low levels of home use further accentuate the commercial nature of rice in the three regions.

Farm Size-Quantity Relationships

The farm size elasticities for rice (Table 17) and the farm size-quantity relationships (Figure 16) strongly support the reasoning behind the theoretical presentation of chapter three. They also emphasize the major enterprise differences prevailing among regions, sub-regions, and even departments in Guatemala.

Rice is, no doubt, a highly commercial crop in R_5. Cultivated mainly in the Zacapa area, where land is available, the rice relationship displays the shape of a commercial crop, supported by a relatively wide range in the elastic response and a minor amount (3 percent) of total production for home use. In R_6, however, rice is grown primarily in the Jutiapa area by taking advantage of small pockets of suitable soil. Once those pockets are under production, enlargement of the farm will not influence rice production, or in other words, the rice land constraint has been reached. For those reasons, farm size-quantity relationships for rice assume the shape of a commercial crop in R_5 and of a traditional crop in R_6.

The unexpected sign found for the farm size and rice supply relationship in R_4 can also be explained in terms of the land constraint. In the conceptual model, it was said that, as income rises, with self-sufficiency guaranteed, farmers tend to diversify production by growing high value crops until the land constraint is reached. In R_4, besides the basic grains under consideration, plantain, sesame, and coffee are also present. These crops may offer farmers a better alternative as farm size becomes larger and cause rice production to vary inversely with farm size.

Price-Quantity Relationships

Price elasticities of supply for rice (Table 18) are discussed without the illustration of price-quantity relationships. The presence of only one expected sign eliminates comparisons among the three regions.

Rice productien in R_6 shows the typical farmer response moving gradually up and along the PIC path as presented in chapter three. R_4 and R_5, however, reveal the same negative relationships encountered for several other crops. In this case, higher prices with low quantities near the asymptotic portion of the PIC path are explained by the limited surplus available just prior to planting time when rice seed prices soar tremendously. By this time, farmers cannot react strongly to high prices since they have been moving upward along the PIC path during the year.

Wheat

Wheat is produced and marketed in R_1 and R_6. Regression coefficients (Table 14 and Table 15), income, farm size, and price elasticities (Table 16 to Table 18), and farm size-quantity relationships (Figure 17) reveal a commercial crop whose behavior, heavily influenced by the governmental price support program, is contrasting in both regions.

Regression Coefficients

While total family income for wheat presents the expected sign and the highest level of statistical significance in R_1, it shows neither characteristic in R_6. Total farm size displays the expected sign in both equations but is more statistically significant in R_1 than in R_6. Quantity demanded on the farm, with the highest level of statistical significance, presents the expected sign in both regions. Price carries the expected sign in R_1 and R_6 but is of lower statistical significance in the former than in the latter.

Education, being more statistically significant in R_1 than in R_6, carries an unexpected sign on the latter. Distance to the market relative to wheat supply shows a positive sign in R_1 and a negative sign in R_6 and no level of statistical significance in either.

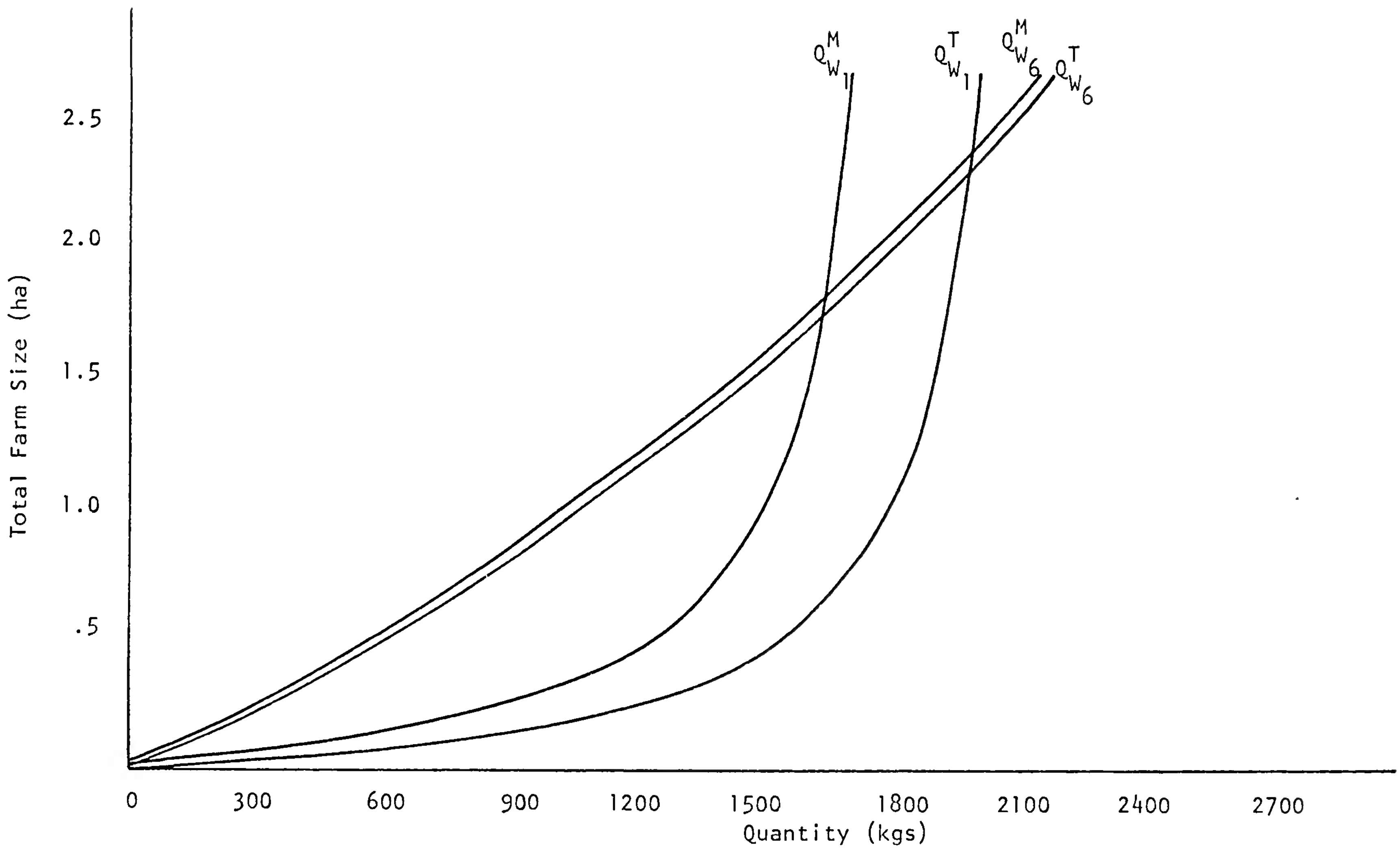

Figure 17.--Farm size-quantity relationships for wheat by regions of Guatemala

The relative profitability ratio presents high levels of statistical significance and the expected signs in both wheat producing regions. The positive sign in R_1 implies that as the ratio (return per hectare in all crops except wheat divided by the return per hectare in wheat) increases, the surplus-output ratio is expected to increase. The numerator in this case includes some subsistence crops while wheat in the denominator is commercial. Having secured self-sufficiency, farmers can afford to grow commercial crops where risk is minimal as is the case of wheat. This case illustrates the typical subsistence region described in the conceptual model. The negative sign in R_6 is as expected since there are traditional and commercial crops in the numerator of the ratio. Rice, for example, may well be a better alternative than wheat in a region as commercial as R_6.

Income-Quantity Relationships

The traditional nature of R_1 as opposed to more commercialized wheat production in R_6 is very well documented by the income elasticities of market supply (Table 16). Wheat is a commercial crop in both regions. However, wheat supply does present very little income responsiveness in R_1 and the opposite sign in R_6. In support of the conceptual model, traditional farmers in R_1, once self-sufficiency has been secured, grow a little wheat which provides a relatively secure source of income. The weak income responsiveness may be caused by the price support program. Although no quantity restrictions have been imposed, the price support is also a ceiling price and may be viewed as a limit on producer revenues beyond which higher value crops may become a better alternative. Because more commercialized regions display a stronger tendency to move into higher value crops, R_6 carries a negative sign for the income variable.

Farm Size-Quantity Relationships

Farm size elasticities (Table 17) and farm size-quantity relationships (Figure 17) further support the statements of the former section. In both regions, the elastic response is minimal up to the 0.25 hectare size, beyond which the responsiveness decreases sharply. Besides the reasons explained above, this reaction could be the result of the heavy use of chemical inputs discussed in chapter four. Intensive application levels and consequent yield increases may be the same as devoting more land to wheat production when land becomes avilable through the use of new technology.

Price-Quantity Relationships

Price-elasticities of market supply (Table 18) reveal that wheat production is minimally responsive to price changes. Wheat producers probably behave in this manner as a result of the price support program.

Summary

An analysis of the traditional and commercial supply response by producers of basic grains was accomplished by estimating and studying the regression coefficients and the respective elasticities for basic grains in five regions of Guatemala. Explanations for the behavioral characteristics identified provide support for the theory as expressed in an earlier chapter. Careful attention, however, must be given to generalizations based on these results. The following chapter will pursue the general implications of the descriptive and regression analyses.

CHAPTER VI

SUMMARY, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

This chapter contains a brief description of why a study of traditional and commercial farm supply response was undertaken, and the objectives necessary to adequately investigate the problem related thereto for Guatemala. Research findings and their implications are presented. Without a thorough examination and presentation of these results, little will be gained in the quest for a better understanding of traditional and commercial supply response. Thus, this chapter draws conclusions and proposes recommendations based upon the implications derived from the empirical results. A special section is devoted to discussing some data problems encountered in the research and how they may have affected the results.

Problem and Objectives

Characteristics portraying Guatemala as a developing country include: a rapily growing population, two-thirds of which is employed in the agricultural sector; a limited arable land base; and many farmers living in poverty conditions, with high rates of unemployment, and very low levels of food production. For these reasons, the country's development efforts are concentrated on the implementation of programs designed to more intensively utilize land, to reduce unemployment, and to increase production and productivity in rural areas.

Work at the Institute of Agricultural Science and Technology (ICTA) of Guatemala is focused on subsectoral programs intended to develop new technology. The quest for technology is aimed at generating productivity increases, especially in basic grains, to enable the country to meet its requirements without increasing the land area committed to production.

Productivity advances, however, may create two different problems. First, small farmers, discouraged by the erratic behavior and low level of basic grain prices, may utilize the new technology to produce the same amount of grains on less land and devote the unused as well as new land to the production of other crops. This has been observed recently in some areas of the country. Second, if farmers utilize the new technology on all of their land, the so called "second generation marketing problems" are likely to appear.

Since it becomes important to understand the traditional and commercial farm supply response as a basis for policies focused on both of these problems, the main objective of this study was to estimate market supply functions for each basic grain or association in the different regions of Guatemala. Other objectives were to compute the corresponding income, farm size, and price elasticities of market supply and to delineate and quantify production-distribution activities for basic grains in the different regions of the country. A Small

Farmer Credit Survey conducted by the Government of Guatemala and the Agency for International Development (AID) in 1974 provided the data necessary to accomplish these objectives.

In general, it was hypothesized that, income, farm size, and price elasticities of market supply for both traditional and commercial basic grains are high at very low levels of income, farm size, and price, respectively. But at higher income, farm size, and price levels they tend to become almost completely inelastic for traditional crops but somewhat less inelastic for commercial crops. To test these hypotheses, market supply equations for each single crop and associated crop enterprise were estimated separately in each region of the country. It was also hypothesized that if the productivity and production of basic grains can increase, production and distribution activities seem to be adequate. To test this hypothesis, production and distribution activities were delineated and quantified. The results obtained are summarized in the following section.

