AN ABSTRACT OF THE THESIS OF

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Title: THE IMPACTS OF GOVERNMENT MARKET INTERVENTION ON WEED CONTROL TECHNOLOGY, INCOME AND EMPLOYMENT: A CASE STUDY OF BASIC GRAIN FARMS IN EL SALVADOR, CENTRAL AMERICA

Abstract approved: ______________________
Dr. Stanley Frank Miller

El Salvador's land resources are intensively cultivated. Labor is relatively abundant and wages are low. This study analyzed the effects of government policies and observed farm price distortions on enterprise/weed control system choices and associated income-employment effects.

A regional linear programming framework was employed to analyze the effects of alternative government policies and observed farm prices on farm efficiency, employment, and income distribution within Central El Salvador. A major conclusion of the study was that the presence of price distortions and off-farm employment alternatives were not sufficient to induce changes in weed control technology on small and medium farms. The most efficient system both from an individual and social point of view was the use of manual

weed control for all selected enterprises. The principal effects of price distortions on the small and medium farms (when compared with their undistorted price solutions) were the tendencies to reduce the number of selected enterprises and to modify the area allocated between enterprises.

On the other hand, the process of capital-labor substitution on large farm appeared to be sensitive to direct and indirect government subsidies on capital when off-farm employment alternatives existed between 0 and 50 percent of total available labor supply. Herbicide-area diffusion ranged from 75 to 87 percent of total area on the large farm whenever the policy mix included direct or indirect capital subsidies.

Comparisons of the alternative distorted price solutions using the undistorted price solutions revealed that whenever capital subsidies were present in any policy mix when off-farm employment opportunities were held at 50 percent of the available labor supply, total weed control employment levels were lower than the social price solution by 45 to 55 percent. The group most seriously affected by weed control employment reductions was the landless laborer. The group's weed control employment losses ranged from 73 to 89 percent below their social price-employment solution.

The presence of capital subsidies in any policy mix under the 50 percent off-farm employment opportunity solutions induced relatively larger income gains (20 to 67 percent) to the three sizes of farms and income losses (3 to 13 percent) to the landless laborers. Production efficiency losses were relatively high in each of the three sizes of farms whenever capital subsidies were present.

In view of these findings the El Salvador government should recognize a conflict between the use of direct and indirect capital subsidies particularly on herbicides and farm machinery and between stated national goals of increasing employment and improving income distribution. Fixing the wage rate at ¢3.85/day induced relative income gains that tend to favor the small farm and landless laborers . . . the least privileged and the biggest group in El Salvadors' total population. Output support induced equal relative income gains (19 percent) to the three sizes of farms. Maintaining subsidies on labor-using modern farm inputs (fertilizer, insecticides and improved seeds) would provide incentives for increasing grain production and intensify the widespread diffusion of these inputs into the basic grain sector of El Salvador.

The Impacts of Government Market Intervention on Weed Control Technology, Income and Employment: A Case Study of Basic Grain Farms in El Salvador, Central America

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LIST OF CONVERSION TABLES

1 kilogram = 2.205 pounds

1 quintal = 100 pounds

1 metric ton = 2,204.6 pounds

1 hectare = 2.471 acres

1 millimeter = 0.039 inch

1 square kilometer = 0.621 square mile

1 El Salvador colon = 0.40 U.S. dollars (1975-76)

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I. INTRODUCTION

The Role of Government in Agricultural Development in Developing Countries

Today, many developing countries are faced with serious problems of low agricultural productivity, rapid population growth rates, high levels of unemployment and underemployment, and widening disparities in income distribution. Mass poverty in the countryside and urban slums have caused serious social disturbances and political instability. Realizing the current and potential social consequences of the worsening economic disparities between various socioeconomic groups, governments of many developing countries have begun to take more active roles in agricultural development (Woods,1975).

Public intervention in agricultural activities have been justified on the grounds that existing social and economic institutions are not sufficiently well developed (or in many instances are nonexistent) to permit national modernization of the agricultural sector and the realization of other national policy objectives. There are several forms of traditional public intervention - provision and maintenance of the basic infrastructure (roads, bridges, power, irrigation systems, etc), creation and operation of agricultural institutions (market centers, credit institutions, schools, extension services, experiment/research stations, etc.), and the establishment and regulation of legal standards governing agricultural business activities (Johnston and Kilby, 1975). Direct and indirect government intervention in product and factor markets are the primary focus of this study, however. Direct government intervention include output subsidies, subsidizing wage rates, direct procurement and sale of farm inputs to individual farmers or to farm organizations. Indirect government intervention includes government policies or programs that indirectly affect the market and thus create bias in the selection of production activities and allocation of resources. Direct and indirect government intervention in the market system can influence the type and rate of agricultural technology adoption, enterprise choice, resource allocation and income distribution among the different economic groups in the agricultural sector.

Distributional Effects of Changes in Agricultural Technology

The social effects of agricultural technological change appear to vary from one social-economic-ecologic setting to another. The interaction of a technology with the existing institutional and ecologic setting determines efficiency and welfare effects. In developed countries continuous agricultural innovation and adoption have played a major role in raising the standards of living of the population.

The impact of new technology in developing countries is unclear. Under appropriate settings, technological change has produced great benefits to the adopting farmers. However, concern has been expressed by some economists concerning the adverse distributional effects of technologic change in developing countries (Gotsch, 1972; Falcon, 1970). Those adversely affected were usually small farmers, tenants and landless laborers. Some have argued that technical change by itself has not caused this adverse distributive effect, but rather the structural and institutional setting that leads to the distributional inequities associated by its use (Gotsch, 1972; Dorner, 1971).

In many developing countries economic and political control is often maintained by the political elite. Under this situation, the introduction of capital intensive technologies have at times been encouraged by government price distortions, which have raised private returns to capital intensive technologies above the social benefit to the nation (Young, 1977).

In El Salvador, the distribution of productive resources, particularly land, is highly skewed (Cutie, 1975; Nathan Associates, 1969). At the same time various government policies have been introduced to favor adoption of modern agricultural technology among large farms. As the country's population and unemployment rates continue to grow the distributional effects of these intervention policies are potentially serious.

The government of El Salvador has recently embarked on an intensive development program for the production and marketing of basic grains. Various forms of direct and indirect government intervention policies have been or are to be implemented. These policies need to be evaluated to determine whether they are consistent with public objectives of increasing agricultural productivity, increasing farm employment and attaining a more equitable income distribution.

Weed Control and Agricultural Technology in El Salvador

The agricultural sector of El Salvador is "dualistic". It consists of a highly productive and concentrated export plantation subsector and an under-productive and resource-dispersed food production subsector (Cutie, 1975). The diffusion of modern agricultural technology is highest in the export crop subsector - mainly coffee, cotton and sugarcane - where farm size is relatively large. The food crop subsector consisting mostly of small farms is characterized by traditional production techniques and relatively modest amounts of modern agricultural inputs. During the last three or four years, government programs to encourage the use of high yielding seed varieties, chemical fertilizers and insecticides have begun to produce modest production increases (Cutie, 1975; Baker and Smith, 1975; Coyners, 1972).

Indirect government subsidies for imported agricultural chemicals, and farm machinery and equipment have induced significant increases in demand for these inputs by the export crop subsector. It has been estimated that the export crop subsector accounts for 89 percent of the total demand for agricultural chemicals. The food crop subsector absorb the other 11 percent.

Increased use of herbicides for weed control also have been influenced by subsidies for the importation of herbicides and the imposition of legal minimum wage rate. The importation of liquid herbicide in 1974 represents a 3.5 fold increase over the 1970 import figure, while the quantity of granular herbicide imported in 1974 was eight times more than in 1970 (MAG, 1975).

The use of herbicides for weed control in the basic grain farm subsector, however, appears to be insignificant at present. Only five to ten percent of total herbicides was used for the production of basic grain crops. Ninety five percent of the herbicides consumed was by large farms, mainly engaged in rice production (Baker and Smith, 1975).

If urgently needed production increases are to be achieved, the importance of weed control must be understood. Crop yields can be reduced by 10 to 90 percent when weeds are not controlled. Weeds as well as cultivated crops respond to improved growing conditions. Therefore, modernization of agriculture actually increases the need for good weed control. In some situations, high labor demand for manual weeding may constrain the expansion of crop production. Some studies have shown that 20 to 50 percent of total labor required in crop production was accounted by weed control labor (Young, 1977; Diaz et al., 1974; Haswell, 1971; Johnston, 1971).

The adoption of herbicides for weed control in El Salvador, it has been argued, can contribute significantly to the worsening unemployment and underemployment problems in the agricultural sector. Herbicide use potentially represents one of the highest labor-displacing techniques in modern agriculture. As Young (1977) pointed out, replacement of manual weeding with herbicides applied by backpack-sprayer can reduce weed control labor demand by as much as 20 to 35 times and by 1000 times when compared to aerial herbicide application. In contrast, several improved agricultural inputs, such as high yielding seed varieties, irrigation, insecticides and chemical fertilizers are labor-using technologies (Cutie, 1975).

To summarize, the continued diffusion of herbicides for weed control in El Salvador arising from either economic incentive or government intervention, could significantly increase unemployment and underemployment levels in the agricultural sector and further aggravate the already widening disparities in income distribution in one of the most densely populated countries on the American continent.

Objectives of this Study

The primary objective of this study is to evaluate the impacts of government market intervention policies and other forms of observed (measurable) farm price distortions on the selection of appropriate weed control systems in the basic grain crop farms of Central El Salvador and their associated income and employment effects. The estimation of socially efficient weed control systems and their associated optimal income and employment will be identified. Then these results will be compared with those obtained from different forms of government intervention policies and observed farm price distortions - singly and in combination.

Content and Organization of this Study

The remainder of Chapter I provides a general background information describing the agricultural sector of El Salvador. Chapter II describes the production trends and the market structure of the basic grain subsector and major government policies affecting it.

Selected literature on the impacts of agricultural technology changes in developing countries and research methodologies employed in evaluating government policies is reviewed in Chapter III. The methodology of this study is also discussed in Chapter III.

A regional linear programming model for the theoretical framework for evaluating the effects of policy-induced price distortions on weed control technology adoption is presented in Chapter IV. In Chapter V, the background information and specific assumptions used in the regional linear programming analysis of representative basic grain case study farms are presented.

The results of the analysis are discussed in Chapter VI. Discussion is focused on individual and combined effects of different types of government intervention policies and observed farm price distortions as compared with the corresponding social optimum solution. Chapter VII summarizes relevant conclusions and policy implications of the regional linear programming analysis. The appropriateness of alternative policies, singly or in combination, are discussed with respect to stated national policy objectives and social equity goals. Suggestions for policy reforms and research priority areas are outlined.

General Background Information of El Salvador

The history of El Salvador may be arbitrarily divided into four major periods, namely, pre-Columbian, Spanish discovery and conquest, political break with Spain, and the present (Cutie, 1975). Before the Spanish conquest, the area which is now El Salvador was made up of two large Indian states and several principalities. The indigenous inhabitants were a Nahoa race called Pipiles, with a civilization similar to that of their Aztec cousins. Their country was a colony of Spain between 1525 and 1821 and was governed from Guatemala City by a Captaincy General. From 1823 to 1837 the country was part of the United Provinces of Central America. Complete political independence was attained in 1838. As elsewhere in Central and Latin America, frequent revolutions or coups d'etat have marked El Salvador's history as an independent state. Relative political stability was achieved in the period 1900-1930, in the decade of the 1950's and early 1970's (Browning, 1971; Thompson, 1956).

Availability and Distribution of Resources

El Salvador is geographically the smallest of the six Central American countries, with a land area of 20,000 square kilometers. Among El Salvador's most valuable resources are its fertile volcanic soil which produces the country's chief crop, coffee; its subtropical climate which makes possible the production of more than one crop per year for some grain and horticultural crops; and its relatively abundant labor supply.

Land use and distribution. El Salvador's land resources are intensively utilized for agricultural production. In 1970 the area in farm holdings comprised about 70 percent of total land area. The number of farms increased by two percent, from 226,896 in 1960 to 272,432 in 1970, but the average size dropped from 7 hectares to 5.4 hectares. Farmland per capita was about 0.6 hectare in 1969 and has dropped to less than 0.5 hectare at present (Census 1961 and 1971, M.E).

Most agricultural land is privately owned and is farmed by owners or tenants. Holdings range in size from plantations of several thousand hectares to plots of less than 0.2 hectare. Comparison of Census data (1961-1971) indicate that the number of very large farms have declined. In 1970, about 49 percent of total number of farms were less than one hectare in size, while large farms of 50 hectares and up comprised only 1.4 percent of total number of farms. The large farms encompassing the best land in the country are owned by wealthy families and are handed down from one generation to another (Coyners, 1972). SIECA-FAO (1974) reported that in 1970, 60 percent of total number of farms occupy as little as 13 percent of total agricultural land while 2.5 percent of total number of farms occupy almost 65 percent of the total agricultural land.

Income appears to be positively associated with land ownership. In 1960 the monthly incomes of farms of less than 1.9 hectares ranged from 62 to 87 colones while those farms of 50 hectares and over earned between 1477 to 5366 colones (Nathan Associates, 1969). In addition, in 1970, 84.2 percent of total agricultural population comprising the landless and those farming less than 0.7 hectare accounted for only 27.8 percent of total agricultural income (SIECA-FAO, 1974).

To sum up, El Salvador's land resources are already extensively cultivated and prospects for new area expansion are few. Potentials for increasing agricultural production appear to be limited to increasing crop yields on land already cultivated. Increasing yields of basic grains on existing land will require widespread diffusion of modern agricultural technology such as high yielding seed varieties, chemical fertilizers, insecticides and improved cultural practices. Due to the predominance of small size holdings in basic grain crop production and extremely limited capital resources and technical expertise, the role of government is very crucial.

As agricultural modernization continues in El Salvador, the skewed resource distribution may exacerbate the already widening disparities in income distribution. Unless a practical way is found to distribute more equitably income gains from technological change, the prospects for improving the standards of living of the vast majority of small farmers, tenants and landless laborers appear to be bleak, and social unrest and political instability may once again disrupt the relative stability now enjoyed in El Salvador.

Population and labor resources. El Salvador's population growth rate during the last ten years was about 3.5 percent per annum. In 1974, total population was estimated at 3.9 million. Population density per square kilometer was 177, making it the most densely populated country on the American continent. About 60 percent of total population was classified as rural in 1970. The working force which comprised 31.4 percent of total population was growing at the rate of three percent per year during the 1961-71 period. What was considered the population explosion of the sixties is turning into the labor explosion of the seventies.

The Ministry of Agriculture (MAG, 1970) estimated that unemployment in agriculture ranged from 38 to 44 percent during the 1965-70 period. Laborers farm small plots of land as squatters or under some arrangements with the landowners, usually producing basic grain foods for their families. Peak employment occurs during the coffee/cotton/sugarcane harvesting season from November through February.

Economic Trends

In spite of the steady growth of the industrial sector, agriculture still remains as the major industry in El Salvador's economy. Agriculture's contribution to gross domestic product (GDP) dropped from 32 percent in 1960 to 25 percent in 1974. The proportion of agricultural products in total exports dropped from 85 percent during the 1960-64 period to 66 percent in 1968.

During the 1960-69 period the economy grew at an average annual rate of 6.8 percent. Rising production and exports of coffee and cotton during the early years of the decade and mounting exports of industrial products to the Central American Common Market countries contributed to this growth. But in recent years the economy's growth rate slowed down considerably. During the 1970-75 period the GDP's growth rate was down to 4.9 percent, while agricultural production grew at a rate of 3.6 percent (BCR, 1975).

The share of the manufacturing industry in GDP increased from 16.4 percent in 1960 to 18 percent in 1974. However, the industrial sector is not large enough to absorb the rapidly expanding labor force in the country. For example, it has been estimated that for every new job created by this sector, there are at least four candidates for it (Thiesenhusen, 1971).

Government and Political Institution and Structure

El Salvador's present government and political structure is based on the 1962 Constitution. It is republican and democratic. It is also highly centralized. The governmental functions are carried out by three branches - legislative, executive and judicial. The country is divided into 14 administrative departments or provinces, each with a Governor appointed by the President. Each department or province is further divided into municipalities. Local government is vested in the municipal council elected by popular vote. Executive power is exercised by the President, who is elected by popular vote for a single five-year term. The President is aided in the discharge of executive functions by 11 appointed cabinet ministers. The Ministry of Agriculture with various service and regulatory agencies implements government policies for developing agriculture in the country.

Legislative power is vested in an unicameral Legislative Assembly consisting of 52 deputies or members, who are elected by popular vote in their respective departments for a two-year term. Legislation may be introduced by the deputies, the President or the Supreme Court and become law only upon presidential approval (U.S. Dept. of State, 1967).

As in many developing countries, most of the political power in El Salvador is actually controlled by a small group who are the representatives of the landed aristocracy and the industry. As a result, government policies, as implemented by various service and regulatory agencies, often tend to reinforce or maintain the economic superiority of this group (LeBaron and Associates, 1975; Nathan Associates, 1969).

Within the agricultural sector, the larger farms producing mostly export crops have been heavily favored over the smaller food crop producing farms by government extension services, credit, tax breaks and indirect subsidies in the importation of modern agricultural technology. While large subsidies and tax advantages have been extended to large-scale export crop production, progress in the implementation of land redistribution and other development programs to benefit small farmers have been slow and modest (Cutie, 1975; Baker and Smith, 1975; Quiroz, 1973).

These policies have intensified the problems of rural poverty and unemployment. Labor displacement in the large farms has been increased through the introduction of labor-saving technologies and less labor-intensive crops (Cutie, 1975; Schwiden, 1965). Consequently, some displaced workers have been forced onto a growing number of smaller and smaller farm units. Others have joined the unemployed ranks in the urban slums of the City of San Salvador, the country's capital, where 75 percent of the national industrial activities take place (Quiroz, 1973; Coyners, 1972; Thiesenhusen, 1971).

II. THE BASIC GRAIN SUBSECTOR: MARKET STRUCTURE AND INSTITUTIONS AND GOVERNMENT POLICY

Introduction

The agricultural sector may be divided into three groups, classified by types and size of enterprise. These groups are:

Group I.....Large plantation agriculture specializing in export commodities such as coffee, cotton and sugarcane. It also includes large cattle ranches and feedlots.

Group II....Medium to small farm operations with total output sufficient to meet family food needs and sell small amounts on the commercial market.

Group III...Subsistence farms not currently in the commercial market stream.

Group I enterprises (Table II-1) have ready access to capital, excellent access to market information in El Salvador and abroad, and have sufficiently organized production and marketing systems. Large sugarcane, cotton and coffee plantations are concentrated in the southern half of the country. However, some large coffee and sugarcane plantations are found in selected pockets of the uplands outside the litoral. Large beef operations are scattered in different locations in the uplands throughout the country.

Group II farms produce some export crops but produce primarily basic grains, fruits, vegetables, livestock and poultry. They are scattered all over the country. Their production feeds both the rural and urban sectors of the nation. They have serious production and marketing problems.