Research Findings

Results found in the delineation and quantification of the production and distribution activities are discussed first followed by a summary of findings concerning traditional and commercial farm supply response.

Production and Distribution Activities

From the input standpoint, basic grain production is most influenced by seed and fertilizer costs. While fertilizer use tends to be a generalized practice, with the level of application depending upon crops and regions, pesticides and soil additives are not commonly utilized. Seed management becomes dependent upon product sales, seed storage, and seed purchase decisions. Thus, variation does prevail in the percentage of total production set aside to be used as seed and animal feed and the percentage of seed which is purchased. Regarding labor, corn, rice, and wheat are the enterprises with the highest employment per hectare, followed by beans and the associations. Except for the latter, where employment per unit of land is very similar, all enterprises present different levels of employment by region.

Total basic grain production differs among crops with respect to yields and product distribution. Average production per unit of land is very similar for each crop grown in different regions. However, when the crops of the associations are grown as single crops, yield decreases for beans while increasing for corn and sorghum.

Excluding wheat and rice, consumption per family is relatively large and does not show major regional differences. Corn is the grain most used for processing, sales "in kind," and donations, all of which are not very generalized activities.

Variations found in cash sales are the result of differences in farm demand for production and consumption purposes. The more traditional the crop is, the lower will be sales. Expenditures incurred in marketing of basic grains are generally one cent or less per kilogram. When these expenditures are expressed as a percentage of the average regional price and ranked from highest to lowest, the order is wheat, rice, sorghum, corn, associations, and beans.

Traditional and Commercial Farm Supply Response

In general, estimated regression coefficients behave as hypothesized. Total income, total farm size, and quantity demanded on the farm are highly significant variables and, with few exceptions, show the expected sign. Price presents different levels of statistical significance and alternate signs. Education, distance, and the relative profitability ratio provide a minor contribution to the model.

Traditional crops generally appear at near zero income levels while commercial crops are cultivated when higher levels of income have been attained. Income elasticities of market supply for both types of crops are very responsive at low income levels. However, while commercial crops still show some responsiveness at higher income levels, traditional crops become almost perfectly inelastic. These findings corroborate the theoretical presentation. That is, farmers at subsistence levels experiencing income increases devote new resources to production and react by marketing the newly created surplus. At higher income levels, responsiveness tends to decrease sharply for traditional crops; once the home use requirement is attained, commercial crops enter the production system.

Traditional crops pervade the basic grains spectrum in Guatemalan agriculture. All of the enterprise associations, being the basic subsistence cropping pattern, belong in the traditional category. Corn is a traditional crop in R_1, R_5, and R_6, but becomes commercialized in R_3 and R_4. Beans are traditional in all regions. Sorghum is both a traditional and a commercial crop in R_4. Rice displays the characteristics of a commercial crop in all three regions (R_4, R_5, and R_6) where it appears. Wheat in R_1 is a commercial crop and is not highly income responsive since it serves the purpose of providing farmers with a relatively secure source of income at low income levels. At higher levels of income, crops other than wheat may become a better alternative. Although no quantity restrictions have been imposed, the price support, by establishing both a minimum and a maximum price, may be viewed as a ceiling on producer revenues. R_6 supports the former explanation; being a highly commercialized region, as opposed to R_1 which is mainly a subsistence region, wheat presents the opposite income sign in R_6. Other commercial crops may have become more income rewarding enterprises.

Total farm size elasticities closely parallel the income elasticities and also support the conceptual model. Traditional crops appear at minimal farm sizes while commercial crops are grown as farm size increases. Both traditional and commercial crops are very responsive at low levels but while some farm size-supply responsiveness remains at higher levels for commercial crops, it decreases sharply for traditional crops once self-sufficiency is attained. Concerning farm size elasticities, all crops can be cateogrized in the same way as those for the income elasticities.

The price elasticities of market supply are generally very low for both traditional and commercial crops. They show a higher response to low price levels than to higher prices. Since farmers move up and along the price-income-consumption (PIC) path and the surplus decreases during the marketing period, they can not react strongly to price changes at the end of the season when prices are highest. The opposite signs found for price in many of the equations can also be explained in the same terms. Thus, it may be possible that, when prices are highest, farmers have already arrived at the asymptotic section of the PIC path and, therefore, higher prices will encounter a lower quantity marketed response.

Data Generalizations and Implications

Descriptive statistics and statistical inference are used in this study. Since the data come from a random sample and do not encompass the entire population, two main assumptions are necessary to make inferences from the statistical results to the population. First, it is assumed that the sample is representative of the true population and, second, that 1973 was a typical year.

Both assumptions appear to be reasonable. As shown in chapter one, the sample contains a sufficient number of observations of traditional and commercial farms to draw safe conclusions at the regional and national levels. Concerning the second assumption there are no reasons to believe that 1973 was not a typical year. Furthermore, it also has been proven in the appendix that the least squares estimators of the regression coefficients are the best linear unbiased estimators (BLUE) of all linear unbiased estimators of the respective parameters.

Notwithstanding the above qualifications, the data display sufficient characteristics conducive to errors in the interpretation of results to necessitate a discussion of these concerns before recommendations are made.

Errors and Omissions in Data Recording

Four errors in data recording related to the information used in this study can be identified [106]. The first, and a very important one, relates to lack of care by the interviewers in recording responses to the question that deals with interplanted crops. Emphasis was not given to recording which crops are interplanted and which of the interplanted crops is the principal crop [106, p. 79]. This omission is mainly reflected in corn and beans in R_1, R_5, and R_6. The second major data-recording error entails the distance variable where figures given in meters or fractions were rounded to the nearest kilometer [106, p. 68]. For that reason, all entries start at the one kilometer level. Third, not all physical losses were recorded, especially by farmers who consume a relatively large share of their production [106, p. 77]. This error appears in the very unlikely 1 percent average computed for losses in all basic grains. Finally, interviewers were not consistent when recording production withheld by farmers for sale at future dates [106, p. 77]. This situation, however, does not affect the results obtained but it does support the theoretical model discussed in chapter three since the model is based on the assumption that farmers save some production to be sold throughout the marketing period.

To the errors and omissions just mentioned, can be added a question in particular that was badly designed and other ommissions. When asking to whom production was sold, it was only possible to check one, two, three or any combination of alternatives but specific quantities sold to each outlet were not obtained. This failure makes it impossible to know the amount of basic grains going through the different marketing channels whenever more than one channel was checked. The remaining omissions relate to failures in specifying quantitative values for several variables such as education, distance to the market, and quantity demanded on the farm. A value equal to the mean was assigned to replace these missing values only when regressing the corresponding equations.

Upward or Downward Bias

Descriptive statistics for the variables included in each of the estimated equations are computed as a basis for discussing the introduction of possible bias in the results. Minimum and maximum values, mean, standard deviation, kurtosis, skewness, missing observations, and total number of questionnaires by region and crop are presented for each independent variable in Table A-1 through Table A-7.[1]

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[1]Kurtosis refers to the relative peakness or flatness of a curve. A value of zero indicates a normal distribution; a positive value means a narrow (more peak) curve, while a negative value indicates a flatter curve. For skewness, a zero value corresponds to a bell shaped distribution; a positive value indicates clustering to the left of the mean with most extremes values to the right, and a negative value means the opposite. The remaining statistics and values are self-explanatory.

Education of household Head

In general, the number of years of formal education is relatively low in every case (Table A-2). Although the results obtained reveal normal distributions in almost every case, some consideration should be given to the occasionally large number of missing observations. These observations were made equal to the mean when, in fact, failure to report educational level might have been due to situations of lower levels of education. The resulting small difference, however, should not greatly affect the results.

Distance to the market

Besides the error leading to the one kilometer starting point for all farms, there is no reason to believe that the results obtained for this variable are not representative (Table A-4). A relatively small number of missing observations does not present major problems of misleading data when set equal to the mean.

Total Farm size

Total farm size deserves special consideration. Since the main purpose of this study is to draw inferences about traditional and commercial farm supply response, size of farm becomes a good indicator of the extent to which the data represent farmers involved in either or both types of farming. Although size of farm has not been defined in the present study, both extremes of the spectrum are not adequately represented. Regression equations with a few relatively large farm sizes, however, were included (Table A-3). The highest mean values, between 15 and 24 hectares, are localized in the corn equation of R_3, in the rice, corn, and beans equations of R_5, and in the beans and corn-beans equations of R_6. However, the kurtosis and skewness statistics computed reveal a positive sign for all the equations meaning both narrow distributions and clustering to the left of the means with most extreme values to the right of the mean, respectively. Thus the few relatively high values do not appear to impose bias in the results obtained. Their presence, however, is revealed and should be recognized when interpreting results for those enterprises.

Total family income

Similar in importance to total farm size, this variable also reveals in some of the equations, the presence of values higher than the non-defined total family income (Table A-7). Although total family incomes of values higher than Q10,000 a year are found in several equations, mean values are relatively low in all equations. The presence of a positive sign in both kurtosis and skewness has the same implications here, meaning the apparent upward bias in the data in these cases in not creating difficulties.

Farmgate price

The price variable is important in the model. The values and statistics computed stimulate some concern about the degree of validity of the findings in several of the equations (Table A-1). All crops, except wheat in R_6, present a relatively large price range to permit estimation of the equations. Standard deviations, on the other hand, are relatively low to allow for estimation within comfortable limits of confidence in most of the equations. A zero or minus sign in kurtosis, signaling a normal or flatter distribution in prices is only present in six of the equations. Besides these six, another four equations diplay a skewness of zero portraying a bell shaped distribution. All in all, inferences about price responsiveness are valid in the ten mentioned equations; in the remaining nine some consideration ought to be given to the distribution and properties of the data in each case.

Quantity demanded on the farm

Data in this variable do not seem to necessitate any special distribution since values will vary according to family size and subsistence needs. Standard deviations, being quite large, support this contention (Table A-5). Furthermore, missing observations replaced by the corresponding mean values are relatively few thereby reducing potential problems from this area of concern.

Relative profitability ratio

No special distribution is desired in this variable either. The ratio will assume values according to the revenues per hectare obtained from the different crops by each farmer. Values and statistics computed seem to corroborate this contention (Table A-6). A word of caution about the number of missing observations, however, seems appropriate. Since missing observations in this case reveal some farmers growing only that specific basic grain or association the missing values can not be replaced by mean values since it is incorrect to attribute unearned revenue to these farmers. Therefore, cases with relatively high numbers of missing values are approached with caution when analyzing the results obtained.

Conclusions and Recommendations

The alternative questions to which this study is addressed are as follows: Do traditional farmers adopt the new technology being generated by ICTA for basic grains to produce the same or less output on less land, or do they make full use of the land and technology to augment basic grain production? What will be the consequences in each case?

The argument in support of the national policy objective to increase basic grain production has been widely discussed in the development literature. The reasoning is that, in a closed economy, food grain prices would fall as a result of significant increases in production. However, lower prices could still provide adequate incentives to farmers if much of the increase is to due to cost-free technological change. Furthermore, with substantial supplies of grain, the government can have much more expansionary fiscal and monetary policies which, if directed toward labor-intensive public projects, can shift the demand curve for grains, and thereby help to counteract some of the decline in prices [32, p. 704]. In the case of Guatemala, demand elasticities for basic grains are not known at any level of the marketing chain. Empirical studies conducted in similar countries have produced inelastic demands. However, the impossibility of estimating demand elasticities at the farm level in this study gives rise to some concern. The problem seems to revolve around the question of whether or not self-sufficiency has been attained in certain regions of the country. Quantities marketed will therefore vary accordingly since the magnitude of the elasticities will differ in every case. Demand elasticities at the consumer level cause less concern. In general, the country is a net importer of basic grains and the demand curve for these grains is elastic at the imported price; an increase in production would probably not drive prices down but would instead bring beneficial effects to the economy. Since the world demand for most basic grains is also elastic at the market price, the country could export any available surplus not absorbed by the domestic market. The question is solved therefore except for the unknown elasticities of demand at the farm level and for the presence or lack of adequate facilities to market the increased production.

The remaining question is more complex. It has been shown that income, total farm size, and price elasticities of market supply are relatively high at low levels with the responsiveness decreasing at a rapid rate for the subsistence crops and at a lower rate for the commercial crops. Wheat, however, is an exception. At higher income levels, the response functions become almost perfectly inelastic. Therefore, it would appear that little hope prevails for the attainment of massive increases in production of all basic grains. Some basic grains in some regions seem to have a slight potential for increased production. These are corn in R_3 and R_4, and rice in R_4 and R_5. But, in general, the resulting increases would fall far behind the desired goal and expectations of the Guatemalan government.

Another relevant finding is an indication that traditional farmers shift to commercial or high value crops once self-sufficiency has been reached. Such shifting may cause serious repercussions. Marketing facility needs for high value crops are in general more sophisticated than for basic grains. These products display more possibilities for damage, spoilage and price differences than basic grains. Therefore, more sophisticated grades and standards, and transportation, handling, packing, storage, and market information facilities are needed.

The above conclusions serve as a base for several recommendations: First, seasonal demand studies at the farm and consumer levels are necessary not only for basic grains but also for high value crops. This would ease the quest for information about the prevailing and future trends in conditions of demand and supply and thereby provide a basis for developing a cropping pattern that would not distort the market mechanism. Second, basic grain production should be emphasized in the crops and regions presenting the higher probability of increasing production. By concentrating efforts in the specific crops and regions where such increases are most likely, (corn in R_3 and R_4, and rice in R_4 and R_5), greater accomplishment may be expected. Finally, it has been inferred that, for the Guatemalan situation, basic and applied research on basic grains alone will neither serve the small farmer's needs entirely as he moves into higher value-higher risk crops nor will it serve the national production goals for basic grain. Furthermore, there seems to be a contradiction between the objective of increasing basic grain production and the goal of overall development of the country. If increases in average per capita income can not be obtained for small farmers alone from the production of basic grains, even if production targets are met, the goal of increased production of basic grains contributes little to economic growth since the traditional farm sector is the one most needing increases in income per capita.

Thus, besides production research, careful consideration should be given to various other alternative programs as incentive to stimulating production to meet national goals while fulfilling the risk aversion and income criteria of traditional farmers. Because of the somewhat diverging yet complementary behavior of traditional and commercial crops on Guatemalan farms, research emphasis must also be assigned to high risk crops along with basic crops. This research must assume a farm system focus while avoiding isolated enterprise evaluations if it is to be of use to small farmers and to meet the production goals of the national government.

CHAPTER VII

REFLECTIONS ON THE THEORY OF DEVELOPMENT

Introduction

> ....What we tend to forget, however, is that the essential aspect of an 'underdeveloped' economy and the factor the absence of which keeps it 'underdeveloped' is the ability to organize economic efforts and energies, bring together resources, wants, and capacities, and so to convert a self-limiting static system into creative, self-generating organic growth [28, p. 335].

However, when the efforts are organized in reverse and the energies and tasks are working toward unattainable goals, the limitations will perpetuate themselves and the self-generating organic growth will never materialize.

It is a reality that all developing countries, at some stage in the development process, must face the issue of extracting a surplus from agriculture while at the same time providing for public investments in the agricultural and industrial sectors. But careful attention must be given to fomenting the realization of a surplus where it is a real, not imagined, possibility within limited resource conditions. A serious misjudgement can lead to a waste of time and resources that might be used more effectively. The opportunity cost for developing countries in this case is extremely high.

The review of literature in chapter two reveals a theory of agricultural development constantly evolving since the end of World War II. That the agricultural sector is to play a key role in the development process is today widely accepted. The precise nature of this role and policies most appropriate to fulfill that role, whatever it is, are not fully agreed upon. One of the prescriptions most often followed has been to emphasize increasing production of food crops per land and labor unit by relying on modern yield-increasing technology. Yet both productivity increases and stagnant or even declining production have been observed in some of these countries. The reason for the disappointing results is the failure to analyze the total small farm or traditional basic economic system.

This study has attempted to close that gap in the theory. Chapter three has presented a conceptual model of the total basic economic system for "traditional" or "small" farms. Owing to his subsistence needs, the land constraint, and his income level, the traditional farmer's behavior within his basic economic system is one of carefully balanced risk aversion, income maintenance, and risk taking. The results presented in chapters four and five tend to validate the model. With the corresponding adaptations the model can be useful for the analysis of the traditional farm sector in different countries with varied single and associated cropping patterns. The results of the model are now merged with the three generation problems of the Green Revolution.

The Green Revolution: Generation Problems and Small Farm Development

Three generation problems related to Green Revolution agriculture have been explicitly delineated by Walter P. Falcon [32]. Research findings from the present study in Guatemala further expand and to some extent modify the implications of these problems.

First Generation

Production related problems, where great production successes have been hampered by serious limitations, are included in the first group. Constraints on adoption of new technology include, for example, lack of adequate and controllable water supplies (without irrigation, fertilizer provides only a low return) and inadequacy or lack of pest management programs.

Regional differences in some countries may illustrate two fold yield increases per acre in one-third of the country due to new technology yet no change elsewhere within the same country [32, p. 701]. Reasons for this condition are in part explained by the Guatemalan experience. Farmers tend to adopt new technologies as risk is reduced and when clear income advantages appear. They are not likely to incur more risk until at least self-sufficiency is established. Thus, risk reduction can occur within the present self-sufficiency crop and income patterns and/or in a potential crop addition to that pattern. Both types of risk reduction may create similar impacts on production systems changes implemented by traditional farmers.

This explanation of traditional farm behavior is corroborated by Figure 18 where traditional and commercial farm income, total farm size, and price-quantity relationships found in the basic grain supply response for Guatemala have been depicted. The supply responsiveness to changes in income, farm size, and price (being larger for traditional crops than for commercial crops at low income, farm size, and price levels, but decreasing faster for the former than for the latter at higher income, farm size, and price levels) has given support to the conceptual model of this study. In addition, the positions of the intercepts for the different crops, by being lower for the traditional than for the commercial crops, further validate the conceptual model. Because of the different and complementary behavior with both types of crops, research emphasis must also fall on high risk crops and not just on basic crops.

In a recent study about rates of adoption of modern inputs in several developing countries, the authors recognize that "experimentation with new techniques involves the risks of the unknown, usually involving additional investment, and small farmers may be less able to undertake such risks" [96, p. 888]. This finding is related to the traditional farmers' behavior, explained in the present study, with regard to higher risk crops. Even in the case of known varieties, traditional farmers will not be willing to take any risk until they have attained individually required self sustaining income levels. Off-farm and part-time rural employment along with agricultural productivity advances in basic crops can provide this stimulus.

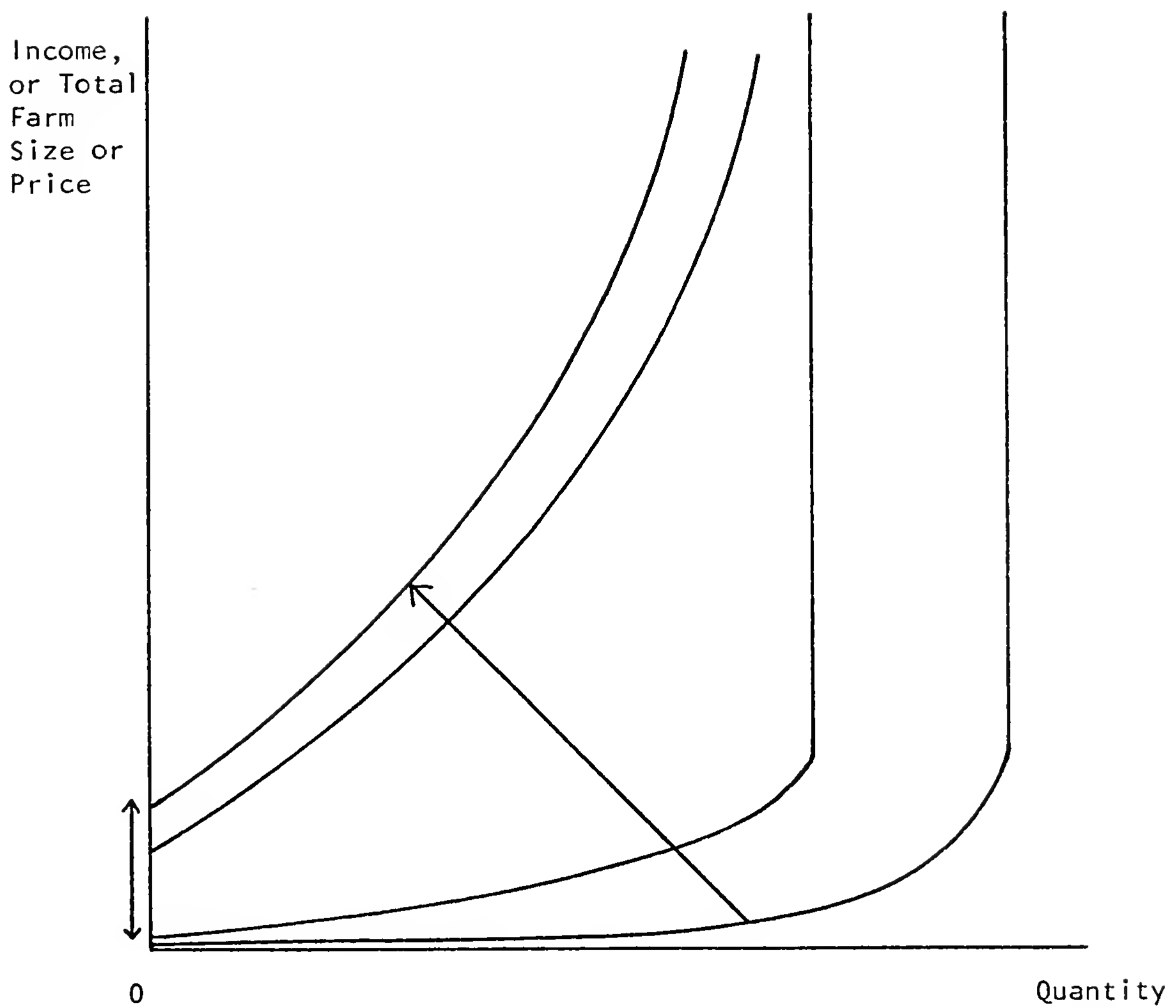

Figure 18.--Traditional and commercial income, farm size, and price-quantity relationships in developing agriculture

Second Generation

Second generation problems encompass difficulties associated with marketing, markets, and resource allocation. Examples of marketing and demand problems generated by the Green Revolution are: transportation bottlenecks; differences in milling, grading, storing, and transporting the products; low consumer acceptance because of quality problems; pricing and marketing inefficiencies; and, finally, barriers to entering international markets.