Table II-1. El Salvador: Number and Percent of Farms by Size Groups, 1970.

Group	Size of Farms (hectares)	Number of Farms	Percent of All Farms
Group I	100 & over	1,961	0.72
Group II	2 to 99.99	77,722	28.53
Group III	less than 2	192,749	70.75
Total		272,432	100.00

Source: El Salvador Census of Agriculture, 1971 (M.E., 1973)

Group III farms produce food crops (basic grains) in small plots of land of less than two hectares (Table II-1). They are scattered over the country occupying hillsides and marginal land. The production of this group does not enter commercial marketing channels and is principally used for family consumption.

The emphasis of this discussion is on the production and marketing problems of farmers in Group II and those in Group III who can be helped to move into the commercial marketing system.

A certain number of farms of less than two hectares can be converted into profitable production units through multiple cropping (Hildebrand *et al.*,1975). They produce high value horticultural crops in rotation with beans, corn or sorghum. However, the vast majority are subsistence farmers. Many are part-time farmers who also serve as agricultural laborers. Most are outside the commercial marketing system and constitute a serious social-cultural-economic problem for the country (Steele, 1975).

The Basic Grain Crop Subsector

Corn, beans, rice and sorghum are the basic food crops. The combined value of production of these crops is second only to that of coffee. They are mono-cropped or where conditions are favorable are double cropped.

Corn is grown throughout the country, on good and poor land, on hillsides and flatlands. Production in 1973 reached an all-time high of 431,376 metric tons produced on 202,350 hectares. In comparison, the production in 1963 was 206,350 metric tons produced on 172,148 hectares. Yields increased from 1.2 metric tons in 1963 to 2.1 metric tons in 1973. Good weather and further diffusion of improved varieties contributed to these excellent yields (MAG, 1975).

Research in the development of better varieties of corn was first begun in 1943. For about 16 years, corn seed improvement was carried out in collaboration with the Rockefeller Foundation-International Maiz and Wheat Improvement Center (CYMMIT) in Mexico. As a result of these efforts two very popular corn varieties were developed and are now widely planted throughout the country (MAG, 1975; Baker and Smith, 1975). The introduction of hybrid seeds, chemical fertilizers, insecticides, and improved cultural practices can increase corn production labor requirement from 25 to 44 percent and corn yields by as much as four fold over traditional modes of production (Granados et al., 1975). Corn production in 1970 used 21 percent of total labor force employed by the agricultural sector (MAG, 1970).

Rice is grown primarily along the Pacific coastal areas of La Paz, Usulatan and San Miguel. Upland rice is the predominant crop and is produced during the June to November rainy season. Areas using controlled flooding are being added and mechanization is common in upland and lowland production. Production has been stimulated by favorable world and domestic prices, availability of good land recently released from cotton production, use of improved seed varieties and increased use of chemical fertilizers. The area in rice in 1967 was double the 1960-64 average of 14,000 hectares, but it dropped to 9,510 hectares in 1973 (MAG, 1975). Consequently production reached a record level of 51,750 metric tons but dropped to 23,460 metric tons. Yields have, however, increased steadily from

1.9 metric tons per hectare in 1968 to 2.5 metric tons in 1973.

Grain sorghum was produced on 100,000 hectares in 1960-64, increased to 130,000 hectares in 1972 and then dropped to 119,000 hectares in 1973. Output averaged to 96,000 metric tons in 1960-64 and rose to 156,000 metric tons in 1973. Yields have not changed significantly during the past years, averaging from 1.0 to 1.3 metric tons per hectare. The increased output is attributed mainly to area expansion. About 10,000 metric tons of this grain are used annually in mixed animal feed. The rest is used for human consumption. Since sorghum is largely interplanted with corn, any increase in the production of corn will indicate some increases in the production of sorghum.

Beans are usually planted as a single crop or intercropped with corn. Most are produced in small farm plots. In 1973, 68 percent of the bean area and 70 percent of the output were produced as a single crop and the rest were intercropped, mainly with corn. Production in 1973 reached record levels of 37,000 metric tons, an increase from 15,000 metric tons in 1963. Due to conflict with Honduras, the principal source of bean imports, the Ministry of Agriculture undertook a crash program to increase plantings of beans. In spite of record bean production, imports of about 5,000 metric tons annually (1973-75) were needed to meet domestic demand.

To summarize, corn, rice, beans and sorghum are the main food crops. Production expansion has been substantial in recent years due in part to favorable weather conditions and the initial effects of incentives provided by government to attain national self-sufficiency in grains. The majority of these crops, except rice are produced in small size farms of two hectares or less. Prospects for increasing income and employment in these farms appears to be mainly in increasing land intensity use through intercropping, double cropping and multiple cropping, and widespread diffusion of modern agricultural technology such as the use of improved seeds, chemical fertilizer and insecticides.

The use of capital intensive technologies particularly mechanization and chemical weed control poses a serious unemployment problem. Considering that unemployment and underemployment problems are already serious in the basic grain subsector, evaluation of the social costs of existing government policies towards this subsector is necessary in order to determine their consequences and consistency with national goals of increasing farm incomes and employment.

Government Policy and Policy Supported Institutions

Policies for the development of the agricultural sector including the basic grain subsector are implemented by the Ministry of Agriculture. El Salvador's general agricultural policy is: (a) to increase production of basic food crops to feed a rapidly growing population, and (b) to improve the living conditions for the thousands of small farmers whose farms are less than two hectares (Coyners, 1972).

The implementation of government policies in the agricultural sector through different regulatory and service agencies and their impacts, are primarily reflected in the areas of agricultural extension, research, credit, cooperatives, and agrarian reform. The structure and functions, and relative performance of these agencies in the aforementioned areas are briefly reviewed in this section.

Agricultural Extension

The extension service evolved from an agricultural research program initiated cooperatively in 1942 by the El Salvador government and the U.S. Department of Agriculture. Extension work as such was started in 1948 and grew steadily until in 1956. There was a field agent in each of the 14 departments of the country plus one or two subagents in some large departments. During 1964-65, it was expanded to 1000 technicians and 50 field offices. The achievements of the extension service in the development of the basic grain subsector has been quite substantial. For example, Chacon *et al*. (1972) estimated that the benefit-cost ratio of technical assistance in El Salvador ranged from 1.27:1 to 2.61:1 during the 1968-70 period. The program for the diffusion of modern agricultural technology in small basic grain farms received added impetus when in 1965, the government of El Salvador in cooperation with USAID conducted a nation-wide mass demonstration project in the use of improved seeds, fertilizers, insecticides and improved cultural practices. The program was carried out by the Extension Service Department through its 50 field offices spread throughout the country. The success of this program in terms of grain production increases and increased use of modern farm inputs has been quite significant and is in part believed to be responsible for the steady increase in adoption of modern agricultural technology in the small basic grain farms in recent years (Threadgold, 1971).

In 1971 the National Center for Agricultural Technology (CENTA) was created to centralize research, education and extension services. The Extension Service Department, which was previously directly under the Ministry of Agriculture, was absorbed by CENTA. It is presently being reorganized in an effort to increase its effectiveness as a catalyst for the further development of the basic grain subsector. Many administrative problems remain unsolved. The effectiveness of the extension service has been limited by lack of adequate program funding, high turn-over rate of personnel and inadequate field equipment. Recently, the department received several vehicles from a USAID grant to help increase the mobility of field extension agents.

Agricultural Research

The government agricultural research program is presently carried out by the Research Department of CENTA. Its main research centers are at Santa Tecla and San Andres. Most of the research activities are agronomic. Emphasis is on varietal improvement, pest and disease control, and improved cultural practices. Economic research is micro-oriented being concerned with costs and returns, farm management, and micro-evaluations of specific programs and projects. Research in other areas of agriculture particularly public policy, regional and national market analysis receives little attention at present. Therefore, there is a need to establish research programs within CENTA capable of undertaking not only agronomic research but also research on agricultural problems and policies of a regional and national importance.

Agricultural Credit

El Salvador's agricultural credit system consists of a Central Bank; seven private banks; one semi-private mortgage bank (Banco Hipotecario); "Federacion de Cajas de Creditos" (F.C.C.), "Federacion de Asociaciones Cooperativas de Ahorra y Credito de El Salvador" (FEDECACES); two public supervised credit agencies, the "Banco de Fomento Agropecuario" (B.F.A.)

and the "Administracion de Bienestar Campesino" (A.B.C.); a cotton cooperative; and a Coffee Institute.

Credit to small farmers is mostly provided by the ABC, FCC, FEDECACES and BFA. In 1970, about 82 percent of total institutional loans were made to the export crop subsector with the remaining 18 percent made to the food crop subsector. Of the $14 million loans extended to the food crop subsector about $8.4 million was granted by the commercial banks. In 1970, ABC loaned $4.3 million to the food crop subsector which was equivalent to only 5.5 percent of total institutional credit. Forty percent of ABC's loan operations were made to small and intermediate size farms. Only five percent of the farmers with less than five hectare holdings were using credit from institutional sources (Solis et al., 1973). Since there are no less than 250,000 small farms of five hectares or less, it is obvious that much of the operating capital for crop production used by these farms was either from past savings or from private money lenders (Steele, 1975).

The data appear to indicate that the established institutional credit sources are not really serving the majority of small basic grain farmers in El Salvador. This situation is in part due to stringent and cumbersome loan rules imposed on farmer borrowers. For example, one loan rule specifies that the farm size must be at least 3.5

hectares. This rule effectively excludes over 90 percent of the cereal producers of the country (Cutie, 1975).

Agricultural Cooperatives

Agricultural cooperatives can become important institutions through which modern agricultural technology can be introduced to farmer members and through which farmers as a group can become an effective competitive force in the basic grain market. Cooperatives have been introduced in El Salvador for quite some time. The most successful ones are those in the export crop subsector.

In the basic grain subsector, there are a few operating cooperatives but membership comprised only a small fraction of the total number of grain producers. For example, the "Fundacion Promotora de Cooperativas" (FPC) which was organized in 1955 for grain producers in the Department of La Libertad, had only 11,500 members in 1970. Another cooperative sponsored by the government is the "Union Communal Salvadorena". Started in 1968 with 95 members in three cooperatives, the organization grew to 1000 members working on 1400 hectares and organized around 18 cooperatives (Maeda et al., 1971).

The present size and scope of grain cooperatives in El Salvador is not sufficient to make these organizations an effective force in the grain market. Unless greater public and private initiatives are exerted to improve the quality of management and expand membership, the potential of cooperatives to play a major role in the modernization of basic grain agriculture is limited.

Agrarian Reform

Agrarian reform in El Salvador is vested on the "Rural Colonization Institute" (ICR). Its main objective is to change the distribution of land by sub-dividing large privately owned estates and idle lands to rural people who have no land. In addition, it has responsibility to provide settlers with technical assistance, medical aid, credit and access roads to the parcels distributed. ICR's performance to date is modest. In 1962, the ICR was administering 31 large estates with a total area of 39,525 hectares. Over 30,000 hectares have been subdivided among 5,860 families. In 1967, the agency was managing 30 colonies with a population of over 60,000 and an area of 50,036 hectares (Coyners, 1972).

Basic Grain Market System

The Grain Output Market

After reserving part of the grain harvest for home consumption, grain producers generally market their produce to merchant-truck buyers who visit their farms at harvest time. Those who have larger grain output and on-farm storage facilities sell only a portion of their output at harvest time to pay off outstanding loans and store the rest for future sale, hopefully at higher prices. Most of the commercial grain eventually are channeled to wholesale grain buyers and processors in the country's major grain market centers such as in San Salvador City and Santa Ana.

The government's participation in the grain market system is through its price stabilization agency, the "Instituto Regulador de Abasticimientos" (IRA). In recent years IRA has entered the market and purchased between 11 to 15 percent of total commercially marketed grain cereals (corn, rice, beans and sorghum). This has not been sufficient to have a significant influence on the price stability. Present storage capacity of IRA of 42,000 metric tons is only about one-half of what IRA needs to stabilize prices (Steele, 1975).

Grain prices have been characterized by a high degree of seasonal fluctuations. Grain prices are relatively higher from June to August (the planting-growing season) and lowest during the months of October to May (the harvest season).

Steele (1975) cited three important factors responsible for the high seasonal price fluctuation and large differentials between farm-gate prices and commercial market prices:

(1) lack of sufficient funds and storage capacity of the Price Stabilization Institute (IRA);

(2) lack of on-farm storage and/or assembly market storage facilities located in close proximity to grain farms active in commercial harvest and marketing of grains;

(3) lack of readily available market price, quantity demand and supply information which would show farmers grain marketing alternatives available to them.

Wide variations exist in gross marketing margins between similar products and between regions for the same products. For example, the marketing margin for corn varies between 25 to 50 percent of consumer price in three studied regions. For rice, it varied from 17 to 35 percent between regions. Corn, rice and beans are very storable commodities; their bulk-value ratios are similar, yet the marketing margins for the limited marketing functions performed (principally transportation, storage and exchange) varies between 17 percent and 60 percent of consumer price. More information is needed to evaluate what causes these wide variations and to determine where marketing inefficiencies exist.

The Farm Input Market System

The input market discussed in this section includes markets for fertilizer, pesticides and improved seeds.

Fertilizer. El Salvador more than any other Central American country, needs to use fertilizer in its grain production. Agricultural lands have been used very intensively and use of fertilizer is crucial to maintain current production levels. An important characteristic of fertilizer is that it is labor-using rather than labor-displacing. Cutie (1975) reported that manual application of fertilizer requires an increase of four man-days per hectare in corn.

El Salvador is the largest importer and consumer of chemical fertilizer in Central America. In 1974, the country's fertilizer import of 319,812 metric tons was equivalent to 0.21 metric ton per hectare of arable land. In 1972, FAO reported that fertilizer consumption per hectare of arable land in El Salvador was 133 kilograms, one of the highest in the hemisphere. In comparison Costa Rica consumed 84 kilograms per hectare while Nicaragua used only 35 kilograms per hectare.

Prior to 1960, fertilizer was utilized mainly by the export crop subsector. The massive corn demonstration program of 1965 changed this pattern by showing the Salvadorean campesinos that fertilizer use was technically and economically viable (Threadgold, 1971). A marketing system for fertilizer, however had not been developed.

In 1966, the "Administracion de Bienestar Campesino" (ABC), a government credit agency with financial and technical assistance from USAID began its agricultural production credit program called "creditos especiales" (in kind credit). The ABC issued purchase orders ("ordenes de entrega") for inputs used which were honored by wholesalers and retailers. One major side effect of the ABC was the proliferation of retail agri-service stores throughout the country. The use of fertilizer in El Salvador was rising steadily until prices rose precipitously in 1974. During the 1975 crop year, however, fertilizer prices dropped and the steady increase in fertilizer use is expected to continue.

The marketing network for fertilizer at the present time is presented in Figure II-1. It begins with importation carried out by private sector importer-wholesaler and public sector importers, the most important being the "Banco de Fomento Agropecuario" (BFA).

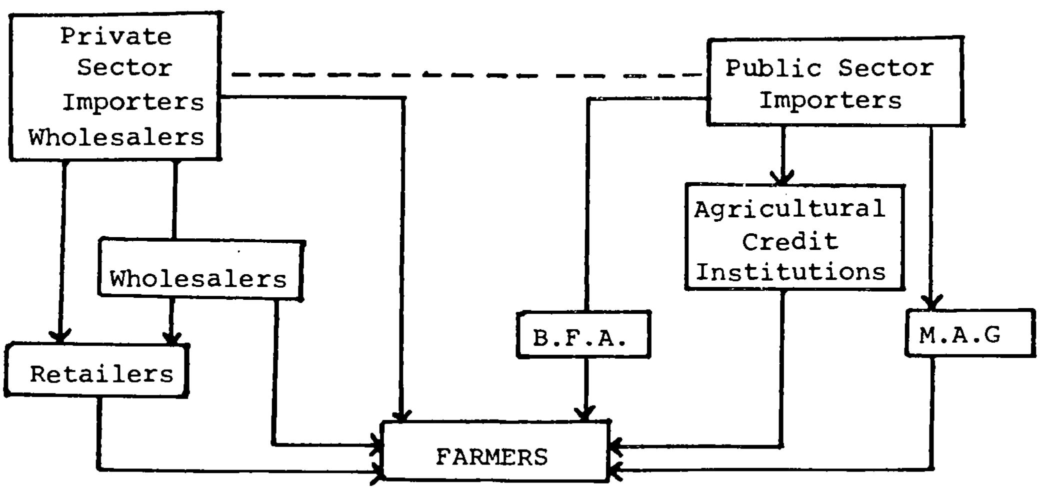


Figure II-1. Fertilizer marketing network diagram.

Importer-wholesalers may sell directly to retail distributors or other wholesalers. The latter case is not common, however, being used principally to obtain cheaper fertilizer without breaking exclusive agreements. The line from importer-wholesalers to farmers represents the movement of major quantities of fertilizers directly to large farmers.

The public sector is just beginning to carry out importation of fertilizers. The principal importer is the "Banco de Fomento Agropecuario" (BFA). Movement of fertilizers is to 35 BFA regional warehouses where it is picked up by individuals or group load recipients on the basis of "ordenes de entrega" (delivery orders).

Traditionally the private sector has been the most active participant in the fertilizer market system at the importation-wholesale level, maintaining control over 80 to 90 percent of the fertilizers distributed (Baker and Smith, 1975).

Insecticides, herbicides and other pesticides. The demand trends in agricultural chemicals are similar to those of fertilizers. Demand is created primarily by the commercial farming sector (coffee, cotton and sugarcane). Small grain farmers are not a big factor in the market. However, it is important for them to have a reliable supply of agricultural chemicals at reasonable prices. Steele (1975) estimated that 15 to 20 percent of the costs of the corn production input package is for insecticides. In 1974, the three insecticides most commonly used by small corn farmers, Aldrin, Dipterex, and Volaton, accounted for 8.3 percent of the CIF value of the dry insecticides imported into El Salvador. The best estimate is that small farmers account for about 11 percent of the total demand for agricultural chemicals.

Figure II-2 presents the Pesticide marketing network. Major import-wholesalers have two alternative sources of supplies, (a) direct importation in the concentrated form of the active product ingredients which are subsequently elaborated (diluted and containerized) into consumer units; or (b) direct importation of consumer units.

Beyond the importation or import-elaboration stages, products may move through or skip any stage in the wholesaler/retailer/farmer chain depending on the volume of transaction.