Falcon [32, p. 701] acknowledges that, even with moderately high on-farm demand from increased production, quantities marketed have risen much more than proportionately to quantities produced. In chapter six, it was recommended that demand studies at the different levels of the marketing chain be conducted. Most marketing problems can be reduced with policies and programs based on knowledge of the on-farm elasticities of demand and the proportion of the increased output the remainder of the population is willing to absorb at prices commensurate with production costs. On the other hand, if production remains stable while productivity for a basic grain increases, the market for the basic grain probably will not receive pressure and falling prices will not result. To achieve increased productivity, stress may be placed on input market systems. But possibly more important is the potential pressure on the market for higher risk commercial crops since farmers may shift to producing these crops after productivity increases have been obtained in the traditional crops. Risk associated with those commercial crops in part can be reduced by placing emphasis on improving market conditions and prices for those crops. Furthermore, input market pressure also may be placed on some non-traditional inputs but not exclusively those necessary to service traditional basic crops.

Third Generation

Receiving the least attention, third generation problems encompass equity, welfare, employment, and social institutions. They arise from four principal sources: First, annual population growth rates of over 2.5 percent in areas already densely populated; second, very low average income levels, coupled simultaneously with great regional and personal disparities in income, wealth, and political power; third, limited opportunities for off-farm employment; and finally, the possibility for technological "leap-frogging" with agricultural inputs and techniques, which are often of a labor-displacing nature.

A built-in supply control mechanism for basic grains and low value-low risk crops produced by the small farm system has been suggested in the conceptual model. Because of that mechanism, over production, at least at the small farm level, might not result so prices should not decline sharply to create great income disparities. On the other hand, if in order to obtain the desired total production increase at the national level emphasis is placed on some commercial basic gain production under larger farms, small farmers will be affected by the fall in basic grain prices.

But if the emphasis is maintained on increased basic grain production by the traditional sector, the government will be enforcing contradictory policies. That is, a conflict prevails between the production goal, which would not substantially increase average per capita income of traditional farmers, and the goal of economic development for the country. Traditional farmers, however, apparently may not be counted upon to substantially increase total production of basic grains to meet the national goal. Yet since they do contribute toward that goal, research on basic grains for traditional farmers is still necessary so that they can realize the productivity increases that will provide the opportunity for them to produce higher value crops. If commercial basic grain prices fall as a result of increased productivity and production, traditional farmers may be forced back into greater land use for basic grain production to secure their low risk low money requirements; therefore, research must continue to provide for increases in traditional basic grain productivity if balanced growth is to occur within the agricultural sector.

Employment related problems are an integral part of the role of agriculture in economic development. Today it appears that the need is not to send rural people to the cities (an old theory to provide cheap labor) but to employ migrants and potentially displaced small farmers on farms as a means to reducing unemployment and income distribution problems. Rural small industry may serve a double purpose for the food system by providing needed employment as well as preprocessing, processing, packing,and storage for some of the surplus production. Working part-time off the farm does not imply a decline in on-farm productive activities. It has been shown in the Guatemalan situation, that, when husbands take up a part-time job, either in the cities or in the country side, wives remain in charge of agricultural activities. The added family income and security related thereto may provide a basis for moving into higher value-higher risk crops just as traditional crops provide that basis.

Suggestions for Further Research

Having to depend entirely on data collected for a purpose different than the estimation of the model portrayed in this sutdy has placed some undeniable limitations on the scope of the research and results. The most limiting condition has been the impossibility of testing for the presence of a backward bending supply curve for basic grains. It was indicated in the conceptual model that, as income and farm size increase and small farmers move out of subsistence into commercial agriculture, there is a tendency to cut back on production of traditional crops. The reciprocal form specified for these variables, due to the nature of the data, impeded the functions from bending backwards. In the case of price, the unexpected signs obtained may also signal the possibility of a backward sloping supply curve as the result of a limited surplus available at the end of the season, when prices are high. Another reason might be the income effect as the farmer moves up and along the price-income-consumption path to a higher income level. In the following season, the farmer moves into commercial crop production and devotes less land to traditional crops. Further research should test for the possible presence of that supply curve.

For such tests, countries and regions should be carefully selected to include those with desired yet typical characteristics. Questionnaires should be designed to collect the necessary and appropriate data, which would of course include sufficient observations of the high-value and high risk crops. That research, when accomplished, will contribute to a better understanding of the small farm basic economic system in the developing nations.

Epilog

Despite the considerable attention given to the modernization of traditional agriculture during the past quarter century, the small farm sector has not received sufficent attention. "It is imperative that this mass of humanity," as pointed out in a recent publication [94, p. i], "be included in the modernization process and share in the material and other benefits of economic development and social progress." The reasons are fairly simple:

> The state of the arts and the knowledge base in this area are dangerously inadequate. Development theory treats the problem of this important stratum of the rural sector inadequately. Much of the empirical work has abstracted from these problems. Many development projects have failed to achieve desirable impacts on the rural poor. Information relative to the fundamental characteristics of this stratum and the barriers which it faces is sparse.
>
> The agricultural development spotlight is now beginning to focus on the basic issue - the unmitigated poverty of disenfranchised rural inhabitants. Development efforts have no alternative but to tackle this massive problem. To do so effectively will require sharp expansion of the relevant knowledge base. It will necessitate modification of conceptual models, expansion of empirical information and the creation of effective development strategies and programs. [94, p. i].

That concern has been present throughout this study. Recent developments in the literature seem to indicate that the time has already come for proper priority to be given to small farm agricultural development within the general economic development framework. The results, when incorporated within effective development strategies and programs, will help resolve one of the most crucial problems faced by developing countries today.

GLOSSARY[1]

Aldea: Hamlet or small village.

Associated enterprises: Sequential intercropping of two or more crops such that all production practices refer to the entire combination of the crops included.

Cabecera: Capital of a department or <u>municipio</u>.

Cantón: A territorial subdivision roughly equivalent to a country, if rural, or a ward, if urban.

Caserío: Rural community too small to be considered an <u>aldea</u>. Often only a collection of scattered dwellings.

Ciudad: City.

Departamento: Each of the 22 major political subdivisions in which the Republic is divided.

ICTA: Instituto de Ciencia y Tecnología Agrícolas (Institute of Agricultural Science and Technology). Decentralized institute of the Governmental Agricultural Sector inaugurated on June 1, 1973, with the purpose of conducting research to generate new technologies mainly for medium and small farmers.

INDECA: Instituto Nacional de Comercialización Agrícola (National Institute of Agricultural Marketing). A decentralized agency in charge of all agricultural marketing activities in the country.

Ladino: According to the 1964 Official Census, term applied to anyone who was not a cultural Indian, which includes persons of European and Asiatic heritage as well as acculturated Indians.

Manzana: A unit of land equal to 6984.4 square meters.

Milpa: Corn, most of the time intercropped with beans and/or other products.

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[1]This section is mostly based on [24].

Municipio: Political subdivision of a department. Similar to a township in the United States.

Pueblo: Village.

Quetzal: Unit of currency, equivalent to one U.S. dollar. Also the national bird of Guatemala.

Quintal: A unit of weight equal to 100 pounds, or 45,359 kilos.

Villa: Small town, larger than a pueblo.

APPENDIX

APPENDIX

The primary purpose of this study has been the estimation of market supply functions for basic grains in the different regions of Guatemala. This appendix contains the list of crops involved, a complete specification of the mathematical and statistical models, and the regression results.

List of Crops

Basic grains include corn, beans, sorghum, rice, and wheat. They may be grown as single crops or associated with one or more crops. The regional distribution of crops for which equations are estimated is as follows: For the associations, corn-beans (C-B) in R_1, R_5, and R_6; corn-sorghum (C-S) in R_6; and corn-beans-sorghum (C-B-S) in R_6; corn in R_1, R_3, R_4, R_5, and R_6; beans (B) in R_1, R_5, and R_6; sorghum (S) in R_4 only; rice (R) in R_4, R_5, and R_6; and, finally, wheat (W) in R_1 and R_6.

The Mathematical Model

The theoretical model developed in chapter three provides the basis for the estimation of the surplus-output ration as a function of a number of independent variables. Variables in the equation are:

Q_i^M / Q_i^T = quantity marketed divided by quantity produced of basic grain i; or percent of basic grain i that is marketed (the dependent variable);

P_i = farm price of basic grain i (quetzales/kg);

E_i = education of household head (number of year of formal education):

A_i = total farm size (ha);

D_i = distance to the nearest market (km);

I_i = quantity of basic grain i demanded at the farm level for all purposes (kg);

W_i = return per hectare in all basic grains except basic grain i divided by return per hectare in basic grain i (quetzales/kg/ha); and

Y_i = total annual family income (quetzales).

Descriptive statistics for each of the independent variables appear in Table A-1 to Table A-7. Their implications have been discussed in chapter six.

Before stating the mathematical form of the behavioral equation to be estimated, some assumptions regarding the behavior pattern of the independent variables must be made. It is assumed that education (E_i), distance (D_i), quantity demanded on the farm (I_i), and the relative profitability ratio (W_i) enter the equation in direct form. It is further assumed that, based on the conceptual model, price (P_i), total family income (Y_i), and total farm size (A_i) enter the equation in reciprocal form. Since quantity marketed (Q_i^M) is the only endogenous variable, the model can be solved with the following single equation:

Table A-1.--The price variable: descriptive statistics for each of the estimated equations

Region	Crop	Min.	Max.	Missing Observ.	N	Mean	St. Dev.	Kurtosis	Skewness
1	C-B	0.085	0.235	0	63	0.131	0.027	3.57	1.66
5	C-B	0.072	0.306	0	33	0.150	0.042	4.92	1.76
6	C-B	0.115	0.271	0	45	0.194	0.040	-0.57	-0.08
6	C-S	0.055	0.176	0	38	0.110	0.018	5.69	0.01
6	C-B-S	0.105	0.236	0	16	0.154	0.034	-0.17	0.73
1	C	0.052	0.213	0	86	0.126	0.026	1.75	0.14
3	C	0.012	0.147	0	51	0.103	0.024	4.62	-1.83
4	C	0.041	0.170	0	208	0.111	0.020	1.36	-0.56
5	C	0.028	0.382	0	250	0.114	0.034	17.70	2.72
6	C	0.054	0.265	0	141	0.116	0.027	8.36	2.04
1	B	0.116	0.711	0	21	0.308	0.114	5.99	2.00
5	B	0.037	0.491	0	63	0.280	0.089	-0.07	-0.08
6	B	0.110	0.750	0	124	0.291	0.091	5.68	1.26
4	S	0.066	0.221	0	42	0.112	0.028	9.19	2.71
4	R	0.077	0.419	0	52	0.190	0.084	0.59	1.18
5	R	0.023	0.287	0	50	0.120	0.048	3.51	1.13
6	R	0.110	0.386	0	28	0.217	0.066	0.05	0.47
1	W	0.095	0.282	0	204	0.169	0.026	2.39	-0.13
6	W	0.129	0.185	0	25	0.167	0.022	-0.94	-1.01

Table A-2.--The education variable: descriptive statistics for each of the estimated equations

Region	Crop	Min.	Max.	Missing Observ.	N	Mean	St. Dev.	Kurtosis	Skewness
1	C-B	1	6	42	63	3.33	1.80	-1.07	0.46
5	C-B	1	6	15	33	2.94	1.31	-0.03	0.80
6	C-B	1	9	19	45	3.62	2.04	-0.00	0.74
6	C-S	2	6	23	38	3.53	1.41	-0.79	0.61
6	C-B-S	2	6	7	16	3.67	1.66	-1.20	0.44
1	C	1	9	30	86	3.46	1.68	0.62	0.90
3	C	1	6	18	51	3.12	1.64	-0.64	0.43
4	C	1	7	106	208	2.92	1.36	0.71	0.97
5	C	1	18	106	250	4.16	3.02	6.43	2.32
6	C	1	11	63	141	3.36	1.82	2.48	1.39
1	B	1	6	6	21	2.80	1.57	0.33	0.98
5	B	2	6	24	63	3.46	1.45	-0.75	0.70
6	B	1	11	57	124	3.34	1.80	3.41	1.63
4	S	1	6	20	42	2.91	1.15	1.27	0.79
4	R	1	6	30	52	2.86	1.64	-0.30	0.79
5	R	1	18	32	50	6.00	4.86	2.09	1.72
6	R	2	6	14	28	4.36	1.65	-1.55	-0.18
1	W	1	18	79	204	3.40	2.38	15.39	3.39
6	W	2	6	15	25	3.20	1.32	0.57	1.29

Table A-3.--The total farm size variable: descriptive statistics for each of the estimated equations

Region	Crop	Min.	Max	Missing Observ.	N	Mean	St. Dev.	Kurtosis	Skewness
1	C-B	0.70	41.90	0	63	8.89	10.08	2.96	1.96
5	C-B	1.20	59.39	0	33	7.25	10.85	15.00	3.77
6	C-B	1.40	55.90	0	45	8.75	10.67	7.23	2.58
6	C-S	1.40	103.41	0	38	18.19	22.87	5.78	2.43
6	C-B-S	1.40	55.90	0	16	14.30	15.22	1.61	1.46
1	C	0.44	29.07	0	86	4.90	5.39	8.32	2.80
3	C	1.40	87.34	0	51	16.22	19.42	6.57	2.62
4	C	0.92	67.08	0	208	11:22	10.43	5.85	2.07
5	C	0.70	449.99	o	250	17.13	48.21	52.91	6.93
6	C	0.70	238.27	0	141	12.64	25.50	43.41	5.76
1	B	0.70	10.84	0	21	3.93	2.48	1.12	1.05
5	B	0.09	405.03	0	63	24.34	68.16	24.46	5.06
6	B	0.70	238.27	0	124	15.96	29.31	26.63	4.45
4	S	0.70	69.87	0	42	14.61	15.32	3.62	1.98
4	R	0.70	55.20	0	52	14.43	11.71	2.87	1.60
5	R	2.23	89.44	0	50	16.62	17.96	8.85	2.91
6	R	2.79	55.90	0	28	13.82	14.14	3.12	1.96
1	W	0.22	44.72	0	204	4.42	5.55	17.54	3.68
6	W	2.52	23.06	o	25	6.44	4.89	4.44	2.17

Table A-4.--The distance to market variable: descriptive statistics for each of the estimated equations

Region	Crop	Min.	Max.	Missing Observ.	N	Mean	St. Dev.	Kurtosis	Skewness
1	C-B	1	92	4	63	12.73	14.77	19.55	4.36
5	C-B	1	40	0	33	26.85	11.16	0.35	-1.28
6	C-B	1	54	4	45	7.71	9.04	15.72	3.76
6	C-S	1	30	2	38	10.25	8.14	0.45	1.22
6	C-B-S	2	26	2	16	8.57	6.81	1.98	1.76
1	C	1	150	20	86	14.12	25.99	13.59	3.66
3	C	1	76	4	51	22.36	21.66	-0.41	0.94
4	C	1	137	20	208	21.38	20.71	6.19	2.10
5	C	1	120	21	250	10.34	12.83	32.20	4.68
6	C	1	55	16	141	11.06	10.74	4.40	2.05
1	B	1	110	2	21	21.32	26.08	5.60	2.41
5	B	1	40	10	63	11.06	9.34	1.41	1.44
6	B	1	163	13	124	14.20	18.92	33.46	4.91
4	S	1	70	4	42	18.40	22.18	0.70	1.51
4	R	1	137	7	52	24.13	23.76	9.61	2.53
5	R	1	100	5	50	15.00	17.68	10.33	2.82
6	R	1	12	6	28	5.5	3.13	-0.72	0.42
1	W	1	150	20	204	12.78	20.16	16.75	3.79
6	W	1	23	0	25	8.60	6.90	-0.77	0.71

Table A-5.--The quantity demanded on the farm variable: descriptive statistics for each of the estimated equations

Region	Crop	Min.	Max.	Missing Observ.	N	Mean	St. Dev.	Kurtosis	Skewness
1	C-B	296	7712	0	63	2332	1309	5.50	1.88
5	C-B	158	9753	0	33	1355	1824	13.23	3.67
6	C-B	45	5895	0	45	1857	1176	2.23	1.14
6	C-S	454	7712	1	38	2697	1799	1.43	1.48
6	C-B-S	1020	6734	0	16	2745	1665	0.45	1.14
1	C	23	5443	0	86	1382	955	4.52	1.87
3	C	363	7712	1	51	2371	1595	2.05	1.42
4	C	272	8165	6	208	1804	1181	6.75	2.08
5	C	45	12701	20	250	1293	1242	36.28	4.78
6	C	91	30074	3	141	1717	3060	54.65	6.74
1	B	25	2722	1	21	356	633	8.74	3.14
5	B	23	1134	1	63	187	194	8.35	2.58
6	B	90	3765	10	124	419	455	27.75	4.66
4	S	45	1814	19	42	471	409	3.22	1.67
4	R	45	1361	14	52	239	233	12.61	3.28
5	R	45	2722	19	50	433	680	6.32	2.73
6	R	45	11567	2	28	907	2238	19.28	4.57
1	W	11	3720	51	204	420	537	16.33	3.65
6	W	136	499	0	25	317	256	-1.00	0.00

Table A-6.--The relative profitability ratio variable: descriptive statistics for each of the estimated equations

Region	Crop	Min.	Max.	Missing Observ.	N	Mean	St. Dev.	Kurtosis	Skewness
1	C-B	0.013	3.51	52	63	1.45	1.14	-0.77	0.52
6	C-B	0.005	1.38	34	45	0.23	0.39	6.06	2.86
6	C-S	0.013	6.09	14	38	0.76	1.43	7.33	2.86
6	C-B-S	0.019	1.95	11	16	0.45	0.84	1.00	1.83
1	C	0.112	9.77	33	86	1.51	1.71	10.16	2.91
3	C	1.293	5.64	47	51	2.75	2.01	-0.20	1.21
4	C	0.039	79.65	138	208	3.89	13.30	28.41	5.47
5	C	0.005	16.88	168	250	1.16	2.36	27.28	4.97
6	C	-1.143	12.55	46	141	1.41	2.22	11.62	3.24
1	B	0.129	27.54	8	21	3.73	7.84	5.45	2.67
5	B	0.013	6.06	13	63	0.59	0.99	18.52	4.07
6	B	0.007	4.64	31	124	0.49	0.71	12.40	3.07
4	S	0.102	76.18	2	42	4.89	12.38	26.91	5.20
4	R	0.003	2.30	7	52	0.51	0.54	2.40	1.61
5	R	0.006	5.62	11	50	0.57	1.02	14.25	3.65
6	R	0.022	2.51	0	28	0.37	0.50	11.15	3.34
1	W	-5.450	4.03	141	204	0.32	0.97	26.51	-2.90
6	W	0.036	0.52	10	25	0.26	0.16	-1.27	0.13

Table A-7.--The total income variable: descriptive statistics for each of the estimated equations

Region	Crop	Min.	Max.	Missing Observ.	N	Mean	St. Dev.	Kurtosis	Skewness
1	C-B	107	3960	0	63	908	839	3.76	2.04
5	C-B	180	7765	0	33	1445	1697	4.83	2.27
6	C-B	158	13128	0	45	2095	2643	9.63	3.12
6	C-S	158	8526	0	38	1593	1695	7.50	2.71
6	C-B-S	158	4250	0	16	1371	1066	1.60	1.32
1	C	35	7891	0	86	1009	1233	11.03	2.95
3	C	150	18685	0	51	2049	3555	16.99	4.22
4	C	93	36323	0	208	2745	3703	32.93	4.58
5	C	41	47600	0	250	2033	4650	72.69	7.96
6	C	60	29025	0	141	1664	3665	33.72	5.47
1	B	33	2807	0	21	659	663	4.14	2.20
5	B	53	5467	0	63	1341	1352	1.58	1.48
6	B	60	29025	0	124	1880	3883	29.11	5.09
4	S	197	36323	0	42	3253	5691	26.36	5.04
4	R	146	12040	0	52	2968	2806	1.30	1.37
5	R	140	47600	0	50	3729	9626	15.50	4.07
6	R	383	14385	0	28	3333	4082	1.66	1.75
1	W	8	7891	0	204	665	893	24.49	4.26
6	W	110	3663	0	25	710	669	14.17	3.71

$$Q_i^M / Q_i^T = \beta o - \beta_1 \frac{1}{P_i} + \beta_2 E_i - \beta_3 \frac{1}{A_i} + \beta_4 D_i - \beta_5 I_i + \beta_6 W_i - \beta_7 \frac{1}{Y_i}$$

Setting the direct variables equal to their means, the following expression is obtained:

$Q_i^M / Q_i^T = Z - \frac{\beta i}{X}$, where X is one of the three variables (Y_i, A_i, P_i) estimated in reciprocal form and Z is the intercept value with all variables other than X at their means.

From the theoretical presentation, Q_i^M / Q_i^T should steadily approach nearer and nearer to the value one, without ever attaining this value. The magnitude of the response depends on the traditional or commercial character of the crop. In terms of limits,

$$\lim_{X \to \infty} Q_i^M / Q_i^T = \lim (Z - \frac{\beta i}{X})$$
$$= Z - \lim_{X \to \infty} \frac{\beta i}{X}$$
$$= Z$$

where $0 < Z \leq 1.0$.

The mathematical properties of the function can be illustrated with the following computations. Let us assume, for simplicity, that

$Y = 1 - \frac{a}{X}$.

Then, when a = 1, and X takes on values of 1, 10, 100, ... , Y equals 0, 0.9, 0.99, ... ; and when a = 10, and X takes on values of 10, 100, 1,000, ... , Y equals 0, 0.9, 0.99...(Figure A-1). Each function approaches the value one with a different slope depending on the value of X, while their intercepts depend on the value of a.