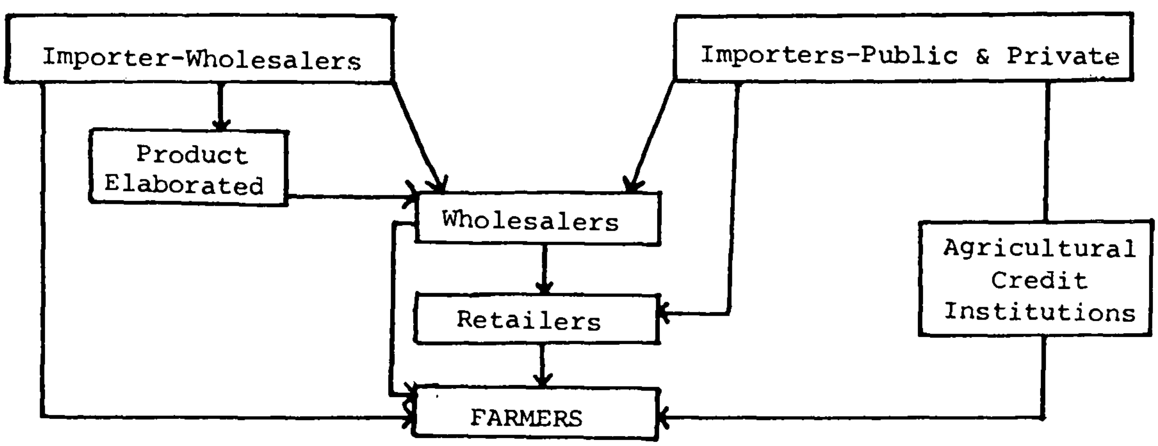


Figure II-2. Pesticide marketing network.

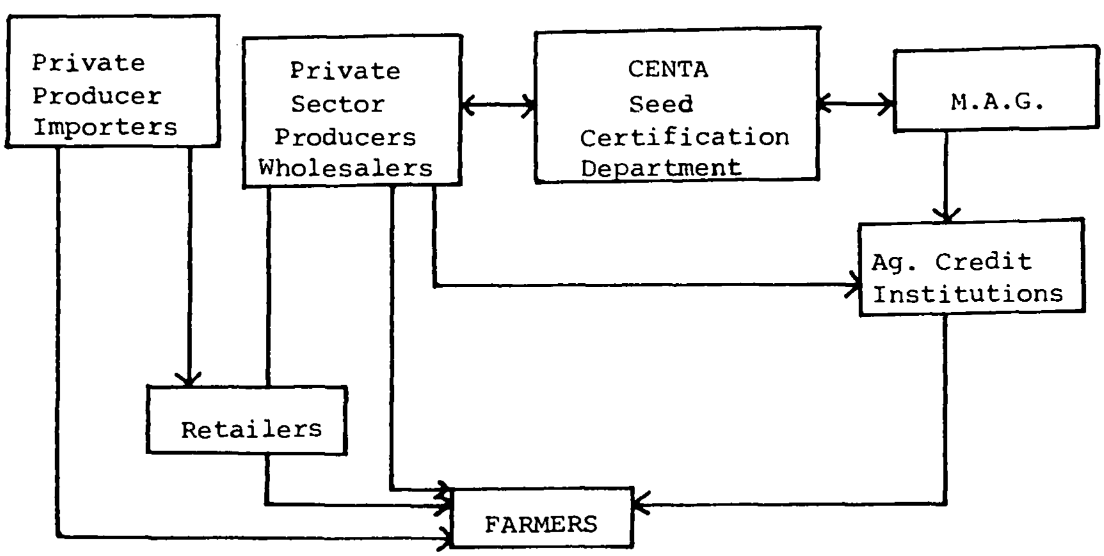
The public sector is barely active in the pesticide marketing system, its first efforts being at distribution of pesticides for coffee and cotton. The role of the public sector in the importation and wholesale distribution of pesticides, to date, has been insignificant. Prior to 1975, the public sector had to rely totally on the private sector limiting its intervention in this area to the control of use, product quality control and import regulations. BFA credit users and cooperative members either purchased their pesticides from retail outlets and were reimbursed or received delivery orders from public sector institutions that were redeemable in designated agricultural supply stores.

Certified seeds. Small farmers are convinced through their experience with domestically developed cereal hybrids, that variety and seed source are some of the key considerations in achieving high yields (Cutie, 1975; Steele, 1975; Coyners, 1972). The problem however, arises as to the quality of seeds. The untrained eye cannot distinguish seed quality until after planting. The potential for misrepresentation of product is high given the marked differences in yield capabilities of improved versus unimproved varieties.

With the signing of Decree No. 229 - Law of Seed and Plant Certification, the government of El Salvador began to take active part in the control of seed production. The Ministry of Agriculture (MAG) was made responsible for the production, sale, importation and exportation of seeds and plants of proven genetic purity and quality. The Department of Seed Certification and Plant Science of CENTA, collaborating with the Department of Commercialization and Statistics of MAG, were given this responsibility.

The use of corn hybrids have gained almost universal acceptance among all classes of corn farmers. While the government seed certification program emphasized mainly corn seed production during the late sixties and early seventies, there has been increased emphasis on producing certified seeds of other basic grains (beans, rice and sorghum) since 1973.

Certified basic grain seeds are produced both by the public and private sectors. The Seed Certification Department of CENTA, under the Ministry of Agriculture (MAG) enforces strict quality control. A diagram of seed marketing system is shown in Figure II-3.



Figures II-3. Certified seed marketing network.

Producers-wholesalers can move their seed directly to farmers, to retailers, or to agricultural credit institutions. The credit institutions obtain seed directly from MAG and do not look to the private sector as a source until MAG supplies are exhausted. Producer-importers have two options, direct sale to farmers or distribution through retailers. Direct sale to farmers is preferred. The certified seed marketing system is the least competitive of the three agricultural input-market subsectors. Only four marketing enterprises compete for the farmer's patronage (Baker and Smith, 1975).

To summarize, the private sector has been traditionally the main active participant in the agricultural input marketing system in El Salvador. Fertilizer marketing, the most active input-market subsector, has been mainly under the private sector. During the early seventies, the public sector has begun to participate directly in the importation and distribution of fertilizers and other agricultural chemicals as an integral part of its centralized agricultural development program for the food crop subsector. This intervention will have a profound effect on the fertilizer marketing system during the coming years. In the case of pesticide marketing, it appears that the private sector will continue to dominate the market and direct public intervention is not expected to be significant. Certified seed marketing appears to be dominated by the public sector and the presence of very few private wholesaler/producer/importers makes it the least competitive of the three main agricultural input market subsectors. This trend may be expected to continue since it is an important part of the government program for increased food production.

Government Policy on Agricultural Inputs

Government policy on agricultural inputs as promulgated by the Ministry of Agriculture are defined in its Five-Year Agricultural Development Plans and Annual Agricultural Programs of the country.

Major sources for reviewing government policies on agricultural inputs are the latest five year plan ("Plan de Desarrollo Agropecuario: 1973-77") and the annual operation plans for 1974 and 1975 ("Plan Operativo del Sector Agropecuario", 1974 and 1975). A brief review of these documents as they relate to agricultural inputs follows.

The basic assumption of government intervention in agricultural input market is to stimulate their use and, hopefully, agricultural productivity. However, three problems must be avoided - uneconomical use, over use and untimely distribution. The "Plan de Desarrollo Agropecuario: 1973-77", recognizes that in the past, the government was passive with regard to input usage. There was no defined government policy to control the use and commercialization of inputs. The plan recommends developing programs for the establishment of maximum sale prices for critical inputs, for strengthening systems for controlling quality norms, for direct importation of inputs by public sector institutions, for promotion of farmer organizations capable of participating in the input marketing system, for technical assistance aimed at more rational use of inputs, for adequate supply of credit for inputs, for regulation of the use of herbicides, and for creation of input marketing infrastructure. Recognition of the adverse income and employment consequences in the use of labor-displacing technology is explicit. One policy specifies that due to the need to increase agricultural employment, it will be necessary to avoid an irrational importation of machinery and chemical products (herbicides) that might cause massive displacement of the labor force.

The "Plan Operativo del Sector Agropecuario: 1974" is more precise in its wording. Recognition of the government efforts in seed certification and fertilizer distribution are made. The Ministry of Agriculture (MAG) is authorized to strictly regulate importation of inputs and is given guidelines as to when and how to permit importation. The Bank for Agricultural Promotion (BFA) is directed to carry out direct importations and to set up a retail distribution system. CENTA and the Salvadorean Institute for the Investigation of Coffee are made responsible for developing technical criteria for input use. CENTA is named to carry out research to determine rational levels for pesticide use as well as being instructed to produce certified seeds. The Ministry of Agriculture (MAG) is designated to supervise all phases of input use and commercialization to ensure that there is compliance with the "Law for Control of Pesticides, Fertilizers and Products for Agricultural Use" (Decree No. 315).

The "Plan Operativo del Sector Agropecuario: 1975" continues in the same direction as the 1974 plan. Yearly goals are defined for both agricultural and livestock subsectors. Finally, the policy for agricultural production inputs is outlined. For 1975, the BFA is to import directly large quantities of fertilizers. CENTA and the BFA are jointly assigned responsibility for the government's technical assistance program. CENTA is also instructed to increase its production of certified seeds. MAG is to continue in the regulation of importation/exportation of inputs with the collaboration of the Ministry of Economy.

Law for Control of Pesticides, Fertilizers and Products for Agricultural Use

The basis of El Salvadorean government's agricultural input policies is Decree No. 315. The law came as a result of increased use of inputs by farmers. The spirit of the law rests in the need to guarantee farmers quality products and to control inefficient, uneconomic and indiscriminate use. The law regulates the production, marketing, distribution, importation, exportation, and use of pesticides, herbicides, fertilizers, additives, defoliants and other chemical and bio-chemical products for agricultural, livestock or veterinary use and its raw materials.

The institution vested with the authority to implement the law is the Ministry of Agriculture (MAG). This authority includes the right to make inspections, analyze product samples, develop recommendations for input use, maintain a registry of approved products, prohibit importation of products, establish quality norms, review technical information provided by the producer and impose sanctions established by law. The Agricultural Defense Department (DDA) of MAG was specifically assigned to: (1) maintain a registry of products and raw materials judged as technically acceptable given the stipulations of Decree No. 315; (2) authorize the importation of agricultural inputs; and (3) authorize the establishment and continued operation of private retail agricultural input outlets.

In summary, governmental policies for agricultural technology diffusion in El Salvador are explicitly incorporated in its five-year plans and annual operation plans. Where the five-year plan fails to assign responsibilities, the annual operative plans are very specific. In the period 1973 to the present, the agricultural input marketing system has undergone radical changes, most notably the increased active role of the public sector. Coupled with the ministerial controls of importation and exportation and the policies outlined in the operative plans, defined governmental policies for agricultural inputs now exist.

III. LITERATURE REVIEW ON RESEARCH METHODS FOR POLICY EVALUATIONS

Introduction

This chapter reviews certain methodologies employed by economists to evaluate social and economic consequences of technical change in agriculture. The main emphasis is on the different research methods used in evaluating impacts of government policy and external market forces on agricultural technologic change in developing countries. The last section discusses the use of a short-run (static) regional linear programming model for evaluating the effects of policy-induced price distortions and market imperfections on agricultural technology choice and its efficiency and distributional consequences.

Classification of Policy Research

Policy may be classified as short-run, medium-term and long-term policy decisions. Public authorities in developing countries are concerned with the types and rates of agricultural technology adoption because it can influence society through its effects on rural-urban migration, output, employment and income distribution (Gemmil and Eicher, 1973). The decision of what types and rates of agricultural technology to employ is ultimately made by millions of small farmers in developing countries. The government has at its disposal, however, many short, medium and long-term policies which influence the profitability of adopting a specific technology on an individual farm.

Short-term policies are those which directly affect a specific type of agricultural technology. Examples of this type of policy include: (a) subsidizing of credit for the purchase of herbicides, spraying equipment and other farm inputs; (b) banning the use of herbicicides in grain production; and (c) granting of preferential import duties on herbicides and spraying equipment. Short-term policies are the subject of analysis of this study.

Medium-term policies affect a specific technology in a more indirect manner. In the medium-term framework, use or adoption of a specific farm technology will affect input-output prices and distribution of wealth in a society. Examples of this type of policy are: (a) subsidizing the prices of basic grain products; and (b) encouragement of domestic production of pesticides, fertilizer, and improved seeds through government subsidies or direct public investment.

Long-term policies are the continuation of short and medium-term policies over a period of several decades. Long-term development strategy is aimed at developing society so that it is consistent with societal objectives and norms (Gemmil and Eicher, 1973). Long-term policies are as much influenced by political philosophy as by economics.

An example may clarify the difference between short, medium and long-term policies and show how they interact. El Salvador's long-run agricultural policy objectives continue to be twofold: (1) to expand production of basic food crops to feed the rapidly growing populations; and (2) to improve the living conditions for the thousands of tenants and small farmers (Coyners, 1972). These policies are being implemented in the short-run through subsidized credit programs to purchase modern agricultural inputs such as improved seeds, fertilizers and insecticides, through preferential import duties of modern farm inputs, and through direct government importation and distribution of these inputs. Medium-term policies such as output price subsidies, minimum wage legislations, family planning programs, agrarian reform and other agricultural extension programs are also employed. The continuation of these policies over a period of several decades hopefully will achieve the long-term policy objectives.[1/]

Different kinds of research are needed to evaluate the costs and benefits of the short, medium and long-term policies. The longer the time horizon and the larger the sector of analysis, the more variables need to be measured. For example, the promotion of increased use of certified seeds

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[1/] Policy is defined here as a settled or definite course of action adopted and followed by a government or institution to achieve specific goals or objectives in the agricultural sector. The policy may be implemented through specific programs or projects by various regulatory and service agencies of the government.

in basic grain production on a government-sponsored cooperative (short-term decision) is not likely to affect the price of basic grains. However, the establishment of domestic production of improved seeds and large-scale basic grain output price subsidies by the government (medium-term policies) are likely to be far-reaching in its implication, including possible expansion of basic grain production and a consequent decline in the prices of grain output.

Short-Term (Static) Analysis

Most economic studies have been concerned with the consequences of policy on single farms, a single district or region. Several techniques of analysis have been employed in short-term analysis.

Cost-benefit analysis. This technique has been widely used, especially for a single farm, district or region. It essentially involves a financial accounting analysis of introducing a specific farm technology (say, chemical weed control) and comparing monetary gains and losses of this innovation against the traditional technology (say, manual weed control). The analysis can be converted into a true economic comparison by adjusting observed (distorted) market prices to correspond to their "shadow" levels or the true social opportunity costs of resources used.[2/] From the analysis,

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[2/]Gittinger (1974 pp. 7-8) defines financial or private analysis as project cost-benefit evaluation where the observed market prices including taxes and subsidies are used. While economic analysis involves cost-benefit evaluation using the true social or economic values of inputs and outputs often termed as "shadow" or "accounting prices".

inferences concerning the social consequences of technology changes can be made.

Cost-benefit analysis may be applied on an ex-post or ex-ante basis. For example, ex-post impacts of technical change can be evaluated by analyzing economic adjustments that took place in a single farm, district or region, when a specific technology was introduced. To do this data will be required for the area under study before and after the technology was introduced. In an ex-ante framework, cost-benefit analysis is used to estimate the expected private and social costs and benefits of replacing a traditional farm technology with an advanced technological innovation.

Many studies using cost-benefit analysis have been conducted. A few covering technological change in developing countries will be discussed here. Swenson (1976) studies the distribution of benefits from increased rice production in Thanjavur, South India resulting from the adoption of new technology of high-yielding varieties, fertilizers and pesticides. A farm management survey was conducted in two villages in the Thanjavur district before and after technology adoption. The results revealed that property rights were highly concentrated in the hands of a few households. The situation did not change after the technology was introduced. Increased real incomes from paddy rice production was obtained by most farm operators. The very large farm operators were the biggest relative gainers with an 18 percent increase in real income from rice. The landless laborers, however, still had the lowest absolute level of income among the agricultural population. The distribution of total incomes among all agricultural households (including both farm operators and landless laborers) became more equal between the two periods. The change was however, marginal and cannot be considered a major shift, but the fact that the Gini ratio did not increase is in contrast to the popular view that the new varieties resulted in a more unequal income distribution.

Ellis (1972) conducted a case study of one farm district in Ethiopia based on a small sample survey of yields and cultural practices on farms with and without tractors. He concluded that both the financial and economic returns to mechanization with tractors were low. Yet tractor use was becoming widespread. He rationalized this trend by hypothesizing that since landlords had better access to information, credit and other factors of production than their tenants, the landlords could obtain the advantages of new seeds and fertilizer by evicting their tenants and mechanizing, rather than having to wait for the tenants to adopt the new bio-chemical technology at less intensive levels.

Rask and Stitzlein's (1973) study in a transition economy from livestock to wheat and soybeans in Southern Brazil revealed that mechanized farms provided higher output and levels of employment. However, in another district where mechanization was introduced without change in enterprise composition and farm size, no significant differences were found between farms with and without mechanization. Young (1977) argued that while mechanization facilitated changes in enterprise composition, it was government policy through wheat price subsidy and subsidies for modern farm inputs including machinery which supported the diffusion of mechanization in Southern Brazil. These output and employment increases and diffusion of mechanization were all induced by government policies rather than mechanization *per se*.

Lima and Sanders (1975) studied the costs of animal traction cultivation versus manual-hoeing for perennial cotton in a semi-arid area in Northeast Brazil. They found no significant differences in cost per hectare between the two systems under similar field conditions. Farms using animal traction were observed to have higher yields and be larger than those using manual-hoe cultivation. Young (1977) pointed out that perhaps it was not animal traction that caused larger areas cropped but that wealthier farmers may have more adequate capital resources to hire labor and buy mules and cultivators.

Clay (1975) used partial budgeting, a type of cost-benefit analysis, to conduct a case study of a sequence of innovations associated with the introduction of tubewell irrigated cultivation of high-yielding wheat in the Kasi Region of Bihar, India. He found that tubewell irrigation technology increased employment of farm labor (farm servants and casual labor) by 36 percent and increased wage income by 46 percent over the pre-innovation period. In addition, total farmer (landowner) incomes increased by 69 percent while agricultural labor income increased by only 31 percent. He concluded that the process of innovation through the introduction of new technologies and purchased inputs brought a substantial increase in output and doubling the value of production. However, income inequalities were increased.

Ex-ante cost-benefit analysis is commonly employed by government agencies, business organizations and labor unions to estimate output and employment associated with a proposed technical innovation. It is used to provide input-output data for more sophisticated analytical techniques.

Young (1977) evaluated the relative costs of alternative weed control systems for intercropped corn and beans, and monoculture cassava in the municipality of Caruaru, Northeast Brazil for 1975. He found that manual weeding was the most profitable method for intercropped corn and beans even when herbicides were available at their subsidized private prices. For monoculture cassava, chemical and mechanical weed control were found to be relatively profitable at their private input prices, yet manual weed control was the exclusive method used in all sample farms included in his study. He argued that the necessary inputs and services for chemical weed control were not yet available in the area and the actual opportunity cost of using family labor for manual weed control may be sufficiently less for small farmers than for employed workers. Most small farmers in the area did not have sufficient capital to purchase and maintain draft animals and spraying equipment.

Barker and Abarientos (1974) compared the costs of chemical and manual weed control for lowland rice using the 1967 field experiment data of the International Rice Research Institute (IRRI) at Los Banos, Laguna, Philippines. The most popular chemical used in rice weed control was 2,4-D (granular form). Comparing the costs of these two weed control systems under four alternative wage rates, they found that chemical weed control would have considerable cost advantage in areas where the wage rate exceeded three pesos.