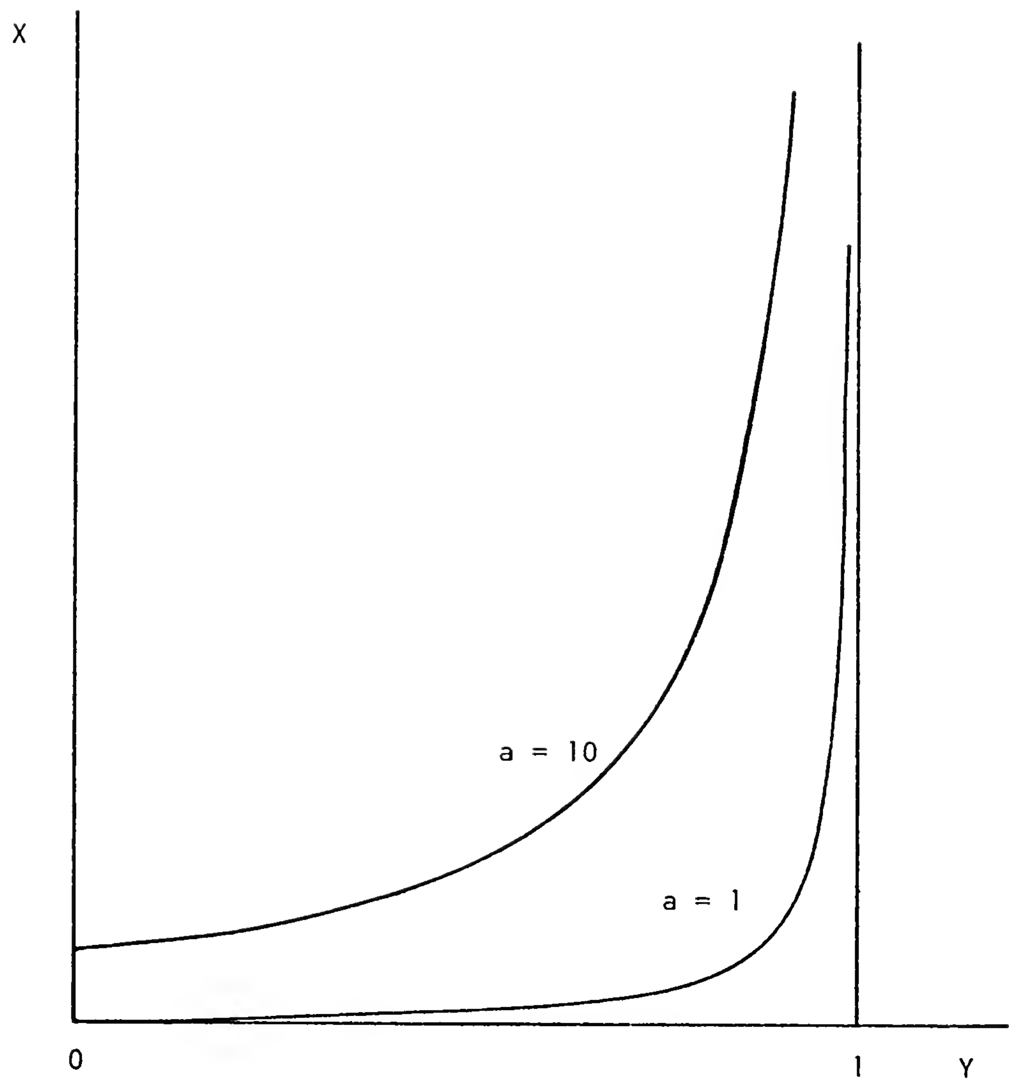

Figure A-1.--Mathematical properties of the specified function

The Statistical Model: Its Assumptions and Possible Violations

The specification of the linear regression model includes the regression equation and the basic assumptions. This section contains the full specification of the model and discusses possible violations of the basic assumptions.

The Regression Model

The multiple regression model is formally described as

$$Y_i = \alpha + \sum_{i=1}^{R} \beta X_1 + \varepsilon_i ,$$

where Y is called the "dependent variable", X the "independent (or explanatory) variables", ε the "stochastic disturbance", α and β the unknown "regression parameters", and the subscript i refers to the ith observation [65, p. 201].

The basic assumptions of the cross-section model are:

(a) Normality: ε_i is normally distributed,

(b) Zero mean: $E(\varepsilon_i) = 0$,

(c) Homoskedasticity: $E(\varepsilon_i^2) = \sigma^2$,

(d) The number of observations exceeds the number of coefficients to be estimated, and

(e) No exact linear relation exists between any of the explanatory variables [65, p. 202, 348].

Possible Violations of the Assumptions

The main purpose of the model is to estimate the regression parameters by means of the assumptions underlying the model. It may be possible, however, that, in so doing, one or more of the basic assumptions may not be fulfilled. The purpose of this section is to explore the possibility that this condition has in fact occurred in this study. All assumptions are scrutinized to show that the least squares estimators of the regression parameters have all of the desirable properties.

Normality.--When the assumption of normality is not fulfilled, the least squares estimators of the regression coefficients are still the best linear unbiased estimators (BLUE), since this property is independent of the form of the parent population. They are therefore still unbiased and have the smallest variance among all linear unbiased estimators of the respective parameters. Though they are no longer efficient, they can be considered consistent and asymptotically efficient.

One practical implication of dropping the normality assumption is that the confidence intervals and tests performed no longer apply. However, they are not too badly affected and can be used as reasonable approximations, when the disturbance's distribution is not very radically different from normal [65, pp. 247-8].

Validity of the normality assumption in the statistical model was evaluated through a direct examination of the residuals. All plots examined were found to have a pattern resembling very closely that of a normal distribution.

Zero mean.--The zero mean assumption of the regression disturbance is based on the specification that the population regression line is

$$E(Y_i) = \alpha + \Sigma\beta X_i.$$

If the mean of the disturbance values is, for example, μ_i, instead of zero, then

$$E(Y_i) = \alpha + \Sigma\beta X_i + \mu_i.$$

When μ_i is a constant, $E(Y_i) = \alpha^* + \Sigma\beta X_i$, and the least squares formula gives an estimation of α^* instead of α, though the least squares estimation of β's are unaffected. There exists no possibility in this case for estimating α and μ separately and for obtaining unbiased or at least consistant estimates. When μ_i varies from observation to observation, α becomes $(\alpha + \mu_i)$; thus, the dependent variable changes for both changes in the X_i's and for other reasons [65, pp. 248-9].

The above situation may be the result of specification error due to the exclusion of some relevant explanatory variables from the equation. An examination of the behavior of the regression residuals can be used to test for this specification error [65, p. 405]. In this case, the scrutiny of residuals in all the equations provides no reason to believe that the zero mean assumption of the model has been violated.

Homoskedasticity.--The characteristic of the regression disturbance known as homoskedasticity implies a constant variance of the disturbance for all observations. When this does not hold, then

$$E(\varepsilon_i^2) = \sigma_i^2,$$

which implies that the variance of the disturbance may vary from observation to observation. The least squares estimators, though still unbiased, cease to be BLUE, and, therefore, do not have the smallest variance in a class of unbiased estimators and are not efficient. They are still consistent but have lost the property of being asymptotically efficient. When heteroskedasticity is present, confidence intervals and tests of hypotheses are meaningless [65, pp. 249-56; 59].

Although the composition of the sample is such that variation among the variances of the disturbance is very unlikely, a test was conducted to corroborate that assertion. Total family income and total farm size are the only two variables with a possibility of violating the homoskedasticity assumption. When the disturbance was plotted against these two variables for each of the estimated equations, there appeared no reason to believe that this assumption would not hold in every equation.

Sufficient observations.--This assumption requires that the number of observations exceed the number of coefficients to be estimated, thus fulfilling the provision for a sufficient number of "degrees of freedom" in estimation. In all equations this assumption is satisfied; the number of observations always exceed the number of parameters.

No multicollinearity.--No exact linear relationship should exist between any of the explanatory variables. When this assumption does not hold, perfect multicollinearity is present. However, multicollinearity is a question of degree and, therefore, we do not test for multicollinearity but measure its degree in any particular sample.

Perfect multicollinearity causes the $(X' X)$ matrix in the least-squares estimator $\hat{\beta} = (X' X)^{-1} X' Y$ to be singular. In the case of high but not perfect multicollinearity, it becomes very difficult to disentangle the separate effects on the dependent variable of the independent variables. The result is the presence of large standard errors of the regression coefficients and the consequent widening of the acceptance region for the hypothesis that a given coefficient is zero. In turn, the possibility of making mistakes in accepting or rejecting hypotheses is very plausible.

The no-multicollinearity assumption was tested by closely examining the matrices of simple correlation coefficients of the independent variables (Table A-8 to Table A-26). Only in 10 cases, out of a possible 399, do the variable combinations show a simple correlation coefficient larger than .50, but, in half the cases, these values are very close to .50. Those occur with total income and farm size (.51) in the corn equation for R_3 (Table A-14) and for R_4 (Table A-15). A value of .53 is observed between distance and farm size in the R_6 wheat equation (Table A-26), total income and farm size in the R_6 corn-bean equation (Table A-10), and between distance and price in the R_6 corn-bean-sorghum equation (Table A-12). Price and farm size in the wheat equation of R_6 show a value of .59 (Table A-26).

Larger values appear in a few instances. Price and distance present a value of .69 in the R_6 wheat equation (Table A-26). Total income and price show a .62 in the R_4 sorghum equation (Table A-21), total income and farm size of .81 in the R_6 corn-sorghum equation (Table A-11), and .84 in the R_6 corn-beans-sorghum equation (Table A-12).

Considering the small number of cases where variable combinations present a simple correlation coefficient larger than .50, and the specific circumstances when they occur, it is safe to infer that multicollinearity is not distorting the least-squares-estimates in any of the equations.

Regression Results

Results obtained from estimating the equations are presented in Table A-27. Numerical values computed for depicting the income, total farm size, and price-quantity relationships are also shown (Table A-28 to Table A-37).

Table A-8.--R_1 corn-beans: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	-0.06	-0.29	0.08	0.09	0.22	-0.29
E_i		1.00	0.04	-0.28	0.04	0.03	-0.06
A_i			1.00	-0.24	-0.39	-0.09	0.34
D_i				1.00	0.17	0.07	-0.25
I_i					1.00	0.18	-0.34
W_i						1.00	0.02
Y_i							1.00

Table A-9.--R_5 corn-beans: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	-0.08	0.02	-0.01	-0.16	0.00	0.11
E_i		1.00	-0.16	-0.03	-0.34	0.00	-0.37
A_i			1.00	-0.02	-0.42	0.00	0.37
D_i				1.00	0.13	0.00	-0.17
I_i					1.00	0.00	-0.34
W_i						1.00	0.00
Y_i							1.00

Table A-10.--R_6 corn-beans: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	0.33	0.21	-0.12	-0.23	-0.04	0.42
E_i		1.00	0.01	0.13	-0.15	-0.15	-0.04
A_i			1.00	0.22	-0.24	0.26	0.53
D_i				1.00	-0.10	0.16	-0.02
I_i					1.00	0.16	-0.21
W_i						1.00	-0.08
Y_i							1.00

Table A-11.--R_6 corn-sorghum: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	-0.05	-0.03	-0.32	-0.06	-0.24	0.04
E_i		1.00	-0.08	-0.35	-0.02	0.31	-0.07
A_i			1.00	0.13	-0.41	0.13	0.81
D_i				1.00	0.02	-0.06	-0.06
I_i					1.00	0.01	-0.40
W_i						1.00	0.22
Y_i							1.00

Table A-12.--R_6 corn-beans-sorghum: simple corrleation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	0.22	0.47	-0.53	-0.17	-0.08	0.41
E_i		1.00	-0.12	-0.47	-0.04	-0.16	-0.05
A_i			1.00	0.07	-0.45	0.36	0.84
D_i				1.00	0.19	0.34	0.10
I_i					1.00	-0.04	-0.38
W_i						1.00	0.34
Y_i							1.00

Table A-13.--R_1 corn: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	-0.03	-0.05	0.36	0.01	-0.04	0.45
E_i		1.00	0.00	-0.05	-0.11	0.16	-0.08
A_i			1.00	-0.14	-0.29	0.11	0.33
D_i				1.00	0.08	0.02	-0.12
I_i					1.00	0.01	-0.24
W_i						1.00	0.06
Y_i							1.00

Table A-14.--R_3 corn: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	-0.03	-0.18	0.38	0.08	-0.03	-0.11
E_i		1.00	-0.10	-0.23	0.08	-0.04	0.10
A_i			1.00	-0.22	-0.31	0.16	0.51
D_i				1.00	-0.10	-0.11	-0.19
I_i					1.00	0.06	-0.16
W_i						1.00	0.06
Y_i							1.00

Table A-15.--R_4 corn: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	-0.04	-0.09	0.11	0.08	-0.16	-0.03
E_i		1.00	-0.05	-0.02	-0.04	0.07	-0.10
A_i			1.00	-0.27	-0.30	0.03	0.51
D_i				1.00	0.16	-0.01	-0.11
I_i					1.00	-0.01	-0.18
W_i						1.00	0.06
Y_i							1.00

Table A-16.--R_5 corn: simple correlation coefficiencts matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	-0.06	-0.21	0.16	0.14	-0.05	0.06
E_i		1.00	-0.10	-0.01	-0.13	-0.04	-0.11
A_i			1.00	-0.09	-0.24	0.11	0.13
D_i				1.00	0.09	0.11	-0.08
I_i					1.00	-0.04	-0.05
W_i						1.00	-0.03
Y_i							1.00