Pinstrup-Anderson and Diaz (1973) determined the employment potentials of three alternative "technology packages" in Colombian cassava production. Their estimates indicated that employing herbicides for weed control could reduce total labor requirement in cassava growing areas by over 40 percent.

While cost-benefit analysis may be useful as preliminary investigations, they have a number of weaknesses compared to more sophisticated programming models. It assumes a technology without explaining or predicting it as a response to economic incentives induced by public policies or external market forces. In addition, cost-benefit analysis does not explicitly take into account resource constraints, farm size heterogeneity and other institutional factors that affect the adoption of a specific technology by various farm size classes in the agricultural sector.

Cross sectional analysis. Another approach to study the short-run effects of technological change is through cross-sectional analysis. The following describes several studies which have employed cross sectional analysis to study micro-economic efficiency and distributional impacts of a specific innovation in local areas or districts.

Cutie (1975) studied the impacts of the diffusion of hybrid corn technology in El Salvador by using a cross-section sample farm data for crop year 1972. In successive regression equations, three dependent variables were used (amount of nitrogen fertilizer, adoption of hybrid seeds, and adoption of nitrogen fertilizer) and eight explanatory variables (farm size, off-farm work, agroclimatic region, distance to market, credit use, extension contacts, farmer's age, and farmer's education). His analysis revealed that location of farms and farm size were the most significant variables in explaining nitrogen fertilizer use and farm size was the main significant variable in explaining corn hybrid adoption. His analysis also showed that more credit and better access to credit would promote the use of fertilizer, while easier access to hybrid seeds could speed their wider diffusion.

Idachaba (1973) employed a multicrop production function model to evaluate the impacts of taxes and subsidies on land and labor utilization in Northern Nigerian agriculture. His results indicated that taxes on cotton and groundnuts reduced farm employment and land use as compared to the situation in the absence of these taxes.

Sidhu (1974) studied the impacts of a new high yielding wheat variety in one Indian district. He fitted a Cobb-Douglas production function to a cross-section data. He found that the new varieties appeared to increase output, reduce wheat production costs and increased employment but inequality of income distribution appeared to have increased.

In a study of the comparative performance of Mexican wheat and traditional wheat varieties planted in dryland conditions in Tunisia, Purvis (1973) used 1969-70 cross-section data. Yields were regressed against total costs of production and seven indices of managerial control variables. His results suggest that the new wheat varieties would produce relatively lower yields than the traditional one unless the recommended cultural practices were maintained at high levels. He concluded that unless new varieties suitable for dryland conditions of Tunisia are developed, the green revolution under dryland conditions may be slower and even more costly than under irrigated conditions.

Donaldson and McInerney (1973) in a cross-section study of the effects of the recent World Bank loans to Pakistan for tractors, compared changes in farm size, income and employment. They pointed out that farm size had grown by an average of 240 percent on farms which had become mechanized. They argued that the main effects of mechanization had been increased income for adopting farmers and substantial tenant displacement as landlords tried to secure the economies of scale for their equipment.

Rao (1972) using farm management surveys and secondary data employed multiple regression analysis to estimate the impacts of mechanization in India. He used mechanization as one explanatory variable and crop intensity, yield, output, and employment as dependent variables. His results indicated no relationship between tractors and employment or cropped area, but tractors appeared to increase output.

Linear programming analysis. Another technique used to analyze the implications of technological change is linear programming. This method is essentially a normative research tool in an *ex-ante* framework. It can be applied in a specific geographic-ecologic-economic setting such as a single farm, a homogeneous district or even an entire region.

To analyze the effects of government policies and external market forces on technology choice and its income-employment effects, the price coefficients, the input-output coefficients of each technology, and other parameters in successive runs of the model can be changed. The results can be speedily evaluated and compared. Selected studies employing regional linear programming analysis in developing countries are reviewed here.

Young (1977) employed a regional linear programming framework to predict the diffusion of herbicide-weed control in a coastal sugarcane region of Northeast Brazil. His results predicted that in the absence of government policies favoring capital, the adoption of herbicide for sugarcane weed control would occur over 27 percent of the regional sugarcane area. When price distortions were present due to taxes, tariff, payroll taxes and indirect subsidies on herbicides, the model predicted the adoption of herbicides on 98 percent of the regional production area. Government induced price distortions were predicted to reduce regional employment equivalent to 21 percent of the 1975 regional labor force. When herbicides were available at undistorted prices efficiency gains from herbicide adoption amounted to one half of one percent of the estimated value of the 1975 sugarcane crop. However, the short-run efficiency gain of one cruzeiro (by plantation owners) resulted to an eight cruzeiros loss in reduced weed control earnings by the displaced agricultural workers.

Ahmad (1972) developed a linear programming model of a typical farm of three sizes to evaluate mechanization in Pakistan. He used the same coefficients in evaluating separately three typical farms. His analysis showed that the incentive to mechanize was very great, but that the return to mechanization depended largely on the presence of a tubewell. In the absence of a tubewell, the private rate of return for owning a tractor was only three percent but in the presence of a tubewell it was 46 percent. Mechanization was still highly profitable to a farm with a tubewell, even if all input price distortions were removed. In Ahmad's farm sample survey, farmers who owned tractors had a cropping intensity of 168 percent compared to bullock users who had a cropping intensity of 144 percent.[3/] However, in the linear programming model crop intensity reached a maximum level of 187 percent and the optimum crop mixture was somewhat different from that in use on tractor farms in the survey. He argued that tractor farmers in the wheat-cotton area had not yet achieved the double dropping of which they are capable because most farmers have not yet accepted the "unconventional" crop rotation of sowing wheat after cotton.

Wills (1972) employed a linear programming model of crop production to estimate the likely effects of wide-

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3/Cropping intensity is defined here as the number of times a given plot of land in the farm was planted/harvested during one year.

spread adoption of modern farm inputs on agricultural employment and incomes in a single Community Development Block in Western Uttar Pradesh, India. Representative farms of different sizes were incorporated in the program so that the solution yielded information about the effects of new technology on different sized farms. He concluded that the widespread adoption of new agricultural technology will roughly double crop production in the area. The disparity between the incomes of large and small holders in the area will be reduced if short-term funds and chemical fertilizers are distributed on the basis of productivity or area operated. The total amount of agricultural employment in the area was projected to increase from 30 to 50 percent. The wage also increased, but the increase in agricultural laborer's incomes due to changes in crop production will be less than the corresponding increases in farm operator's incomes. When high wages during the harvest months induce widespread adoption of labor-saving machinery in the large farms, incomes of agricultural laborers will be substantially reduced and income disparities between farm operators and laborers will be further exacerbated.

Donovan (1974) used a regional linear programming framework to predict the employment and income effects of double and triple cropping, introduction of power tillers, labor force expansion and various changes in input and output prices on an irrigated region in the Mandya District, South India. His results suggest that for a region with assured irrigation, there are potentials for considerable intensification of agriculture which could expand regional employment from 75 to 100 percent over the 1971-72 level and increase regional income from 150 to 190 percent. The intensification depends mainly on widespread diffusion of multiple-cropping technology and crop production performance already achieved by the better farmers in the region. To attain this predicted agricultural development in the region he suggested that the following programs must be effectively functioning; localized research which ensures the availability of flexible, short-duration cereal varieties, a substantial program of extension, demonstration and farmer training, and provision of sufficient short-term credit to support cash operating costs.

General equilibrium analysis. General equilibrium framework assumes that a country's factor and product markets are in static equilibrium (Gemmil and Eicher, 1973). The researcher attempts by its use to determine what types of equilibrium conditions would result under alternative factor and product prices. An example of such a study was done by Thirsk (1972) in evaluating the impacts on gross national product and employment of the Colombian government's policy of providing subsidized credit for mechanization. He also was concerned whether the benefits of mechanization goes to labor or capital.

Medium-Term Research

Budgeting is similar to the cost-benefit analysis used for short-term studies, but may also be used for longer time horizons and focus on projected effects of medium-term policies several years into the future. An example of this type of study was conducted by Singh and Billing (1971) on the projections of the impacts of mechanization in the Indian Punjab and Maharashtra.

Dynamic programming analysis contain a dynamic component and makes projections through time. Singh and Day (1972) employed recursive linear programming in evaluating the interactions of new technology with labor demand and supply in the Indian Punjab agriculture. Singh and Ahn (1972) also used recursive linear programming to determine what would have been the effects of alternative policies on employment and capital-labor substitution in Southern Brazil agriculture. This method is really applicable in analyzing technical change on a single farm. Hence, in the study of Singh and Day, they treated the Pakistan Punjab as if it were one large aggregate farm; whereas in the study of Singh and Ahn, they synthesized Southern Brazil agriculture into three farm size types.

The use of recursive linear programming techniques to make aggregate regional projections may be subject to aggregation bias since it treats a region as an aggregate of a small number of farm sizes. In addition, recursive linear programming is criticized for the arbitrary way in which constraints in the diffusion of new technology... the so-called "flexibility constraints", are assumed. Other methods of incorporating technology diffusion into models are equally arbitrary (Rogers and Shoemaker, 1971).

Simulation. To quote Gemmil and Eicher (1973): "Simulation does what an individual researcher does in making projections on the back of an envelope, only a million times faster." The use of macro-level simulation has been applied to evaluate the impacts of alternative agricultural development strategies in a number of developing countries. Examples of such studies include: Byerlee (1973) who studied the indirect employment and income distribution effects of agricultural development strategies in Nigeria; Rossmiller *et al*. (1972) who studied recommended development strategies for South Korean agriculture; and Johnson *et al*. (1969) who analyzed Nigerian agricultural policy.

The use of simulation models for evaluating the impacts of new technology requires a great quantity of micro-level data. In the absence of adequate data and information, it can be useful in developing hypothesis for future testing.

Long-Term (Perspective) Analysis[4]

Long-term research may be divided into historical and instrumental studies. Historical studies generally review technology changes or economic development that has occurred in a country or countries for several past years and is not intended to provide specific policy guidelines. Instrumental studies, on the other hand, provide guides for future long-term policy.

Historical research. Historical studies recognize that technological change or economic development is conditioned by the economic philosophy prevailing in a country or region. Two of the main philosophies are free-market capitalism and controlled-market Marxism. Under the free-market capitalism, a policy of "*laissez faire*" is followed, which would imply that the rate and type of technological change would evolve naturally as a result of the free interplay of competitive market forces. Under the Marxist philosophy, the evolution and diffusion of agricultural technology would be based on the enforcement by the state or central authority of socially desirable types and rates of technical change.

Examples of historical studies include: the historical development of motive farm power in Europe by White

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[4] The discussion in this section draws heavily from Gemmil and Eicher (1973, pp. 44-50).

(1964); Evenson et al. (1970) traced the historical development of sugarcane varieties since the 18th century; and Ruttan and Hayami (1973) reviewed the historical development of international technology transfer for farm mechanization from the United States to Russia and the stages of farm mechanization in the United States and Japan.

Instrumental research. Instrumental analysis is based on the proposition that some institutions have to undergo structural changes in order to facilitate economic adjustments and minimize the adverse social consequences that occur in the process of agricultural modernization. Schmitz and Sekler (1970) invoked the compensation principles of welfare economics in evaluating the impacts of tomato harvester in California. They projected that the tomato harvester innovation was financially profitable even if the displaced workers had been compensated for five years by their former employers at their previous wage level. They suggested that a new institution was needed to compensate the losers in such a technological change. Since this new technology is not neutral in its impacts, the winners should pay the losers in some manner outside the normal system of taxation.[5/]

[5/] Some argue that normal taxation will result in relatively equitable income redistribution (e.g. Chopra, 1972), but they are difficult and impractical to implement particularly in developing countries (Gemmil and Eicher, 1973).

To evaluate the probable direction and consequences of technological innovation, some economists employ a theoretical-speculative framework based on political, sociological, and economic theory (Ruttan, 1973; Gotsch, 1972; Dorner, 1971; Mellor, 1969; Johnston and Cownie, 1969). Policy implications from this type of analysis are based upon extensive information about the ecological setting, local institutions, the economic and technical characteristics of the technology, supply and demand characteristics of factor and product markets, and the constraints imposed by socio-cultural environment. A number of economists argued that conventional neoclassical theory and most quantitative models disregard and assume away the relevant institutional-cultural factors present that also significantly influence the probable direction and distribution of gains and benefits associated with technical change (Dorner, 1971; Myrdal, 1970 and a few others).

Gotsch (1972) developed an institutional framework for evaluating the welfare implications of technical change. This typology has been conveniently summarized by Young (1977) as is reproduced in Table III-1.

The agricultural sector of El Salvador is characterized by relatively skewed land resource distribution, highly centralized regulatory and service agencies and a hierarchial social organization (LeBaron and Associates, 1975). If Gotsch's framework is applied to the problem of herbicide

Table III-1. Gotsch's Typology for Classifying Development Situations with Respect to the Welfare Consequences of Technical Change.

Component	Characteristics Favoring: Equal Distribution of Benefits and Costs	Characteristics Favoring: Inequitable Distribution of Benefits and Costs
New technology	Simple, divisible, labor-using	Complicated, lumpy, labor-displacing
Farm size distribution	Relatively egalitarian	Relatively unequal
Institutions	Decentralized, effective community organizations	Top-down, no community organizations
Social organization	Individualistic, loosely structured	Hierarchial

adoption, it would imply that the introduction of chemical weed control, a labor-displacing technology, would exacerbate existing income inequities among the different groups in the Salvadorean agricultural sector. While Gotsch's framework provides a general (non-quantitative) evaluation of technical change, there would still be a need for quantitative models incorporating institutional factors in order that specific policy implications can be derived from such studies.

Scope and Methodological Considerations of the Study

This thesis represents an attempt to evaluate the impacts of existing government policies and observed farm price distortions on the choice of enterprises and weed control technology and its distributional consequences on basic grain farms in Central El Salvador. The proposed evaluations direct attention to what was described in the literature review as ex-ante, short-term (static) policy research, employing linear programming and some aspects of theoretical-speculative predictions. The following section justifies the use of a regional linear programming analysis for the basic grain farm case study.

Justification of the Linear Programming Approach

The advantages of employing a regional linear programming model for evaluating the impacts of government policies and observed farm price distortions on the choice of the most profitable enterprise/weed control system composition for the basic grain farm case study region include the following:

1. The programming assumption of constrained profit maximization criterion which determines the choice of enterprise/weed control system composition by basic grain farmers in the case study region appear to be realistic. As LeBaron and Associates (1975) pointed out, the El Salvadorean farmer is either an enterpriser/entrepreneur or a potential enterpriser and that the El Salvador peasant

culture has already undergone social changes that precede or accompany agricultural modernization.

2. The model allows direct evaluation of policy-induced price distortions as it affects enterprise/weed control system choice. Thus optimal solutions are estimated under assumptions of social factor and product prices, and private (distorted) product and factor prices. As pointed out by Gemmil and Eicher (1973) the usefulness of a model should be judged principally on its ability to realistically evaluate policy decisions.
3. The model incorporates basic grain farms of different sizes with heterogenous characteristics and varying resource constraints that determine which farms will adopt the new technology.
4. The model includes assumptions of various levels of off-farm labor demand available to the farm labor-supplying household. This captures the influences of labor demand competition on the choice of enterprises and weed control technology systems in basic grain farms of different sizes and allocation of available labor supply between weed control work and off-farm employment opportunities in the case study region.
5. A model with farm size decomposition and labor-supplying household decomposition will be able to

evaluate income and employment changes among the different sized basic grain farms and labor-supplying household groups. In contrast, production function analysis basically determines changes in functional income distribution between capital and labor, each of which are assumed homogenous. Economic surplus models determine the distribution of costs and benefits between two general classes of consumers and producers (Young, 1977).

Deficiencies and Limitations of Linear Programming Model[6]

Since the linear programming model is basically set in a comparative static framework, it cannot capture the effects of technical change in a dynamic context. The linear programming solutions only predict the "equilibrium" outcomes or end points over a given adjustment period to specified sets of constraints and behavioral assumptions. In addition, ordinary linear programming solutions determine only the so-called "first round impacts" of technological change, i.e., changes in output and input utilization including income and employment changes of different sized farms and of different groups of farm labor.

On the other hand, dynamic research methods could evaluate the process of technical change and economic

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[6] The discussion draws heavily from Young (1977, pp. 32).

adjustments over many years into the future. As Young (1977) suggested it is theoretically possible to incorporate into a general dynamic programming model the second round effects and subsequent round adjustments for factor and product prices, linkages with other sectors of the economy, induced changes in agricultural organization, influences on local institutions and power structures, and impacts on demographic variables like the rate of population growth. While it is highly desirable to employ general dynamic analysis to evaluate agricultural technology change, the research expertise and data needed for such a venture are not available for this thesis project. Perhaps, the lessons learned from this short-term static analysis could provide research guidelines for future studies on long-term dynamic analysis over a wider geographical area.

IV. THE REGIONAL LINEAR PROGRAMMING MODEL: STRUCTURE AND THEORETICAL CONSIDERATIONS

This chapter consists of three main sections. The first section describes the hypothetical region where the model is applied and gives the structure of the regional linear programming model. The second section discusses the theoretical framework and basic assumptions for evaluating the enterprise/weed control technology adoption process. The third section describes the theoretical framework for measuring the efficiency and distributional consequences of technology adoption as induced by market distortions due to government market intervention and other forms of observed farm price distortions.

The Hypothetical Region and Structure of the Model

Hypothetical Region

If the total population of farm production units is large, the cost of analyzing each unit is prohibitive. A practical approach to the problem is to analyze "representative farms". The principal weakness in the approach is accurately specifying the representative farms to eliminate bias. Regional problems can be analyzed using a series of representative farms based on an important decision characteristic. In this study size is used to differentiate three representative farms. The three farms constitute a representation of the Central Region of El Salvador. The region has only three labor-supplying components consisting of small farm family labor, medium farm family labor and landless labor. The labor supplying component can find employment either from weed control work in each of the three farms or from off-farm employment available in the region.

Each of the three farms in the region have fixed amounts of land and capital resources that can be employed for basic grain crop and coffee production. There are two main methods of weed control that each farm can utilize for the alternative crop enterprises, namely, manual and herbicide weed control.

Structure of the Model

The regional linear programming model developed for this study is designed to predict the short-run effects of policy induced price distortions and observed farm input-output price distortions on the choice of enterprise/weed control systems and associated income and employment effects for the three representative basic grain farms in Central El Salvador for crop year 1975. The different prices for inputs and outputs are exogenously introduced into the programming model either singly or in combinations by changing input and output prices in the coefficient estimates of net crop incomes, usage rates and variable costs of crop production.

The programming model consists of three principal groups of activities: (a) alternative enterprise/weed control system production activities available to each of the three farm size types, (b) on-farm weed control labor-using (buying) activities for each of the three farm size types, and (c) labor-selling activities for each of the three labor-supplying households. The objective function is to maximize regional incomes from crop production-weed control activities and from off-farm employment.[7/]

The model constraints include the following: (1) regional land constraint that allocates land by type and farm size, (2) regional labor supply and demand balancing equation, and (3) operating capital for each of the three farm size types. The model allocates available operating capital in each farm to production costs and weed control labor costs required by the selected enterprise/weed control system composition.

Finally, the model includes accounting equations for calculating total family incomes and total employment for

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[7/] Maximization of regional income *per se* is not the main focus of this study. It is used in this model as a device to estimate optimum resource allocation between and within the four representative farm households in the closed region under specified resource constraints, off-farm labor demand situation and factor-product prices.

each of the four farm households (small, medium, and large farms, and landless labor).

The general mathematical formulation of the model is:

1. Maximize:

$$Z = \sum_{i=1}^{2} \sum_{h=1}^{8} c_h X_{h_i} + [\sum_{j=1}^{14} c_j X_{j3} + \sum_{j=1}^{15} c_j X_{j4} + c_{16} X_{16,5}]$$

$$+ [\sum_{k=1}^{7} c_k X_{k6} + c_8 X_{8,7}] + \sum_{\ell=1}^{6} \{-e_1 [D_\ell + M_\ell]$$

$$+ e_2 [-E_\ell - L_\ell + S_\ell + V_\ell]$$

$$+ e_3 [-F_\ell - I_\ell - K_\ell + T_\ell + U_\ell + W_\ell + G_\ell + P_\ell + Q_\ell]\}$$

$$+ \sum_{n=1}^{6} Y_n$$

where:

i = index of land class: i=1,2, represents land classes in small farm; i=3,4,5 represents land classes in medium farm; and i=6,7 indicates land classes in large farm.

h,j,k = indices of alternative enterprise/weed control systems: h=1,2,...,8 indicate enterprises in small farm; j=1,2,...,16 indicate enterprises in medium farm; and k=1,2,...8 indicate enterprises in large farm.

c_h, c_j, c_k = net returns per hectare to weed control and management: where, c_h represents net returns to enterprises in the small farm; c_j and c_{16} represent net returns to enterprises in the medium farm; and c_k and c_8 represent net returns to enterprises in the large farm.

Z = total regional income from crop production-weed control activities and off-farm work.

X_{hi}, X_{ji}, X_{ki} = hectares of land type i on which alternative enterprises are planted: where, X_{hi} indicate small farm land type i planted to the hth enterprise; X_{j3}, X_{j4}, $X_{16,5}$ indicate hectares of land type i=3,4,5 on which alternative medium farm enterprises are planted; and X_{k6}, $X_{8,7}$ indicate hectares of land type i=6,7 on which large farm enterprises are planted.

e = daily wage rate for weed control work: where, e_1 = wage rate for unpaid family labor in small and medium farms; e_2 = wage rate paid by the medium farm; and e_3 = wage rate paid by the large farm and in off-farm work.

ℓ = index of monthly period of available labor supply and/or monthly period of labor sold and purchased for weed control and off-farm work: where, ℓ =

1,2,3,...,6 (May, June, July, Aug., Sept., Nov.).

D_ℓ, M_ℓ = man-days of unpaid family labor employed for weed control in their own farms in the ℓth month: D_ℓ is for unpaid small farm labor and M_ℓ is for unpaid medium farm labor.

E_ℓ, F_ℓ, I_ℓ, K_ℓ, L_ℓ = man-days of hired weed control labor purchased by the medium and large farms in the ℓth month: where, E_ℓ and F_ℓ represent man-days of small farm weed control labor purchased by the medium and large farms; I_ℓ represents man-days of medium farm weed control labor purchased by the large farm; and L_ℓ, K_ℓ are man-days of landless weed control labor purchased by the large farm.

S_ℓ, T_ℓ, V_ℓ, W_ℓ, U_ℓ = man-days of weed control labor sold by the labor-supplying households in the ℓth month: where, S_ℓ and T_ℓ represent small farm family labor sold to medium and large farms; V_ℓ and W_ℓ represent landless labor sold to medium and large farms; and U_ℓ represent medium farm labor sold to large farm.

G_ℓ, P_ℓ, Q_ℓ = man-days of off-farm employed labor in the ℓth month from the small farm labor, medium farm labor and landless labor households, respectively.

Y_n = accounting activities (n=1,2,...,7): where, Y=1, 2,3,4 represent total incomes earned by small, medium, and large farms, and landless labor households; Y = 5,6,7 represent total employment from all sources obtained by small and medium farms, and landless labor households.

2. Land Resource constraint equations:

Small farm:

$$\sum_{h=1}^{8} 1\ X_{hi} = A_i \qquad \text{for } i = 1,2.$$

The same equation holds for the medium and large farms. For the medium farm the relevant equations are:

$$\sum_{j=1}^{14} 1\ X_{j3} = A_3$$

and

$$\sum_{j=1}^{15} 1\ X_{j4} = A_4.$$

In the case of the large farm, the land constraint equations are:

$$\sum_{k=1}^{7} 1\ X_{k6} = A_6$$

and

$$1\ X_{8,7} = A_7\ ,$$

where:

A_i = hectares of land class i available to each farm: where, A_1 and A_2 indicate total area of land class i=1,2 on the small farm; A_3, A_4 and A_5 indicate total area of land class i=3,4,5 on the medium farm; and A_6 and A_7 represent total area of land class i=6,7 on the large farm.

3. Labor supply constraint equations:

<u>Small farm family labor</u>:

$$1\ D_\ell + 1\ E_\ell + 1\ F_\ell + 1\ G_\ell \leq Y_\ell$$

$$\text{for } \ell = 1,2,\ldots,6$$

The same equation holds for the medium farm labor and landless labor households. The labor-using activity variables for the medium farm includes M_ℓ, I_ℓ, P_ℓ and total labor supply for the medium farm is represented by R_ℓ. In the case of landless labor household, the labor-using activity variable include L_ℓ, K_ℓ, and Q_ℓ, and the total labor supply for the landless labor household is represented by B_ℓ.

where:

Y_ℓ, R_ℓ, B_ℓ = man-days of labor supply available in the ℓth month from the small farm, medium farm and landless labor households, respectively.

4. Weed control labor balancing (buying and selling) equations:

<u>Small farm family labor transfer to medium and large farm weed control activities</u>

$$1\ E_\ell - 1\ S_\ell = 0;\ 1\ F_\ell - 1\ T_\ell = 0$$

$$\text{for } \ell=1,2,\ldots,6$$

where:

$(1\ E_\ell - 1\ S_\ell)$ = labor transfer to medium farm weed control activities and $(1\ F_\ell - 1\ T_\ell)$ represents labor transfer to large farm weed control activities.

Similar equations apply to medium farm labor and landless labor transfer activities. In the case of the medium farm labor transfer activities $(1\ I_\ell - 1\ U_\ell = 0)$ represents labor transfer to large farm weed control activities. For the landless labor transfer equations $(1\ L_\ell - 1\ V_\ell = 0)$ and $(1\ K_\ell - 1\ W_\ell = 0)$, represent labor transfers to medium and large farm weed control activities, respectively.

5. Weed control crop labor requirement balancing equations:

Small farm enterprise/weed control activities:

$$\sum_{i=1}^{2} \sum_{h=1}^{8} a_{h\ell} X_{hi} - 1\ D_{\ell} = 0$$

$$\text{for } \ell=1,2,\ldots,6$$

The same equation holds for medium and large farm enterprise/weed control activities. For the medium farm the total weed control labor requirements for all crops are represented by the terms in

$$[\sum_{j=1}^{14} a_{j\ell} X_{j3} + \sum_{j=1}^{15} a_{j\ell} X_{j4} + a_{16,15} X_{16,5}]$$

and are balanced by the labor-source activities represented by the terms in

$$(1[M_{\ell} + E_{\ell} + L_{\ell}]).$$

In the large farm the total crop labor requirements are represented by the terms

$$[\sum_{k=1}^{7} a_{k\ell} + X_{k7} + a_{8,5} X_{8,7}]$$

and are balanced by labor-source activities

$$(1[F_{\ell} + I_{\ell} + K_{\ell}]).$$

where:

$a_{h\ell}$, $a_{j\ell}$, $a_{k\ell}$ = man-days per hectare required for weed control in the ℓth month by alternative enterprises in the farms: where, $a_{h\ell}$ applies to the small farm enterprises; $a_{j\ell}$ and $a_{16,5}$ applies to the medium farm enterprises; and $a_{k\ell}$ and $a_{8,5}$ applies to large farm enterprises.

6. Regional off-farm employment constraints:

$$1\ G_\ell + 1\ P_\ell + 1\ Q_\ell \leq H_\ell$$

$$\text{for } \ell=1,2,\ldots,6$$

where:

H_ℓ = total man-days of regional employment demand in the ℓth month.

7. Operating capital constraint equations:

<u>Small farm operating capital</u>:

$$\sum_{i=1}^{2} \sum_{h=1}^{8} r_h X_{hi} \leq C_1$$

Operating capital equations are similar for the medium and large farms. For the medium farm the total operating capital (C_2) should be greater than or equal to crop production expenses

$$[\sum_{j=1}^{14} r_j X_{j3} + \sum_{j=1}^{15} r_j X_{j4} + r_{16} X_{16,5}]$$

and weed control labor costs

$$(\sum_{\ell=1}^{6} e_3[F_\ell + I_\ell + K_\ell]).$$

where:

r_h, r_j, r_k = variable costs per hectare (excludes weed control labor costs) required by alternative farm enterprises: where, r_h applies to small farm enterprises; r_j and r_{16} applies to medium farm enterprises; and r_k and r_8 applies to large farm enterprises.

C_1, C_2, C_3 = total amount of operating capital available in the small, medium and large farms, respectively.

8. Total income accounting equations:

Small farm household:

$$\sum_{i=1}^{2} \sum_{h=1}^{8} c_h X_{hi} + \sum_{\ell=1}^{6} \{[e_2 S_\ell] + e_3 \; [T_\ell + G_\ell] \quad - 1 \; Y_1 = 0$$

The same type of equations holds for medium and large farms and landless labor households. In the case of the medium farm, it's total income (Y_2) comes from crop incomes

$$(\sum_{j=1}^{14} c_j X_{j3} + \sum_{j=1}^{15} c_j X_{j4} + c_{16} X_{16,5})$$

and from labor earnings

$$\left(\sum_{\ell=1}^{6} \{e_2[U_\ell] + [e_3P_\ell]\}\right).$$

The large farm's total income (Y_3) comes from crop incomes

$$\left(\sum_{k=1}^{7} c_k X_{k6} + c_8 X_{8,7}\right),$$

while the landless laborer's labor income (Y_4) from weed control and off-farm work are represented by the terms

$$\left(\sum_{\ell=1}^{6} \{[e_2V_\ell] + e_3\ [W_\ell + Q_\ell]\}\right).$$

9. Total employment accounting equations:

<u>Small farm household</u>:

$$\sum_{\ell=1}^{6} 1\ [D_\ell + E_\ell + F_\ell + G_\ell] - 1\ Y_5 = 0$$

Again similar equations apply to medium farm and landless labor households. For the medium farm household, the activity variables are M_ℓ, I_ℓ, P_ℓ and Y_6. For the landless labor household, the activity variables are L_ℓ, K_ℓ, Q_ℓ and Y_7.

10. Non-negativity constraints:

<u>Land using activities</u>:

$$X_{hi},\ X_{j3},\ X_{j4},\ X_{16,5},\ X_{k6},\ X_{8,7} \geq 0$$

for h=1,2,...,8 on i=1,2,; j=1,2,...,14 on i=3; j=1,2, ...,15 on i-4; k=1,2,...,7 on i=6; and k=8 on i=7.

Labor-using activities:

$$D_\ell, M_\ell, E_\ell, L_\ell, S_\ell, V_\ell, F_\ell, I_\ell, K_\ell, T_\ell, U_\ell, W_\ell, G_\ell, Q_\ell \geq 0$$

for ℓ=1,2,...,6

Detailed descriptions of alternative enterprise/weed control systems for each farm size type, specification of numerical values for all coefficients and constraint levels, and descriptions of the sample basic grain farms are presented in Chapter V.

The preceding model contains the general assumptions of linear programming, namely, additivity of resources and activities, linearity of objective function, non-negativity of decision variables, divisibility of activities and resources, finiteness of activities and resource restrictions, proportionality of activity levels (constant resource productivity and constant returns to scale), single valued expectations for all input-output coefficients, prices and constraint levels (Agrawal and Heady, 1972). These assumptions are acceptable for this enterprise/weed control choice study. Manual hoeing and herbicide application with backpack manual sprayer are generally divisible technologies and are additive. Aggregation errors common in programming a region as a single farm unit rather than as a number of separate heterogeneous farm size types, are minimized in this study. In addition, variations in resource availability and economic-technical-ecological environmental differences between farm size types are explicitly considered in this model.

In conclusion, the constrained profit maximization objective function, which allows for differing net returns of alternative enterprise/weed control systems on different land types and farm sizes, and permits labor supply to be employed in weed control and off-farm work is considered to be appropriate for the basic grain sector of Central El Salvador and is used in this study.

Theoretical Considerations for Evaluating Enterprise/Technology Adoption Process

Profit Maximization Assumption

The underlying behavioral assumption of this model is that basic grain farmers are economic men motivated by profit. Decisions as to what enterprise/weed control composition to adopt on their farms, the prices of inputs and outputs, existing weed control systems available, other farm technology available (fertilizer, improved seeds, insecticides, improved cultural practices and others), and alternative employment opportunities available, are made in an attempt to maximize profit. It is recognized that other non-pecuniary motives may influence a farmer to use modern farm technology. This may be due to the desire to gain social "prestige" in the community. In the case of adopting a labor-displacing technology, he may want to minimize the uncertainties of labor management. Although these non-pecuniary motives are important factors in influencing the choice of enterprise and technology, it is relatively difficult to quantify them and to incorporate them in a deterministic model as the one used in this study. Non-pecuniary or indirect costs of capital-intensive technologies may also be incorporated into the model. But the "opportunity costs" of the risk of adopting a capital-intensive enterprise/weed control system due to inefficient and untimely application techniques, weather factors, and other associated factors might equal or exceed the management difficulties associated with traditional technology. Since no adequate data of this type are presently available only directly quantifiable costs of alternative enterprise/weed control systems will be evaluated.

Input Supply Assumptions

The conventional linear programming assumptions of constrained levels of labor supply and operating capital could be represented by a supply function depicted in Figure IV-1. Labor (capital) is assumed to be available at a constant price up to the point of constraint, X_t, and thereafter the supply curve becomes perfectly inelastic.

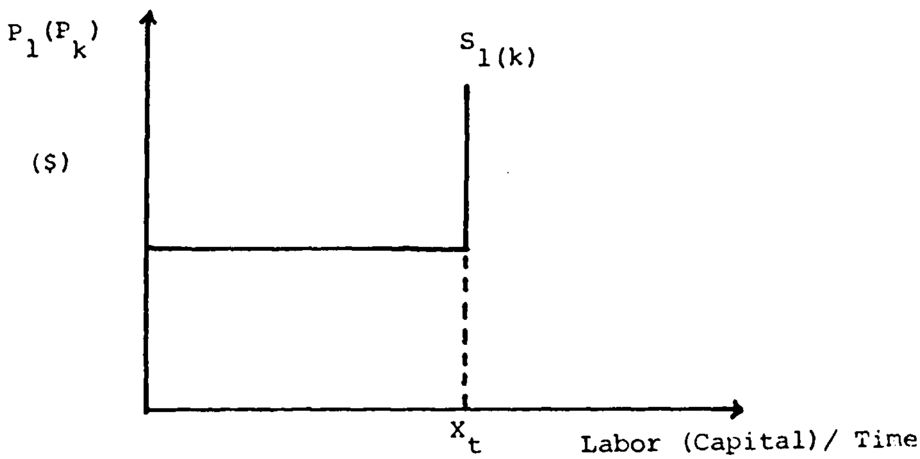

Figure IV-1. Labor (capital) supply curve implied by conventional linear programming constraints.

This assumption is realistically applicable for individual farm planning models with fixed capital, fixed family and/or hired labor supplies and for some regional models where the labor and capital markets are assumed to be closed. This formulation is the one adopted in this model since it was assumed that the region under analysis is a closed region.

Although farm labor is relatively abundant in El Salvador on a yearly basis, it is not in specific monthly periods of the production season when there is competition between labor demand for weed control and off-farm employment. Labor migration from other regions of the country to Central El Salvador is relatively restricted during the basic grain production season because of rain. Poor farm roads, lack of adequate transportation, and accommodation facilities in the Central Region during the rainy season prevents any significant labor immigration to the Central Region.

Constrained operating capital, fixed for each farm size type, appears to be realistic. The capital market is not well developed in El Salvador particularly in the basic grain subsector. Existing private and public credit institutions are few in number and their services are tailored to meet the credit needs of the more affluent export crop subsector rather than the basic grain subsector (Solis *et al.*, 1973). Collateral requirement for short-term crop loans is based upon the size of cropland area farmed.

Fixed Area Assumption

As previously stated the agricultural land resources of El Salvador are already intensively cultivated and prospects for new land supply expansion are small. This is particularly true in the Central Region where all available cropland is already under intensive cultivation.

Farm Technology Level Assumptions

Two types of farm technology are assumed to be available - traditional and modern. The small and medium farms can adopt either one or both systems, while the large farm can use only modern farm technology. This assumption appears to be realistic as revealed by the sample farm survey conducted for this study in Central El Salvador.

The traditional system consists of using manual or animal traction power and manual tools in all phases of crop production. Native low yielding grain seeds are used. The modern farm production system relies on mechanical power in seedbed preparation; uses modern farm inputs such as improved high yielding grain seeds, chemical fertilizer, insecticides, herbicides and spraying equipment; and uses recommended cultural practices in crop production. Since modern farm inputs and the information systems needed to use these inputs are presently available in El Salvador it is reasonable to assume that they can be utilized by each of the three farm size types.

Traditional and modern activities are available for each alternative enterprise. Crop enterprises which use improved or hybrid grain seeds also use the complementary modern farm inputs (fertilizer, insecticides and pesticides) and recommended cultural practices. However, either manual or herbicide weed control systems can be employed. Crop enterprises using traditional or native low-yielding seed grains are assumed to use labor-intensive production practices particularly manual weed control and no modern farm inputs. This is reasonable from an economic standpoint since the relatively low yields obtained from planting traditional seed varieties would make the use of modern farm inputs an unprofitable enterprise. The double crop enterprises are weeded by herbicide on one of the crops - either the first or the second crop. Hence, the alternative double crop enterprises either use pure manual weed control or mixed manual-herbicide weed control.

The government intervention policies on input prices as well as observed farm input prices are reflected in the alternative net returns and variable costs coefficient estimates for each traditional and each modern grain crop enterprise.

Off-Farm Employment Assumptions[8/]

Three off-farm employment demand assumptions are made. Separate programming runs are conducted for each off-farm employment situation. It is assumed in the first, zero (0) off-farm labor demand, that the only source of employment of available weed control labor supply would be in weed control labor demand in each of the three farm size types. Programming solutions obtained under this assumption would serve as a benchmark for comparing distributional gains and losses in incomes associated with enterprise/weed control adoption from the two other off-farm employment assumptions.