Table A-17.--R_6 corn: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	-0.01	0.05	0.08	-0.09	0.02	0.19
E_i		1.00	-0.25	0.17	0.03	-0.06	-0.14
A_i			1.00	-0.10	-0.26	0.11	0.39
D_i				1.00	-0.03	-0.15	-0.06
I_i					1.00	0.00	-0.26
W_i						1.00	0.09
Y_i							1.00

Table A-18.--R_1 beans: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	-0.44	-0.36	-0.21	0.11	0.19	-0.14
E_i		1.00	0.22	0.07	0.17	-0.08	0.05
A_i			1.00	0.14	-0.26	0.10	-0.09
D_i				1.00	-0.04	0.04	-0.10
I_i					1.00	0.20	-0.14
W_i						1.00	0.18
Y_i							1.00

Table A-19.--R_5 beans: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	-0.01	0.03	0.02	-0.06	-0.03	-0.05
E_i		1.00	0.41	0.02	0.01	-0.15	0.03
A_i			1.00	-0.03	-0.16	0.03	0.07
D_i				1.00	0.10	0.03	-0.29
I_i					1.00	-0.02	-0.38
W_i						1.00	0.14
Y_i							1.00

Table A-20.--R_6 beans: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	-0.09	0.05	-0.01	-0.09	-0.09	0.20
E_i		1.00	-0.17	-0.01	-0.06	-0.11	-0.05
A_i			1.00	0.00	-0.30	-0.04	0.31
D_i				1.00	-0.06	-0.02	-0.03
I_i					1.00	-0.05	-0.23
W_i						1.00	-0.03
Y_i							1.00

Table A-21.--R_4 sorghum: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	-0.01	-0.07	-0.04	0.11	0.07	0.62
E_i		1.00	0.05	-0.02	-0.08	0.17	0.06
A_i			1.00	-0.24	-0.25	0.07	0.22
D_i				1.00	-0.13	0.26	-0.21
I_i					1.00	-0.02	-0.07
W_i						1.00	0.23
Y_i							1.00

Table A-22.--R_4 rice: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	-0.14	-0.03	0.11	-0.04	0.01	0.23
E_i		1.00	-0.23	0.30	0.03	0.03	-0.03
A_i			1.00	-0.11	-0.28	0.01	0.26
D_i				1.00	-0.27	0.13	-0.03
I_i					1.00	0.14	-0.34
W_i						1.00	-0.18
Y_i							1.00

Table A-23.--R_5 rice: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	-0.28	-0.08	-0.04	-0.17	-0.22	0.37
E_i		1.00	-0.19	-0.08	0.01	-0.01	-0.31
A_i			1.00	0.10	-0.24	-0.30	0.15
D_i				1.00	-0.09	0.12	-0.20
I_i					1.00	0.11	-0.23
W_i						1.00	0.04
Y_i							1.00

Table A-24.--R_6 rice: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	0.10	-0.30	-0.25	0.44	-0.17	-0.20
E_i		1.00	-0.03	-0.39	-0.03	0.02	-0.41
A_i			1.00	0.27	-0.33	-0.12	0.32
D_i				1.00	-0.01	-0.01	0.15
I_i					1.00	-0.05	-0.33
W_i						1.00	-0.01
Y_i							1.00

Table A-25.--R_1 wheat: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	-0.11	-0.15	0.00	-0.04	-0.17	-0.08
E_i		1.00	-0.02	0.01	0.22	0.03	-0.11
A_i			1.00	-0.14	-0.23	0.11	0.19
D_i				1.00	0.10	-0.01	0.09
I_i					1.00	-0.11	-0.11
W_i						1.00	0.05
Y_i							1.00

Table A-26.--R_6 wheat: simple correlation coefficients matrix of the independent variables

	P_i	E_i	A_i	D_i	I_i	W_i	Y_i
P_i	1.00	0.05	0.59	0.69	-0.02	-0.50	0.17
E_i		1.00	-0.16	0.09	-0.00	-0.33	-0.32
A_i			1.00	0.53	-0.04	-0.40	0.42
D_i				1.00	-0.02	-0.39	0.05
I_i					1.00	0.05	-0.06
W_i						1.00	0.19
Y_i							1.00

Table A-27.--Regression coefficients for each basic grain or association by regions of Guatemala[a]

Region	Crop	Constant	P_i	E_i	A_i	D_i	I_i	W_i	Y_i	d.f.	R^2
1	C-B	0.27392	-0.00524[f] (0.00419)	0.00482[f] (0.00541)	-0.08943[b] (0.01974)	0.00024 (0.00040)	-0.00001[b] (0)	0.00144[d] (0.00099)	-10.61613[b] (4.25824)	55	.33
5	C-B	0.28718	-0.00415[g] (0.00500)	0.00364 (0.01175)	-0.05829[f] (0.05218)	0.00126[d] (0.00093)	-0.00001[f] (0.00001)	0 (0)	- 6.04527 (9.61876)	26	.02
6	C-B	0.34978	-0.00388 (0.00642)	0.00647[d] (0.00481)	-0.08192[d] (0.05403)	0.00049 (0.00082)	-0.00003[b] (0.00001)	-0.00412 (0.00753)	-16.55984[b] (7.64936)	37	.44
6	C-S	0.19378	-0.00112 (0.00267)	0.00540[g] (0.00665)	-0.05217[f] (0.05855)	-0.00074[f] (0.00076)	-0.00001[b] (0)	0.01147[b] (0.00428)	- 7.57932[f] (7.34657)	30	.34
6	C-B-S	0.51144	-0.01083[g] (0.01299)	0.00509 (0.01283)	-0.36586[c] (0.14030)	-0.00335[f] (0.00326)	-0.00002[c] (0.00001)	-0.02748 (0.05376)	20.90172[d] (14.82739)	8	.50
1	C	0.44802	0.02884[b] (0.01312)	0.01116 (0.01686)	-0.14456[c] (0.07254)	0.00176[d] (0.00113)	-0.00011[b] (0.00003)	0.00129[f] (0.00148)	-20.41058[b] (7.41719)	78	.28
3	C	1.03937	-0.00049 (0.00162)	0.00699 (0.01321)	-0.37019[b] (0.13443)	0.00019 (0.00092)	-0.00006[b] (0.00001)	-0.00528[b] (0.01877)	-105.81248[b] (16.74541)	43	.70
4	C	1.01516	-0.00193 (0.00502)	-0.00305 (0.01266)	-0.20645[b] (0.07638)	0.00035 (0.00063)	-0.00007[b] (0.00001)	0.01868[b] (0.00524)	- 75.78100[b] (8.82157)	200	.44
5	C	0.76560	0.00881[b] (0.00380)	0.01286[b] (0.00528)	-0.08178[c] (0.04451)	-0.00129[d] (0.00099)	-0.00008[b] (0.00001)	-0.00029 (0.00126)	- 39.90728[b] (4.50239)	242	.38
6	C	0.46929	0.02270[b] (0.00897)	0.01256[f] (0.01301)	-0.00962 (0.07740)	-0.00052 (0.00171)	-0.00001[f] (0.00001)	0.00352[c] (0.00178)	- 32.85251[b] (9.40590)	133	.12
1	B	0.33231	0.07544[b] (0.02915)	-0.02071[g] (0.02981)	0.31937[b] (0.11896)	0.00010 (0.00139)	-0.00004 (0.00006)	-0.00071 (0.00367)	- 16.94399[b] (5.60921)	13	.48
5	B	0.76875	0.00532[g] (0.00665)	0.00880 (0.02105)	-0.02692[c] (0.01234)	-0.00188[g] (0.00261)	-0.00013[f] (0.00012)	0.00014 (0.00151)	- 11.58908[d] (8.50285)	55	.01

Table A-27.--continued

Region	Crop	Constant	P_i	E_i	A_i	D_i	I_i	W_i	Y_i	d.f.	R^2
6	B	0.63009	0.03663[b]	0.01075[f]	0.09483[d]	0.00046	-0.00020[b]	-0.00067[b]	-32.08327[b]	116	.34
			(0.01099)	(0.01149)	(0.06430)	(0.00082)	(0.00003)	(0.00026)	(7.48973)		
4	S	1.04221	0.00095	-0.01663[f]	0.03633	0.00087[f]	-0.00015[b]	0.00807[b]	-27.06131[d]	34	.40
			(0.00953)	(0.01608)	(0.06260)	(0.00069)	(0.00004)	(0.00320)	(16.50459)		
4	R	0.94006	0.00730[b]	0.00957[c]	0.01260	-0.00049[c]	-0.00012[b]	0.00669[b]	- 7.14182[d]	44	.45
			(0.00238)	(0.00542)	(0.02230)	(0.00027)	(0.00003)	(0.00147)	(5.18718)		
5	R	0.98878	0.00063[g]	0.00077	-0.12806[d]	0.00017	-0.00004[b]	-0.00032	-10.63218[b]	42	.23
			(0.00090)	(0.00227)	(0.07980)	(0.00037)	(0.00001)	(0.00218)	(4.37460)		
6	R	0.88339	-0.00581	0.01630[f]	-0.02060	0.00520[g]	-0.00004[b]	0.00172[g]	-76.41856[c]	20	.46
			(0.01153)	(0.01713)	(0.19699)	(0.00678)	(0.00001)	(0.00223)	(31.31350)		
1	W	0.92030	-0.00893[f]	0.01989[b]	-0.03073[c]	0.00019	-0.00020[b]	0.01076[c]	- 3.37986[b]	196	.37
			(0.00871)	(0.00509)	(0.01631)	(0.00049)	(0.00002)	(0.00648)	(0.96901)		
6	W	1.02771	-0.00331[d]	-0.00206[f]	-0.02066[f]	-0.00012	-0.00031[b]	-0.01455[c]	0.01958	17	.96
			(0.00225)	(0.00188)	(0.01798)	(0.00028)	(0.00001)	(0.00580)	(0.92662)		

[a]Figures in parentheses are standard errors. C, B, S, R, and W represent corn, beans, sorghum, rice, and wheat, respectively.

[b]Significant at the 99 percent level.

[c]Significant at the 95 percent level.

[d]Significant at the 90 percent level.

[e]Significant at the 80 percent level.

[f]Significant at the 60 percent level.

[g]Significant at the 50 percent level.

Table A-28.--Income-quantity relationships for the associations graphed in Figure 8[a]

Y_i[b]	C-B		C-B		C-B		C-S	
	1		5		6		6	
	Q^M	Q^T	Q^M	Q^T	Q^M	Q^T	Q^M	Q^T
10	7740	9672	5564	6920	2102	3959	11951	14578
20	11302	13534	7600	8956	3942	5849	16442	19069
50	15565	17797	9492	10848	6340	8197	20763	23390
100	17653	19885	10323	11679	7605	9462	22676	25303
200	18892	21124	10787	12143	8397	10254	23754	26381
400	19572	21804	11034	12390	8845	10702	24329	26956
600	19808	22040	11118	12474	9003	10860	24526	27153
800	19928	22160	11161	12517	9083	10940	24626	27253
1000	20001	22233	11187	12543	9133	10990	24686	27313
1200	20049	22281	11204	12560	9165	11022	24726	27353
1400	20084	22316	11216	12572	9189	11046	24755	27382
1600	20111	22343	11225	12581	9207	11064	24777	27404
1800	20131	22363	11233	12589	9221	11078	24793	27420
2000	20147	22379	11238	12594	9232	11089	24807	27434
2200	20161	22392	11243	12599	9241	11098	24818	27445

[a] C, B, and S stand for corn, beans, and sorghum, respectively.