The sample farm survey in the Central Region of El Salvador revealed that the farm labor force can also obtain off-farm employment in the export crop sector (seedbed preparation, seeding, fertilizing, spraying, etc.) and other non-farm jobs (home industries, carpentry, brick making, etc.). Thus, the second off-farm employment assumption is that 50 percent of the available weed control labor supply could also be employed in off-farm work within the closed region. This is probably the actual situation now prevailing in the basic grain sector of El Salvador. The availability of off-farm employment may influence in either direction, the effects of policy induced price distortions and observed farm price distortions with respect to the enterprise/weed control technology adoption.

[8/] For further elaboration and the quantitative value of the three levels of off-farm employment demand see page 126.

The short-run (static) prediction of the impacts of government policies in the basic grain region under a 50 percent off-farm employment situation may reveal useful implications for policy evaluation. This will provide policy makers with some clues as to how existing policy mix and observed farm price distortions affect the distributional gains and losses obtained by various groups in the basic grain sector and whether the associated income and employment effects are consistent with the stated national policy objectives of increasing farm employment and incomes, and improving the distribution of incomes in the sector.

The third assumption of 100 percent off-farm labor demand implies that the available weed control labor supply in the region could be also fully employed in off-farm work. This condition is not presently obtainable in El Salvador's basic grain sector and will not be so for a long time. However, the evaluation of the possible effects of government policies on enterprise/weed control technology adoption under this situation would provide a long-run glimpse of the situation when the export crop sector and industrial sector of El Salvador will have become fully capable of absorbing the excess farm labor force. The influence of a full off-farm employment situation on the impacts of government policies on enterprise/weed control technology adoption may be more pronounced than when only partial off-farm employment opportunities are available. Under this situation it is conceivable that capital intensive enterprise/weed control systems may be adopted by the different farm size types even when labor intensive enterprise/weed control systems are nominally cheap.

Risk and Dynamic Implications

The static-deterministic programming model employed in this study indicates only the end point of the process of enterprise/weed control technology adoption once all farm size types have adapted the most profitable enterprise/weed control system composition under specified price regimes, off-farm labor demand assumptions, and the physical-economic state assumed for the programming run.

The model does not explicitly consider the risk factors associated with the selection of a specific crop enterprise and its weed control system. Agronomic weed control experiments for rice, corn and beans conducted in two successive years (1974 and 1975) in El Salvador indicated that timely and proper implementation of manual and herbicide weed control systems produce equal yield responses (AID/OSU, 1977). Hence, the effects of alternative weed control systems on net crop income are assumed to be determined in a non-stochastic manner by their relative costs for any particular land type-farm size (Young, 1977). In reality both weed control systems are risky. Weather uncertainties and human errors can cause significant variations in both the effectiveness and cost of specific weed control methods even if prices are known with certainty. Considerable delay in manual weeding particularly during the critical period when weeds compete with the crop for plant nutrients, will cause reduced yields and a consequent increase in weed control labor requirements and costs. In the same manner, when herbicides are applied at the proper time and in correct amounts, effective weed control can be obtained. But judgement errors or wrong application procedures may result in ineffective weed control and serious damage to the crop.

In El Salvador technical services for chemical weed control appears to be readily available to farmers in the case study region. In fact, chemical weed control in the export crop sector (cotton and sugar cane) has begun to be widespread in recent years (Baker and Smith, 1975).

The model assumes that there are no risks associated with adopting either manual or herbicide weed control for basic grain crop production. Since there is no available data or information to identify and quantify risk factors associated with enterprise/weed control technology adoption, these factors were ignored in the analysis.

Theoretical Framework for Analyzing Efficiency and Distributional Effects of Enterprise/Weed Control Technology Adoption

The principal focus of this thesis is to evaluate the efficiency losses and distributional consequences of policy-induced price distortions and observed farm price distortions in the basic grain sector of Central El Salvador. To arrive at a meaningful policy evaluation it is necessary to develop a framework wherein the variables to be measured are properly defined and classified. The theoretical framework for evaluating the consequences of technical change was adopted from Young (1977). He outlined a theoretical framework for evaluating the welfare effects of technology adoption and it is reproduced in Table IV-1.

Table IV-1. Theoretical Classification of Welfare Changes from Adopting a New Technology.

Cause/Type	Efficiency Changes	Distributional Changes
Efficiency enhancing development	I (Gains)	II (Gains or losses)
Market distortions[a/]	III (Losses)	(V (Gains or losses)

[a/]Excludes market distortions classified under "public goods".

Two principal causes of adopting a specific weed control system are evaluated. The first cause consists of new developments in weed control technology or external market forces which makes the newly developed weed control system more efficient when all inputs are priced at their "social opportunity cost."[9/] A new technique is said to be "more efficient" if a given output could be produced with lower resource costs or output can be expanded with the same resource expenditure at their social prices.

The second cause that could induce adoption of a specific weed control technique is when relative factor prices are distorted due to government policies and market imperfections or failures. Under this situation, the adopted weed control technique may be privately profitable to the adopting farmer, but it is not efficient when the resources used by this technique are evaluated at their social opportunity costs. The alternative policy determined input-output prices and observed (distorted) farm prices affecting basic grain production in El Salvador is discussed in Chapter V.

Welfare consequences resulting from the adoption of a specific weed control technique by type of effects, consists of "efficiency" and "distributional" effects. Efficiency effects of a specific weed control technique are measured from the standpoint of the social opportunity costs of utilized resources to produce a given level of

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[9/] Young calls this type of development an "efficiency enhancing development." The "social opportunity costs" of all inputs refers to a situation where all input prices are those which would prevail under a free market condition when price distortions induced by government intervention policies and/or market failures are absent.

output. Distributional effects define the welfare gains and losses obtained by the various groups in the society resulting from the adoption of a given weed control technique. In the case of the basic grain sector of El Salvador, the distributional effects from adopting a weed control technique would be the income-employment gains and losses that are obtained by the different farm size types and different farm labor-supplying households.

When a specific weed control technique is adopted under free market conditions (i.e., social price regime), this technique would be the most socially efficient and hence, only efficiency gains (increased income or reduced cost) can be obtained as defined in quadrant I of Table IV-1. However, when the adoption of a given weed control technique is induced by market distortions such as policy-induced price distortions and price distortions due to market imperfections or failures, only efficiency losses are obtained by the adopting farmers and the efficiency loss is defined in quadrant III, Table IV-1. Adopting farmers find this technique to be privately efficient but in fact it is a socially inefficient technique. The efficiency loss represents the added social costs required by this technique as compared to another technique that would have been adopted if the utilized resources were priced at their social opportunity cost.

In defining distributional gains and losses associated with the adoption of a weed control technique, value judgments have to be made in relation to the society's equity goals or "social welfare function" (Young, 1977). For example, in the case of El Salvador's basic grain sector, the adoption of a relatively cheap (socially or privately) herbicide weed control may increase net crop incomes of landowners, and reduce labor earnings and employment of displayed farm workers. These changes would be considered a distributional loss if society's goal is to move towards a more equitable income distribution and a distributional gain if the society places a relatively high value on the incomes of landowners and little or none on landless laborers.

To clarify further the efficiency and distributional effects of herbicide weed control adoption, a description of the measurement procedures is presented in the next section of this chapter.

Measuring the Efficiency Losses and Distributional Effects of Enterprise/Weed Control Technology Adoption as Induced by Government Market Intervention/Farm Price Distortions

Since the main focus of this thesis is to measure the induced efficiency losses and distributional effects of government policies and observed farm price distortions several linear programming runs will be made using data and technical information obtained from a representative basic grain farm survey conducted in Central El Salvador, under different government prices and different observed farm prices and alternative off-farm employment situations. These runs are discussed in detail in the last section of Chapter V. However, a brief outline is presented below to facilitate discussion.

A. Social Optimum Solutions: Manual and herbicide weed control systems and complementary farm inputs are available at social (non-distorted) prices. One run each under the three alternative off-farm employment assumptions.

B. Private Optimum Solutions under Alternative Government Prices: Five different government price regimes are introduced one at a time by changing coefficients of net crop incomes, wage rates and variable production costs. Each of the five price regimes will be run separately under each off-farm labor demand situation.

C. Private Optimum Solutions under Alternative Observed Farm Price Regimes: Five different observed farm price regimes are introduced one at a time. Each of the five price regimes will be run separately under each off-farm labor demand assumption.[10/]

Comparisons of the results of Runs A and B under each of the three off-farm labor demand assumptions will reveal

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[10/] The detailed description of alternative government prices and observed farm price regimes are presented in pages 139 and 142.

the efficiency losses and distributional effects if government prices were in force. Comparisons of Runs A and C under each of the three off-farm labor demand assumptions will reveal the efficiency losses and distributional effects of farm price distortions observed among the representative basic grain case study farms in Central El Salvador.

Figure IV-2 utilizes the unit isoquant framework to depict the effects of various factor price distortions in weed control technology choice and its associated efficiency

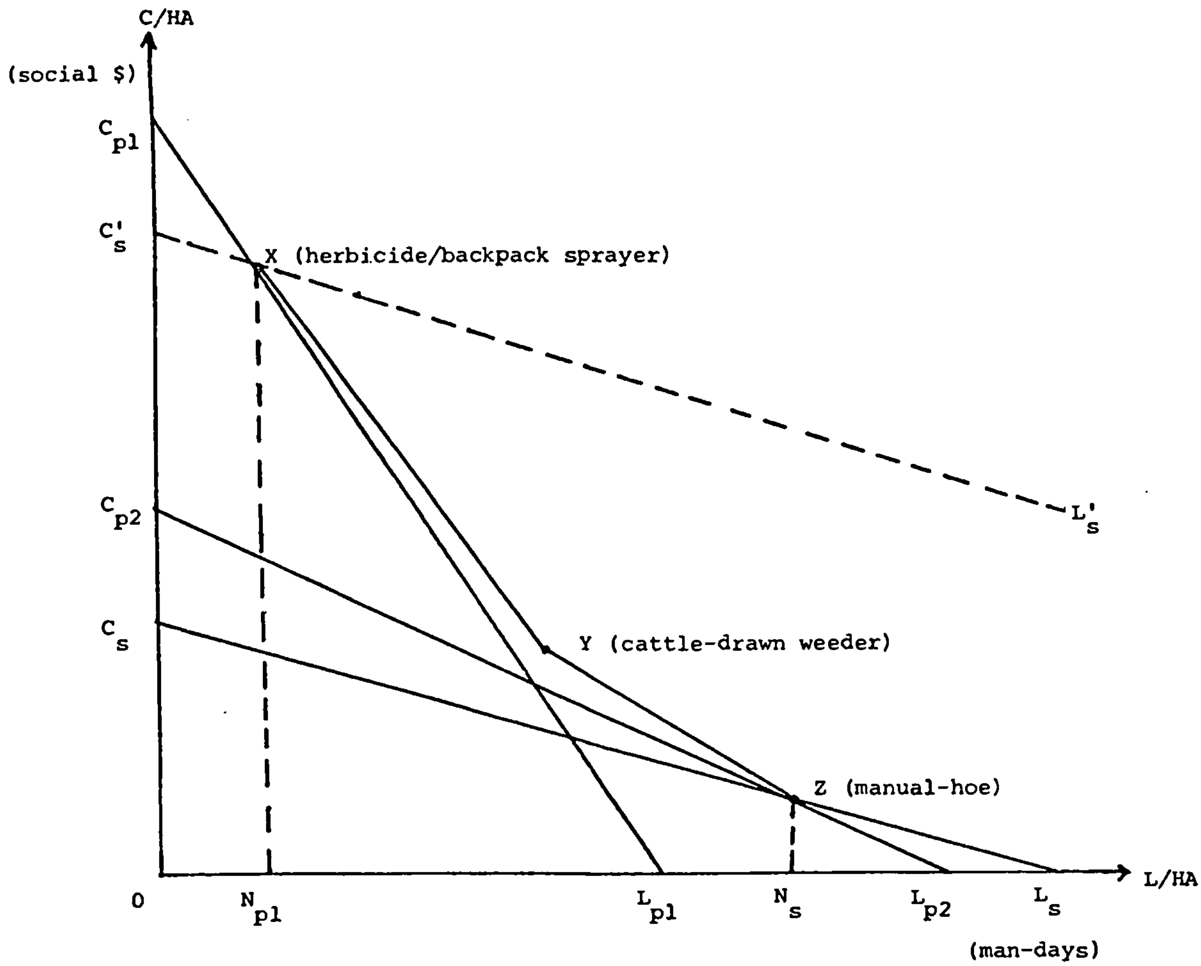

Figure IV-2. Effects of factor price distortions in weed control technology choice.

and distributional effects.[11/] Isoquants XYZ display a hypothetical frontier of technically efficient weed control systems for a given basic grain crop (say, corn), land type and farm size type. The linearly segmented isoquant is characterized by the presence of "corner tangencies" which can realistically describe the mechanism of technology selection of the cost minimizing-linear programming model.[12/]

Capital requirements per hectare, measured in terms of the social costs of utilized material and capital services are plotted on the vertical axis, and weed control labor requirements on the horizontal axis. All techniques on the unit isoquant give equally effective weed control. The isoquant represents a given amount of grain output (say, 1000 kilograms) per hectare. Let us assume that the original isocost line, C_sL_s, represents resources used at their social prices. Then the point of tangency at Z (manual-hoe) would become the most socially efficient weed control technique employing ON_s man-days per hectare for weed control

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[11/] The unit isoquant construct is similar to the one employed by Timmer (1972) to evaluate rice milling technologies in Indonesia and is the same construct used by Young (1977) to evaluate herbicide technology diffusion in Northeast Brazil. The results of two successive years (1974 and 1975) of weed control experiments for basic grains in El Salvador by AID/OSU justifies the use of this analytical framework.

[12/] In the parlance of linear programming, the "dual" solution of a cost minimization objective function would be profit maximization. In this context, the framework described above would be applicable to the profit maximization-linear programming model used in this study.

work. Suppose the government implemented a subsidy program for capital inputs including herbicides (say, exemption from import taxes), that caused the reduction of the private price of capital by say, 50 percent, while the price of labor remained constant. The capital axis is scaled according to the social value of capital, but the private price of a dollar's worth of capital has been reduced by 50 cents by the subsidy. So, the isocost line representing the new lower capital/labor price ratio becomes $C_{p1}L_{p1}$ and this induces the adoption of technique X (herbicide/backpack sprayer), as the least cost technology. Evaluated by the social costs of utilized resources (as indicated by isocost line $C_s'L_s'$ which is parallel to social isocost line C_sL_s and which permits the purchase of technology X), the employment of technique X, wastes $(C_s'-C_s)$ dollars per hectare. These represent the efficiency losses due to the adoption of socially inefficient technique X as indicated in quadrant III of Table IV-1. If this was a pure capital subsidy, adopting landowners would obtain private production cost savings of $(L_s-L_{p1})P_L$ per hectare, which represents the difference in the value of two isocost lines, C_sL_s and $C_{p1}L_{p1}$. The price of labor, which was assumed to be constant, is used as a numeraire in estimating the value of the two isocost lines. At the same time, the amount of displaced labor, (N_s-N_{p1}) man-days per hectare would be translated into reduced labor earnings of $(N_s-N_{p1})P_L$ per hectare.

Suppose that the government subsidy on capital was by less than 50 percent so that the new isocost line would become $C_{p2}L_{p2}$. The point of tangency would still be at Z (manual-hoe). Then the privately efficient technique would be the same as the socially efficient technique. There would be no reduction in weed control employment but the landowners would still realize product cost savings of $(L_s-L_{p2})P_L$ per hectare. This last case is similar to the situation in the Aggreste farm region of Northeast Brazil as reported by Young (1977).

The efficiency losses induced by government policies can be estimated by comparing the social costs of weed control for Run A to those of Run B. The efficiency losses induced by market imperfections as reflected in observed (distorted) farm prices can be estimated by comparing the social costs of weed control for Run A to those of Run C.

The distributional gains and losses in terms of crop incomes and labor earnings can be determined by comparing the results of Run A and Run B for the government price regime assumption and comparing results of Run A and Run C for the observed farm price regime assumptions.

It should be pointed out that the preceding graphical framework used for measuring efficiency losses and distributional effects did not consider the specific constraints of labor and capital resource nor off-farm labor demand assumptions. To incorporate these constraints would require a multidimensional graphical analysis. However, the regional linear programming model developed for this study explicitly includes these constraints. In this event, the optimum solution predicted by the preceding simple graphical analysis will be modified by the resource constraints specified for each farm size type.

Young (1977) argued that when the adoption of a technology is induced by government price distortions, no efficiency gains can occur to balance against the welfare losses of displaced workers. Other potentially important social and political benefits may be derived from the implementation of government intervention policies but these factors could not be captured with the short-run-deterministic programming model employed in this study.

V. BACKGROUND INFORMATION AND BASE DATA AND ASSUMPTIONS OF BASIC GRAIN FARM CASE STUDY FOR CENTRAL EL SALVADOR

This chapter is divided into three main sections. The first section deals with the procedures for selection of case study sample farms. The second section summarizes the data and information obtained from the survey. The third section presents base data and specific assumptions used in the regional linear programming model developed for this study.

Survey of Representative Basic Grain Farms

A survey of selected basic grain farms of various sizes was conducted by the author between February-March, 1976. The survey was primarily aimed at gathering basic information regarding prevailing cropping patterns, weed control systems and other socio-economic data by farm size to be used to characterize the representative farms and as a base for evaluating the benefits and costs of alternative enterprise/weed control systems under specific ecologic and technical setting in Central El Salvador.

Selection of Sample Farms

A purposive (non-random) sampling procedure was employed. Three main criteria were used to select case study farms, namely, (a) at least one basic grain crop (corn, beans, rice and sorghum) had to be the major enterprise in the farm; (b) the farms had to employ different systems of weed control prevailing in Central El Salvador; and (c) the farms had to be located in a contiguous geographical area in Central El Salvador.

The Agricultural Extension Service, a department of CENTA (Centro Nacional de Tecnologia y Agropecuaria) under the Ministry of Agriculture (MAG) provided personnel and transportation facilities to select the sample farms and assisted the author in conducting farm interviews. Bias in sample farm selection was evident since there was a tendency for the assisting extension service personnel to select farmers who were regular cooperators. The selected sample farms were probably the more progressive farms.

Farm interviews were conducted in Spanish, information elicited from farm operators were recorded in a pre-tested questionnaire which was written in Spanish. At least two agricultural extensionists were present during the interviews and they acted as interpreters for the author. Since the farmer interviewees did not have written formal farm records, their replies came from recollections. Hence, reservations must be attached to any information obtained from this survey. Extra care was employed in interviewing farm cooperators and in recording their answers in the questionnaire. It is believed that the data collected from this farm survey were sufficiently reliable and adequate for this study.

Location and Grouping of Sample Farms

Twelve sample basic grain farms were surveyed in three contiguous provinces in Central El Salvador. Seven farms were located in the province of San Salvador; four farms in Cuscatlan and one farm in La Libertad (Figure V-1).

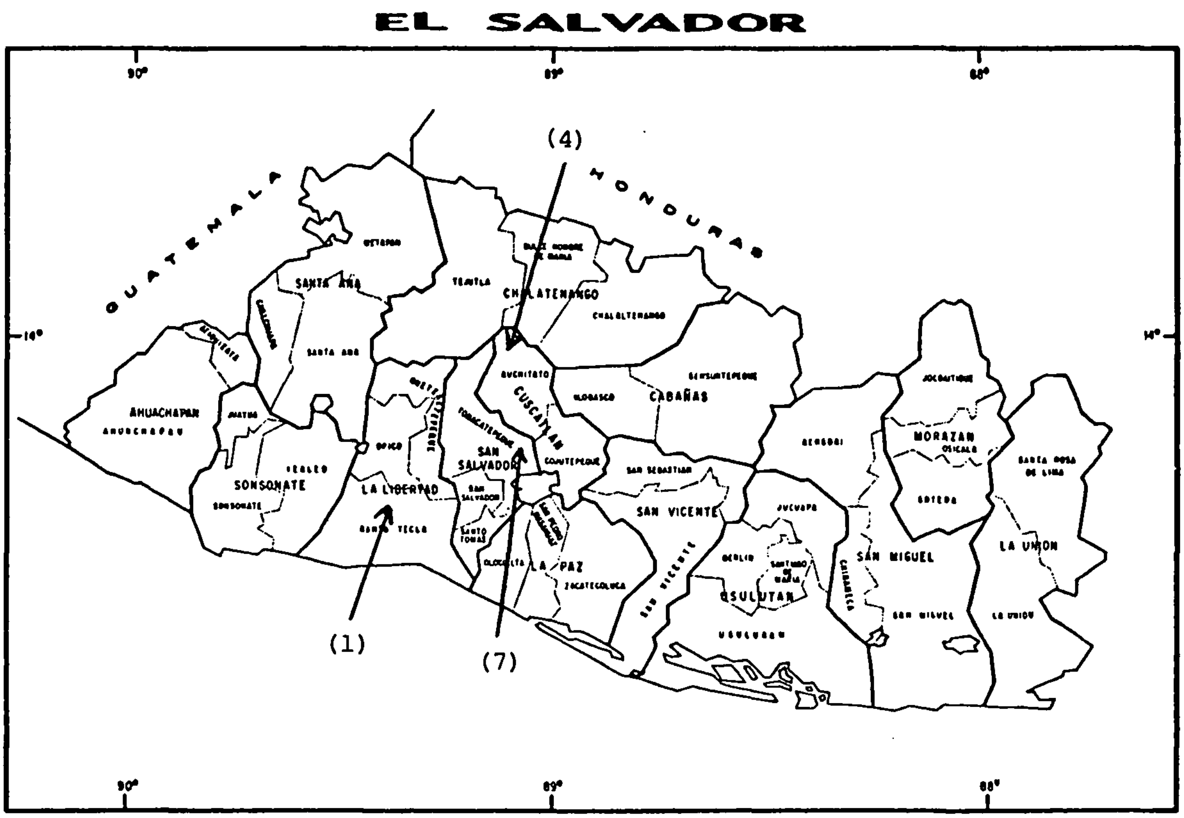

Figure V-1. Location of twelve sample farms, Central El Salvador.

The Central Region is generally mountainous and interspersed with plateaus and river valleys. It contains several extinct volcanoes and one active volcano whose last explosion in 1965 caused considerable damage to crops and property. There are two distinct seasons prevailing in the region and throughout the country. The wet season starts in May and lasts through October and the dry season, extends from November through April. Annual precipitation ranges from 1536 mm to 2269 mm.[13/] Due to the absence of large scale artificial water storage systems and irrigation development in the country, basic grain crop production is mainly dependent on rainfall. Thus, the cropping season for basic grains is during the rainy season (May to November).

The twelve farms surveyed were divided into three groups corresponding to three farm size classes:

Farm Size Class	Total Farm Area (ha)	No. of Farms
1. Small farm	less than 1 to 2.80 ha	6
2. Medium farm	5.60 to 12.60 ha	3
3. Large farm	17.50 to 44.10 ha	3
	Total	12

Representative Basic Grain Farm Summary

Information obtained during the farm survey and summarized in this section are for crop year 1975 (April, 1975 to February, 1976).

[13/] National Meteorology Service; 10 year average (1963-1973).

Profile of Farm Operators and Family Size

The average ages of farm operators ranged from the early forties (small and medium farm operators) to the late fifties (large farm operator). Large farm operators had more farming experience (44.7 years) than small farm operators (26.5 years) and medium farm operators (16 years). The average farm operator had two to three years of formal schooling. Most farmers were owner-operators (eight farms) and renters. The size of farm family household ranged from five to six persons in small and medium farms to eight persons in the large farms (Table V-1). The extended family which is a common social institution in developing countries is quite pronounced on large farms. The farm household may include husband and wife, sons and daughters, as well as grandchildren and relatives.

Land, Labor and Capital Resources

To facilitate comparison of farm resources and activities between farm size types, the data were converted into percentages and ratios.

Land resources (Table V-2). The average size of small farms (1.81 ha) was about one-fourth of a medium farm (7.93 ha) and about one-fourteenth of a large farm (26.73 ha). All of the basic grain crops were produced on non-irrigated

Table V-1. Selected Characteristics of Twelve Farm Operators and Size of Farm Households, Central El Salavador, 1975.

Farm Size Class	No. of Farms	Age (years)	Operator: Farm Experience (years)	Operator: Educ. Attained (years)	Operator: Tenure Status	Family Size: Household Members[1/]: Adults (+16 yrs)	Family Size: Household Members[1/]: Children (10-15 yrs)	Family Size: Household Members[1/]: Children (-10 yrs)	Family Size: Total
A. Small Farm (0.35 ha-2.80 ha)	6	42	26.5	2.3	owner-4 renter-2	2.5	1.5	1.8	5.8
B. Medium Farm (5.6 ha-12.6 ha)	3	41	16.0	3.0	owner-2 renter-1	2.7	1.0	1.7	5.4
C. Large Farm (17.5 ha-44.1 ha)	3	58	44.7	2.0	owner-2 part-owner -1	5.3	1.7	1.3	8.3

[1/] Household members include farm operator, spouse, children and relatives.

Table V-2. Land Resources by Farm Size Class, Central El Salvador, 1975.

Resources	Small Farm		Medium Farm		Large Farm	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Total Farm Area (average)	1.81	100	7.93	100	26.73	100
Non-irrigated cropland	1.69	93	3.50	44	18.67	70
Permanent cropland	0.12	7	0.70	9	1.52	6
Pastures and others[1/]	--	-	3.73	47	6.54	24

[1/] Include sites of farm buildings and land not suited for permanent cultivation.

cropland whose topography ranged from hilly to gently rolling.

Small farms had 93 percent of total farm area under non-irrigated cropland, while in the large and medium farms non-irrigated cropland comprised 70 percent and 44 percent of total farm area, respectively. Large and medium farms had relatively more diversified land resources in the form of non-irrigated cropland, permanent cropland (for coffee and assorted fruits) and pasture land (livestock). The farm area devoted to permanent crops and pastures are generally hilly terrain and are not suited for continuous basic grain crop production.

From census data and field observations, it was generally noted that the small and medium farms owned or cultivated the poorer grades of land, while the larger farms owned the better grades of land. However, this was not reflected in the sample farms surveyed.

Farm labor supply and employment (Table V-3). A major portion of available family labor supply was provided by men (79 to 81 percent), primarily by the farm operator himself and adult male children and other male dependents. Women and children of working age devoted most of their time to domestic chores and the remainder to educating children. The time devoted to these activities were not included in the available family farm labor and explains the relatively small amount of family labor supply available

Table V-3. Farm Labor Supply and Employment, Central El Salvador, Crop Year - 1975.

Item	Small Farm man-days	Small Farm %	Medium Farm man-days	Medium Farm %	Large Farm man-days	Large Farm %
A. Available Family Labor Supply[1/]	451	100	265	100	453	100
Men	(365)	(81)	(209)	(79)	(365)	(80)
Women	(38)	(9)	(56)	(21)	(44)	(10)
Children	(48)	(10)	-	-	(44)	(10)
B. Family Labor Utilization	451	100	265	100	453	100
1) Work on farm:	134	30	238	90	333	74
Field crop production	(77)		(71)		(10)	
Permanent crop production	(10)		(5)		(61)	
Livestock care	(6)		(70)		(80)	
General farm activities[2/]	(41)		(92)		(182)	
2) Non-farm and off-farm work[3/]	129	29	-	-	75	17
3) Unemployed	188	41	27	10	45	9
C. Hired Labor[4/]	29	-	180	-	1200	-

[1/] Man-days estimated as follows: (1 man-day = 8 hours)
Adult male (15 yrs and over) = 1 man-day
Adult female (15 yrs and over) = 0.75 man-day
Children (10-14 yrs old) = 0.50 man-day

[2/] Includes supervision, procuring farm supplies, farm repair and maintenance, etc.

[3/] Includes work in other farms (seedbed preparation, planting, harvesting grain and export crops) and non-farm work (retail business, brick-making, home industires, carpentry, etc.).

[4/] Includes landless laborers, small and medium farm family labor.

for farm and non-farm work by women and children. Most of the labor supplied by women and children was employed in seeding, harvesting, and primary processing of harvested crops.

Family labor utilization in small farms was equally divided between on-farm agricultural activities (30 percent) and off-farm (agricultural and non-agricultural) employment (29 percent). About 41 percent of available labor supply in small farms were unemployed. Small farm family labor utilized for on-farm agricultural activities were devoted mainly for basic grain crop production (58 percent of total on-farm man-days of agricultural activities).

In the case of medium and large farms, family labor was primarily employed in on-farm agricultural activities (90 and 74 percent) mainly in livestock production and general farm activities (includes supervision, procuring farm supplies, repairs and maintenance, etc.). Unemployment was relatively lower in medium and large farms (10 and 9 percent) and very little off-farm employment (0-17 percent). However, in the case of the medium farms included in the survey, the off-farm work and unemployment rates may not be typical for medium farms in the region. The author suspects that if a larger sample size of medium farms were included in the survey, off-farm employment and unemployment rates would be much higher. Greater farm size and more extensive farm diversification by large and medium farms provided greater employment absorption capacity. The larger farms generally hired landless workers, small and medium farm labor to perform most of the grain crop production activities.

Farm investment and availability of spraying equipment. Real estate (land and farm buildings) investment accounted from 86 percent (small farm) to not less than 76 percent (large and medium farms) of total farm investment (Table V-4). Working capital (farm machinery and equipment, livestock and operating (cash) capital) in the small farm was about one sixth (1/6) from that of medium farms and 1/26 from that of the large farms.

Backpack sprayers and hand sprayers appear to be readily available at various agricultural retail stores in the region. The price ranges from $20 to $80 depending upon the capacity of the tank and brand name. In addition, these stores rent out spraying equipment for a fee and there are a number of firms engaged in providing spraying services for pests and weed control.

Among the twelve farms included in this study, five farms owned from one to three backpack sprayers (three to five gallon capacity). All three of the large farms owned sprayers while only one small farm and one medium farm owned sprayers. Except for large farms, the ownership of backpack sprayers is probably not a typical situation for the

Table V-4. Capital Investment by Farm Size Class, Central El Salvador, Crop Year, 1975.

Item	Small Farm Value ¢	Small Farm %	Medium Farm Value ¢	Medium Farm %	Large Farm Value ¢	Large Farm %
Real Estate	8,159	86	25,797	77	112,325	76
Farm Land	(6,721)		(22,630)		(90,025)	
Building	(1,438)		(3,167)		(22,300)	
Working Capital	1,319	14	7,552	23	35,045	24
Farm Machinery and Equipment[1]	(87)		(1,495)		(5,118)	
Livestock and Poultry	(200)		(3,057)		(4,927)	
Operating Capital	(1,032)		(3,000)		(25,000)	
Total Investment	9,478	100	33,349	100	147,370	100

1/ a) Among six (6) small farms surveyed, one farm owned two backpack sprayers (3 gallon and 5 gallon capacity).
b) Among the three medium farms, one farm owned a backpack sprayer (5 gallon capacity).
c) Among the three large farms, all owned backpack sprayers (5 gallon capacity). One of the farmers owned two backpack sprayers and two farmers owned one backpack sprayer each.

majority of small basic grain farms in the region in spite of its modest investment cost. Extreme capital scarcity and the fact that spraying equipment can be rented elsewhere could partly explain the low level of ownership of spraying equipment among small and medium farms.

Cropping Pattern and Seedbed Preparation

Cropping pattern. Small and medium farms generally employed annual double cropping (in the same plot of land) of alternative basic grain crops (Table V-5). The cropping scheme includes corn-beans, beans-corn, corn-sorghum. In some cases, small plots of land in each farm are intercropped with a basic grain crop and a horticultural crop (vegetables). The relatively high intensity of land use in small and medium farms through double cropping and intercropping schemes is a risk-aversion strategy used by farmers to insure against crop failure and to provide employment for the relatively abundant supply of family labor on these farms.

In the case of large farms annual mono-cropping appears to be the prevailing pattern. This cropping pattern includes corn, beans and rice (upland). Each of these crops is planted once in the same plot of land and after harvest the land is left idle during the rest of the year. Rice (upland) was found to be grown as a major grain enterprise only in the large farms. Rice, a high value crop,

Table V-5. Basic Grain Cropping Pattern, Method of Seedbed Preparation and Weed Control Systems, Central El Salvador, 1975.

Farm Size	Cropping Pattern (Annual Basis)	Method of Seedbed Preparation: Power	Method of Seedbed Preparation: No. Passes (Plow & Harrow)	Weed Control System: Manual Hoe/Sickle No.	Manual Hoe/Sickle md/ha	Animal Traction No.	Animal Traction ad/ha	Herbicide (Backpack sprayer) No.	Herbicide (Backpack sprayer) man-days	Total Weedings No.	Total Weedings md/ha
A. Small Farm (n=6)											
(0.35 ha-2.80 ha)	a) Beans-Corn (May-Aug)	animal	2	3	42.8	-	-	-	-	3	42.8
	b) Corn-Sorghum (May-Aug)	manual	(land clearing)	3	47.2	-	-	-	-	3	47.2
	c) Corn-Beans (May-Aug)	animal	2	4	35.7	-	-	-	-	4	35.7
	d) Corn/Beans-Beans (May-Aug)	tractor	2	2	20.4	-	-	1	2.9	3	23.3
	e) Corn I (May)	animal	4	1	10.0	1	5.7	-	-	2	15.7
	f) Corn II (May)	animal	1	2	30.0	-	-	-	-	2	30.0
	g) Beans (May)	animal	4	1	17.2	-	-	-	-	1	17.2
B. Medium Farm (n=3)											
(5.6 ha-12.6 ha)	a) Corn-Beans (May-Aug)	animal	2	4	42.9	-	-	-	-	2	42.9
	b) Corn-Sorghum (May-Aug)	tractor	2	-	-	2	7.9	1	2.9	3	10.8
	c) Corn (May)	animal	3	3	21.4	-	-	-	-	3	21.4
D. Large Farm (n=3)											
(17-5 ha-	a) Corn I (May)	tractor	1	1	11.4	1	5.7	-	-	2	17.1
44.1 ha)	b) Corn II (Nov)	tractor	1	1	11.4	-	-	-	-	1	11.4
	c) Corn III (May)	tractor	1	1	11.4	-	-	-	-	1	11.4
	d) Corn IV (May)	tractor-animal	2	2	18.0	1	2.0	-	-	3	20.0
	e) Rice I (May)	tractor-animal	2	-	-	-	-	1	2.5	1	2.5
	f) Rice II (May)	tractor-animal	2/3	1	8.6	-	-	1	2.9	2	11.5
	g) Beans (May)	manual	(land clearing)	1	19.1	-	-	-	-	1	19.1

requires good quality land, efficient production management and adequate investments in improved seeds, fertilizer, pests and weed control to be profitably produced. These factors explain why rice is grown primarily in large farms.

Seedbed preparation. Among the complementary cultural practices required in basic grain production, seedbed preparation appears to be the most basic to good weed control. In fact, seedbed preparation is a form of weed control. In Central El Salvador, seedbed preparation for basic grain crops is usually done before the onset of the rainy season (April-May).

Small and medium farms generally employ animal traction for seedbed preparation (Table V-5). In very rough and hilly terrain the machete and/or hoe is used to clear the land of weeds and stubble and is the only form of seedbed preparation possible. On the large farms, tractor and animal traction were usually employed for seedbed preparation. All of the large farms included in the survey used tractor-custom service for land preparation.

The intensity of seedbed preparation (number of plowings and harrowings) whether by animal traction or tractor varied from one farm to another depending upon the type of soil and topography, field conditions, and weed population. This ranged from one to two passes (plowing/disking) in pure tractor prepared seedbeds; two to three passes in mixed tractor-animal traction prepared seedbed; and two to four passes in pure animal-traction prepared seedbed.

The tractor-custom services presently available to basic grain crop farmers are used in seedbed preparation for export crops (cotton and sugarcane). They are generally suited for large plots of land of regular shapes. For this reason, most of the tractor services employed in basic grain farms are on large farms. On some large farms, the shapes of the field are irregular and in some cases strewn with large boulders. Here the tractors could not plow the sharp edges of the field and areas between large boulders. In these areas animal traction is used. This explains the mixed tractor-animal traction prepared seedbed on some large farms.

Weed Control Systems

Five methods of weed control were observed among the farms surveyed. This included two types of pure systems, namely, (1) manual method (with hoe or sickle) and (2) herbicide (delivered by backpack sprayer) and three mixed systems, namely, (3) manual-oxen cultivator, (4) manual-herbicide, and (5) herbicide-oxen cultivator.

The manual (hoe/sickle) alone and the manual component of the mixed systems were the most common methods of weed control on all farms. Pure manual weed control was most pronounced on small and medium farms (Table V-5). This is the typical weed control system for basic grains in El Salvador.

Pure herbicide and mixed manual-herbicide weed control method was observed in the large farms mainly for upland rice production. The relative adaptability of herbicide weed control in upland rice production is well recognized in El Salvador. It is estimated that about 95 percent of herbicides consumed by basic grain farms were used in rice production (Baker and Smith, 1975).

Labor Intensity in Weed Control

The labor intensity in weed control (man-days weeded and number of times weeded) depends upon the crop planted, type of weed control system employed, weed population in the specific field, efficiency and timeliness of seedbed preparation, efficiency and timeliness of weeding operation and season.

From data and information obtained from the sample farm survey, some of the above factors were identified. After an attempt was made to determine how these factors affected the level of labor intensity in weed control. As indicated in Table V-5, the double (annual) cropping enterprises required from two to four times of weeding and in terms of weed control labor, it ranged from 11 to 47 man-days depending upon the type of crop and weed control system employed. Double cropped enterprises employing pure manual weed control required from 36 to 47 man-days per hectare; mixed manual-herbicide required 23 man-days per hectare; and mixed herbicide-animal traction, 11 days per hectare.