[b] In quetzales per year.

Table A-29.--Farm size-quantity relationships for the associations graphed in Figure 9[a]

A_i[b]	C-B		C-B		C-B		C-S		C-B-S	
	1		5		6		6		6	
	Q^M	Q^T	Q^M	Q^T	Q^M	Q^T	Q^M	Q^T	Q^M	Q^T
0.05	4745	6977	3534	4900	4032	5889	9203	11830	-432	2313
0.10	8440	10672	5718	7074	6830	8687	14440	17067	1560	4305
0.25	13418	15650	8316	9672	10292	12149	19474	22101	6156	8901
0.50	16300	18532	9663	11019	12154	14011	21884	24511	11074	13819
0.75	17512	19444	10199	11555	12909	14766	22808	25435	14194	16939
1.00	18180	20412	10487	11843	13317	15174	23297	25924	16350	19095
1.25	18602	20834	10667	12023	13574	15431	23600	26227	17928	20673
1.50	18894	21126	10790	12146	13749	15606	23805	26432	19134	21879
1.75	19107	21339	10880	12236	13877	15734	23954	26581	20085	22830
2.00	19270	21502	10948	12304	13974	15831	24067	26694	20854	23599
2.25	19398	21630	11001	12357	14051	15908	24155	26782	21489	24234
2.50	19502	21734	11044	12400	14113	15970	24226	26853	22023	24768
2.75	19588	21820	11080	12436	14164	16021	24285	26912	22477	25222
3.00	19660	21892	11109	12465	14206	16063	24334	26961	22868	25613
3.25	19721	21953	11135	12491	14243	16100	24375	27002	23209	25954
3.50	19774	22006	11156	12512	14274	16131	24411	27038	23508	26253

[a]C, B, and S stand for corn, beans, and sorghum, respectively.

[b]In hectares.

Table A-30.--Price-quantity relationships for the associations graphed in Figure 10[a]

P_i[b]	C-B		C-B		C-B		C-S		C-B-S	
	1		5		6		6		6	
	Q^M	Q^T	Q^M	Q^T	Q^M	Q^T	Q^M	Q^T	Q^M	Q^T
0.03	17521	19753	9523	10879	15882	17739	23791	26418	16377	19122
0.06	19615	21847	10489	11845	17353	19210	24358	26985	20822	23567
0.09	20415	22647	10850	12206	17900	18757	24552	27179	22802	25547
0.12	20838	23070	11040	12396	18185	20042	24651	27278	23922	26667
0.15	21099	23331	11156	12512	18360	20217	24710	27337	24642	27387
0.18	21276	23508	11235	12591	18478	20335	24750	27377	25144	27889
0.21	21405	23637	11291	12647	18563	20420	24778	27405	25514	28259
0.24	21502	23734	11334	12690	18628	20485	24800	27427	25799	28544
0.27	21578	23810	11368	12724	18678	20535	24816	27443	26024	28769
0.30	21639	23871	11395	12751	18719	20576	24830	27457	26206	28951
0.33	21690	23922	11417	12773	18752	20609	24840	27467	26537	29102
0.36	21732	23964	11436	12792	19780	20637	24850	27477	26484	29229

[a]C, B, and S stand for corn, beans, and sorghum, respectively.

[b]In quetzales per kilogram.

Table A-31.--Income-quantity relationships for corngraphed in Figure 11

Y_i[a]	1		3		4		5		6	
	Q^M	Q^T	Q^M	Q^T	Q^M	Q^T	Q^M	Q^T	Q^M	Q^T
10	-831	552	-2108	217	-1527	225	-908	282	-1214	467
20	-449	934	-1898	427	-1312	441	-655	535	- 823	858
50	203	1586	-1299	1026	- 721	1032	- 32	1159	49	1730
100	687	2070	- 401	1924	110	1863	705	1895	933	2614
200	1060	2443	1097	3422	1367	3120	1587	2777	1830	3511
400	1302	2685	3278	5603	2954	4707	2430	3620	2557	4238
600	1394	2777	4791	7115	3915	5668	2837	4027	2871	4552
800	1442	2825	5900	8225	4560	6313	3077	4267	3047	4728
1000	1472	2855	6750	9075	5022	6775	3235	4425	3159	4840
1200	1492	2875	7420	9745	5370	7123	3348	4538	3236	4917
1400	1507	2890	7964	10289	5641	7394	3431	4621	3293	4974
1600	1518	2901	8413	10738	5858	7611	3496	4686	3336	5017
1800	1527	2910	8790	11115	6036	7789	3548	4738	3371	5052
2000	1533	2917	9111	11436	6184	7937	3590	4780	3399	5080
2200	1539	2922	9388	11713	6310	8063	3625	4815	3422	5103

[a]In quetzales per year.

Table A-32.--Farm size-quantity relationships for corn graphed in Figure 12

A_i[a]	1		3		4		5		6	
	Q^M	Q^T	Q^M	Q^T	Q^M	Q^T	Q^M	Q^T	Q^M	Q^T
0.05	-970	413	-2020	305	-1351	402	-570	620	1251	2932
0.10	-659	724	-1732	593	- 989	764	-108	1082	1842	3523
0.25	- 53	1330	- 956	1369	- 93	1660	764	1954	2327	4008
0.50	459	1842	101	2426	974	2727	1482	2672	2520	4201
0.75	730	2113	942	3267	1717	3470	1855	3045	2589	4270
1.00	898	2281	1628	3953	2264	4017	2083	3273	2624	4305
1.25	1012	2395	2197	4522	2683	4436	2237	3427	2645	4326
1.50	1094	2477	2677	5002	3015	4768	2348	3538	2659	4340
1.75	1157	2540	3088	5413	3285	5038	2432	3622	2670	4351
2.00	1206	2589	3443	5768	3508	5261	2498	3688	2677	4358
2.25	1246	2629	3753	6078	3695	5448	2551	3741	2683	4364
2.50	1278	2661	4026	6351	3855	5608	2594	3784	2688	4369
2.75	1305	2688	4269	6594	3993	5746	2630	3820	2692	4373
3.00	1328	2711	4485	6810	4114	5867	2661	3851	2695	4376
3.25	1348	2731	4680	7005	4219	5972	2687	3877	2698	4379
3.50	1366	2749	4856	7181	4313	6066	2710	3900	2701	4382
3.75	1381	2764	5016	7341	4397	6150	2730	3920	2703	4384
4.00	1394	2777	5162	7487	4472	6225	2747	3937	2705	4386

[a]In hectares.

Table A-33.--Price-quantity relationships for corn graphed in Figure 13

P_i [a]	Region 3		Region 4	
	Q^M	Q^T	Q^M	Q^T
0.03	5750	8075	3724	5477
0.06	5986	8311	4336	6089
0.09	6067	8392	4572	6325
0.12	6109	8434	4697	6450
0.15	6134	8459	4774	6527
0.18	6150	8475	4826	6579
0.21	6163	8488	4864	6617
0.24	6172	8497	4893	6646
0.27	6179	8504	4916	6669
0.30	6184	8509	4934	6687
0.33	6189	8514	4949	6702
0.36	6193	8518	4961	6714
0.39	6196	8521	4972	6725
0.42	6199	8524	4981	6734

[a] In quetzales per kilogram.

Table A-34.--Income-quantity relationships for beans graphed in Figure 14

Y_i[a]	Region					
	1		5		6	
	Q^M	Q^T	Q^M	Q^T	Q^M	Q^T
10	-172	167	-53	131	-274	112
20	- 52	287	41	225	-177	209
50	167	506	208	392	50	436
100	338	677	336	520	298	684
200	476	815	438	622	569	955
400	568	907	506	690	805	1191
600	604	943	532	716	912	1298
800	623	962	546	730	973	1359
1000	634	973	554	738	1013	1399
1200	642	981	560	744	1041	1427
1400	648	987	564	748	1061	1447
1600	652	991	567	751	1077	1463
1800	656	995	570	754	1089	1475
2000	658	997	572	756	1099	1485
2200	661	1000	573	757	1108	1494

[a] In quetzales per year.

Table A-35.--Income-quantity relationships for rice graphed in Figure 15

Y_i [a]	Region 4		Region 5		Region 6	
	Q^M	Q^T	Q^M	Q^T	Q^M	Q^T
10	59	235	-22	247	-734	109
20	273	449	217	486	-627	216
50	815	991	876	1145	-319	524
100	1483	1659	1821	2090	155	998
200	2324	2500	3291	3560	981	1824
400	3173	3349	5223	5492	2266	3109
600	3601	3777	6436	6705	3220	4063
800	3858	4034	7268	7537	3957	4800
1000	4030	4206	7875	8144	4543	5386
1200	4154	4330	8336	8605	5020	5863
1400	4246	4422	8699	8969	5416	6259
1600	4318	4494	8992	9261	5750	6593
1800	4376	4552	9234	9503	6035	6878
2000	4423	4599	9437	9706	6282	7125
2200	4462	4638	9609	9878	6498	7341

[a] In quetzales per year.

Table A-36.--Farm size-quantity relationships for rice graphed in Figure 16

A_i[a]	Region			
	5		6	
	Q^M	Q^T	Q^M	Q^T
0.05	-165	104	692	1535
0.10	- 62	207	1613	2456
0.25	233	502	2996	3839
0.50	692	961	3882	4725
0.75	1114	1383	4276	5119
1.00	1502	1771	4499	5342
1.25	1862	2131	4642	5485
1.50	2195	2464	4742	5585
1.75	2505	2774	4816	5659
2.00	2794	3063	4872	5715
2.25	3063	3332	4917	5760
2.50	3316	3585	4953	5796
2.75	3553	3822	4983	5826
3.00	3776	4045	5009	5852
3.25	3987	4256	5030	5873
3.50	4185	4454	5049	5892

[a]In hectares.

Table A-37.--Farm size-quantity relationships for wheat graphed in Figure 17

A_i[a]	Region 1		Region 6	
	Q^M	Q^T	Q^M	Q^T
0.05	100	415	36	62
0.10	382	697	97	123
0.25	863	1178	273	299
0.50	1214	1529	543	569
0.75	1382	1697	788	814
1.00	1482	1797	1012	1038
1.25	1547	1862	1217	1243
1.50	1593	1908	1406	1432
1.75	1628	1943	1579	1605
2.00	1654	1969	1740	1766
2.25	1675	1990	1890	1916
2.50	1693	2008	2029	2055
2.75	1707	2022	2158	2184
3.00	1719	2034	2280	2306
3.25	1730	2045	2393	2419
3.50	1739	2054	2500	2526

[a]In hectares.

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BIOGRAPHICAL SKETCH

Jose Alvarez was born in Oriente, Cuba, on December 10, 1940. He attended Law School in Oriente University and Havana University. In February, 1969, he came to the United States. He received his Bachelor of Arts degree with a major in economics, with honors, from the University of Florida, in December, 1971, and his Master of Science in Agriculture in August, 1974. He is now a candidate for the degree of Doctor of Philosophy.

He is a member of the American Agricultural Economics Association, the American Economic Association, the Southern Agricultural Economics Association, Omicron Delta Epsilon, and the Society for International Development.

He is married to the former Mercy Fernández and has two children, Mercita and Ricardo José.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

C.O. Andrew, Chairman
Associate Professor of Food and Resource Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Leo Polopolus
Professor of Food and Resource Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

R.W. Ward
Associate Professor of Food and Resource Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

W.W. McPherson
Graduate Research Professor of Food and Resource Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

M.J. Carvajal
Assistant Professor for the Center for Latin American Studies

This dissertation was submitted to the Graduate Faculty of the College of Agriculture and to the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

June 1977

Dean, College of Agriculture

Dean, Graduate School