The single annual grain crop enterprises obviously required less frequent weedings and less man-days for weed control. In the case of manually weeded corn in small and medium farms, this required two to three weedings and in terms of weed control labor used, it ranged from 16 to 30 man-days per hectare. Animal traction was employed by these farms for seedbed preparation. In the large farms, where seedbed preparation was by tractor, the manually weeded corn crop required an average of 11.4 man-days per hectare. The least labor intensive weed control system observed was pure herbicide and in the case of rice crop, this required only 2.5 man-days per hectare.

Crop Yields and Level of Farm Technology

The level of farm technology employed by the sample farms was arbitrarily measured in terms of the number and rates of utilization of the so called "modern technology" embodied in farm inputs and cultural practices for specific grain crops. These technology variables include types of grain seeds used (native or hybrid), fertilizer, insecticides, herbicides and method of seedbed preparation (animal traction or tractor).

Regardless of cropping systems (single or double cropping) and farm size class, the use of hybrid seeds, commercial fertilizer and insecticides is positively associated with crop yields (Table V-6). Of course, crop yields varied from one farm to another due to differences in land types, ecologic systems and management practices.

In summary, the arbitrary grouping of twelve case study farms into three main farm size classes (small, medium and large) revealed the following characteristics. The small and medium farms generally adopted double annual cropping of basic grain crops while the large farm employed single annual cropping system. Weed control labor was primarily supplied by small and medium farm family labor and landless labor. The selection of enterprise/weed control systems in each farm was constrained by the availability of land, labor, and capital resources. Small and medium farms generally employed labor intensive crop/weed control system due to abundance of family labor supply while the large farms tended to employ capital intensive crop/weed control systems. Manual weed control method is the dominant weed control system in basic grain farming although the larger farms tend to use less labor intensive weed control systems and either pure herbicide or mixed herbicide-manual methods.

Modern farm inputs including herbicides and spraying equipment are readily available in the retail market for

Table V-6. Production Rates by Cropping System and Level of Agricultural Technology Employed, Central El Salvador, Crop Year, 1975.

Farm Size/ Cropping System	Yield (kg/ha)	Level of Agricultural Technology Applied: Seed Used: Type N=Native H=Hybrid	Seed Used: Seeding Rate (kg/ha)	Insecticides: Pesticide	Insecticides: Herbicide	Commercial Fertilizer: Nitrogen (kg/ha)	Commercial Fertilizer: Phosphorus (kg/ha)
A. Small Farms (N=6)							
1) Beans-Corn							
Beans (May)	1,037	N	46	No	No	-	-
Corn (Aug)	2,333	H	16	Yes (low)	No	45	45
2) Corn-Sorghum							
Corn (May)	2,268	H	16	No	No	54	26
Sorghum (Aug)	1,296	N	13	No	-	-	-
3) Corn-Beans							
Corn (May)	4,045	H	16	Yes	No	80	53
Beans (Aug)	714	N	52	Yes	No	32	39
4) Corns/Beans-Beans							
Corn (May)	2,106	H	16	No	No		
Beans (May)	583	N	70	No	No	107	53
Beans (Aug)	486	N	52	Yes	No		
5) Corn I (May)	3,546	H	16	Yes	Yes[1/]	107	53
6) Corn II (May)	2,916	H	20	No	No	95	39
7) Beans (May)	778	N	70	No	No	-	-
B. Medium Farms (N=3)							
1) Corn-Beans							
Corn (May)	2,592	H	16	No	No	107	53
Beans (Aug)	453	N	27	No	No	13	13
2) Corn-Sorghum							
Corn (May)	3,240	H	16	No	No	65	65
Sorghum (Aug)	1,377	N	13	No	Yes[2/]	-	-
3) Corn (May)	2,592	H	16	Yes	No	54	26

Table V-6. (continued)

		Level of Agricultural Technology Applied					
		Seed Used				Commercial Fertilizer	
Farm Cropping System	Yield (kg/ha)	Type N=Native H=Hybrid	Seeding Rate (kg/ha)	Insecticides: Pesticide	Insecticides: Herbicide	Nitrogen (kg/ha)	Phosphorus (kg/ha)
C. Large Farms (N=3)							
1) Corn-I (May)	2,592	H	20	No	No	69	-
2) Corn II (Nov)	648	N	16	No	No	-	-
3) Corn III (May)	2,592	H	20	No	No	38	26
4) Corn IV (May)	3,758	H	20	Yes	No	94	52
5) Rice I (May)	2,592	H	123	No	Yes[3]	41	26
6) Rice II (May)	3,888	H	114	Yes	Yes[4]	53	53
7) Beans (May)	648	N	46	Yes	No	-	-

1/ Gramoxon applied at the rate of 1.1 liters/ha three (3) days after seeding.

2/ Edonal applied at the rate of 0.36 liters/ha before seeding.

3/ Applied Surcopur at the rate of 1.43 liters/ha and Edonal at 0.36 liter/ha, twenty-two (22) days after seeding.

4/ Applied Surcopur at the rate of 1.43 liters/ha; and Edonal at 0.36 liter/ha, twenty-two (22) days after seeding.

all farm size classes. The use of modern farm inputs like improved seeds, fertilizer, insecticides, and others is widespread. The private costs of manual weed control on all crops is cheaper than herbicide or mixed herbicide-manual methods due to the relatively high costs of herbicide and lower labor costs.

Base Data and Assumptions used in the Regional Linear Programming Model

Information and data obtained from the farm survey, local published sources and the agronomic weed control experiments conducted by personnel of Oregon State University, were used to develop the linear regional programming model used in this study. In this section, the main focus is on the base data and additional specific assumptions employed in the programming analysis.

Farm-Size Specific Resources and Off-Farm Employment Constraint Levels

The farm-size specific resource constraint levels and regional off-farm labor demand constraints are presented in Table V-7.

Land Resource Constraint Levels

The small farm is assumed to have 1.69 hectares of cropland consisting of subsistence cropland (0.5 hectare) and commercial cropland (1.19 hectares). The medium farm

Table V-7. Land, Labor, Capital and Off-Farm Employment Resources, and Type of Constraints, Crop Year, 1975.

Farm/Household	Land (ha)	Operating Capital (colon)	Weed Control Labor Supply (man-days) May	Jun	Jul	Aug	Sep	Nov	Total	Type of Constraint
<u>Small Farm</u> (1.69 ha)		¢ 1,032	20	30	30	20	30	30	160	≤ 1/
Subsistence Cropland	0.50	-	-	-	-	-	-	-	-	=
Commercial Cropland	1.19	-	-	-	-	-	-	-	-	=
<u>Medium Farm</u> (4.20 ha)		¢ 3,000	20	30	20	20	30	30	150	≤ 1/
Subsistence Cropland	0.50	-	-	-	-	-	-	-	-	=
Commercial Cropland	3.00	-	-	-	-	-	-	-	-	=
Coffee Land	0.70	-	-	-	-	-	-	-	-	=
<u>Large Farm</u> (20.19 ha)		¢25,000	-	-	-	-	-	-	-	=
Commercial Cropland	18.67	-	-	-	-	-	-	-	-	=
Coffee Land	1.52	-	-	-	-	-	-	-	-	=
<u>Landless Laborers</u>	-	-	500	500	500	500	500	500	3000	≤
<u>Off-Farm Labor Demand Assumptions</u>										
Zero (0) - No off-farm employment available			0	0	0	0	0	0	0	=
50% off-farm labor demand available			270	280	275	270	280	280	1655	≤
100% off-farm labor demand available			540	560	550	540	560	560	3310	≤

1/ Inequality constraints applies to operating capital and labor.

owns 4.2 hectares alloted to subsistence crop (0.5 hectare), commercial grain crop (3.5 hectares), and coffee (0.7 hectare). The large farm has 20.19 hectares consisting of 18.67 hectares for commercial grain production and 1.52 hectares under coffee production. The quality of commercial cropland in the large farm is assumed to be better than the subsistence and commercial croplands in the small and medium farms which is reflected in terms of higher yields for large farm enterprises. In addition, it is assumed that the coffee lands in the medium and large farms are already established. The programming model forces all land types to be fully cultivated.

Labor Supply Constraints

It is assumed that there are only three labor supplying households in the region, namely, small farm, medium farm, and landless households. The total weed control labor supply available in each labor supplying household is given in terms of monthly periods (May, June, July, August, September, and November) where weeding is important. October is excluded because no weed control activity is required. The total labor supply levels (man-days) are distributed as follows: 160 man-days in the small farm household; 150 man-days in the medium farm; and 3000 man-days for landless labor households (Table V-7). The large farm household does not supply weed control labor.

Small farm labor supply is employed for weed control either on their own farm, on the medium and large farms, or off-farm. In addition, the small farm cannot hire farm labor and has to utilize their own family labor for weed control work required in their farm.

Weed control work required on the medium farm can either be done by the use of their own family labor or it can be hired from small farm laborers and landless laborers. Medium farm family labor can either be employed for weed control work on their own farm, and on the large farm or in off-farm work.

The landless labor can only be employed for weed control work in medium and large farms or in off-farm work. The program allows for "slacks" in labor-using activities for each labor household type.

Operating Capital Constraints

Operating capital is for crop production costs including weed control. It was assumed to be obtained from existing government agricultural banks. The operating capital levels are 1032 colones for the small farm; 3000 colones for the medium farm; and 25,000 colones for the large farm (one colon = $0.40 U.S.). The program allows for "slacks" in the capital-using activities.

Regional Off-Farm Employment Levels

Off-farm employment is construed here to mean all types of agricultural and non-agricultural activities not related to weed control. These activities include employment in the export crop sector (coffee, cotton and sugarcane) like seeding, fertilizing, pest control and harvesting and non-farm employment like home industries, brickmaking, carpentry, public works, etc.

The three off-farm employment demand levels are:

1. Zero off-farm labor demand
2. Fifty percent off-farm labor demand
3. One hundred percent off-farm labor demand

In Table V-7 the maximum regional off-farm employment levels include 1655 man-days under the 50 percent off-farm employment demand assumption and 3310 man-days under the 100 percent off-farm labor demand assumption. These maximum regional off-farm labor demand levels are available in six monthly periods (May, June, July, August, September, and November) to correspond with the monthly weed control labor supply of the labor-supplying households. Separate programming runs are made for each of the three off-farm labor demand assumptions.

Alternative Enterprise/Weed Control Systems

Observed basic grain cropping pattern and potentially available weed control systems in Central El Salvador, served as the basis for developing the alternative enterprise/weed control systems for each farm size. These enterprises are presented in Table V-8.

The small farms have eight available enterprises, all of which are double crop systems. Two weed control systems are available for each of the alternative grain enterprises which use hybrid seeds, namely, pure manual and mixed herbicide-manual method. In the case of double cropped enterprises using both hybrid and native grain seeds, only the hybrid seed-crop component of the double cropped enterprises receives the herbicide treatment, while the native seed-crop component receives manual weed control. Where both crops in a double crop enterprise use hybrid seeds, the herbicide treatment is confined to either one of the crops. This assumption is due to the difficulty of using herbicides which do not injure one of the two crops in a double crop sequence.

The medium farm has 16 alternative enterprise/weed control systems available. Seven of the enterprises are of the single cropping system and nine are of the double cropping system. In the case of single crop enterprises, those using hybrid seeds can employ either pure manual or pure herbicide weed control, while native-seed enterprises employ only pure manual weed control. For double crop enterprises, the alternative pure manual and mixed herbicide-

Table V-8. Land Input Cofficients by Land Use Type and by Farm Size Class.

Item	Weed Control System	Land Coefficients by Land Use Type (ha)						
		Small Farm		Medium Farm			Large Farm	
		Subsistence Cropland	Commercial Cropland	Subsistence Cropland	Commercial Cropland	Coffee Land	Commercial Cropland	Coffee Land
Land Resource Levels:		(0.5 ha)	(1.19 ha)	(0.50 ha)	(3.50 ha)	(0.70 ha)	(18.67 ha)	(1.52 ha)
Small Farm (1.69 ha)								
1) Corn Hybrid/Beans Hybrid	manual	1	1					
2) Corn Hybrid/Beans Hybrid	herbicide/man.	1	1					
3) Beans Native/Corn Hybrid	manual	1	1					
4) Beans Native/Corn Hybrid	man./herbicide	1	1					
5) Beans Native/Corn Native	manual	1	1					
6) Corn Hybrid/Sorghum Native	manual	1	1					
7) Corn Hybrid/Sorghum Native	herbicide/man.	1	1					
8) Corn Native/Sorghum Native	manual	1	1					
Medium Farm (4.20 ha)								
1) Corn Hybrid	manual			1	1			
2) Corn Hybrid	herbicide			1	1			
3) Beans Hybrid	manual			1	1			
4) Beans Hybrid	herbicide			1	1			
5) Corn Hybrid/Beans Hybrid	manual			1	1			
6) Corn Hybrid/Beans Hybrid	herbicide/man.			1	1			
7) Beans Native/Corn Hybrid	Manual			1	1			
8) Beans Native/Corn Hybrid	man./herbicide			1	1			
9) Beans Native/Corn Native	manual			1	1			
10) Sorghum Hybrid	manual			-	1			
11) Corn Native	manual			1	1			
12) Beans Native	manual			1	1			
13) Corn Hybrid/Sorghum Native	manual			1	1			
14) Corn Hybrid/Sorghum Native	herbicide/man.			1	1			
15) Corn Native/Sorghum Native	manual			1	1			
16) Coffee				-	-	1		
Large Farm (20.19 ha)								
1) Corn Hybrid	manual						1	
2) Corn Hybrid	herbicide						1	
3) Rice Hybrid	manual						1	
4) Rice Hybrid	herbicide						1	
5) Beans Hybrid	manual						1	
6) Beans Hybrid	herbicide						1	
7) Sorghum Hybrid	manual						1	
8) Coffee	manual						-	1

manual systems are employed in the same manner as those in the small farm enterprises.

The large farm is assumed to have eight available single crop-enterprise/weed control systems. All enterprises use hybrid seeds. Two weed control systems are available for each crop, namely, complete manual and herbicide weed control. It will be noted that the sorghum and coffee enterprises in the medium and large farms employ only manual weed control. In addition, all alternative enterprise/weed control systems that use hybrid seeds also use the complementary modern farm inputs such as fertilizer, insecticides and recommended cultural practices.

Technical (Input/Output) Coefficients

The input/out coefficients are presented in Tables V-8, V-9, V-11, V-12, V-13 and V-14.

Land Coefficients

The land use by each enterprise is assumed to be for the entire cropping season (May to November). For the single cropping system, each crop is planted in the same area only once in the season. For the small farm enterprises, each of the enterprises would need one hectare of subsistence cropland or commercial cropland to produce one hectare of the enterprise-activity (Table V-8).

In the medium farm, all enterprises containing either beans or corn or both requires one hectare of subsistence or commercial cropland to produce one hectare of each enterprise-activity. The sorghum enterprise-activity is assumed to require only commercial cropland while the coffee-activity requires only coffee land.

On the large farm, each of the seven grain enterprises would require one hectare of commercial cropland to produce one hectare and coffee production is limited to coffee land.

Weed Control Labor Coefficients

The weed control labor coefficient is expressed in terms of man-days per hectare for each enterprise on a monthly basis running from May through November (Table V-9). It was assumed that there was no economies of size associated with either manual or herbicide weed control among the three farm size types. In the case of manual weed control the same type of hand implements (hoe, sickle and machete) and quality of labor were used on all farm sizes. These assumptions appear to be realistic for Central El Salvador. The sample farm survey revealed that weed control equipment and labor are equally available to all farm sizes.

The manual weed control labor requirements for each enterprise was based on averaged data from the sample farm survey, local published literature and the weed control agronomic experiments. Likewise, the herbicide weed

Table V-9. Weed Control Labor Requirements per Hectare.

Enterprise	Weed Control System	Monthly Weed Control Labor Required (man-days) May	Jun	Jul	Aug	Sep	Nov	Total Weed Control Labor Required
1) Corn Hybrid	manual	12.87	2.86	--	--	--	--	15.73
2) Corn Hybrid	herbicide	2.0	2.86	--	--	--	--	4.86
3) Rice Hybrid	manual	--	8.00	8.00	8.00	--	--	24.00
4) Rice Hybrid	herbicide	--	1.43	1.43	--	--	--	2.86
5) Beans Hybrid	manual	--	11.44	--	--	--	--	11.44
6) Beans Hybrid	herbicide	1.43	--	--	--	--	--	1.43
7) Corn Native	manual	--	--	--	--	15.73	--	15.73
8) Beans Native	manual	--	11.44	--	--	--	--	11.44
9) Sorghum Hybrid	manual	--	10.00	11.44	--	--	--	21.44
10) Corn Hybrid/Beans Hybrid	manual	12.86	2.86	--	12.86	12.86	--	41.44
11) Corn Hybrid/Beans Hybrid	herbicide/man.	2.00	2.86	12.86	12.86	--	--	30.58
12) Beans Native/Corn Hybrid	manual	--	12.86	--	--	--	15.72	28.58
13) Beans Native/Corn Hybrid	man./herbicide	--	12.86	--	--	--	4.86	17.72
14) Beans Native/Corn Native	manual	--	12.86	--	12.86	15.72	--	41.44
15) Corn Hybrid/Sorghum Native	manual	12.86	2.86	--	12.86	12.86	--	41.44
16) Corn Hybrid/Sorghum Native	herbicide/man.	2.00	2.86	--	12.86	12.86	--	30.58
17) Corn Native/Sorghum Native	manual	12.86	2.86	12.86	--	12.86	--	41.44
18) Coffee[1/]	manual	--	--	--	--	8.58	--	8.58

[1/]Coffee plantation is already established and of fruit-bearing age.

control labor requirement was based on the averaged data from the sample farm survey and the AID/OSU weed control experiments.

Alternative Price Regime Assumptions

Three basic price regimes were assumed:

Assumption A: Social prices for all outputs, labor and capital.

Assumption B: Government administered prices for all outputs and inputs.

Assumption C: Observed (distorted) factor and product prices.

Assumptions B and C represent regimes of private (distorted) factor and product prices which reflect direct and indirect government intervention policies and other measurable causes of price distortions prevailing in Central El Salvador.

Social Price Regime (Assumption A)

Input-output prices that would prevail under a freely competitive market system constitute the social price regime. Output prices of basic grains were based on the average commercial market price prevailing in Central El Salvador for crop year 1975-76. These were obtained from published sources and a market survey. The commercial market price (i.e., social price) of basic grains (corn, rice, beans and sorghum) were found to be higher than the observed farm-gate prices (Assumption C) and lower than the government output price support program set for 1975-76 (Assumption B).

The social capital input prices were obtained by correcting observed retail market prices of indirect government "subsidies". The subsidies occurred in the form of preferential import duties. In El Salvador, all imported farm inputs are exempt from a 30 percent general import tax (for all imports originating from outside the Central American Common Market), but have special custom duties imposed, ranging from five to seven percent (*ad-valorem*) (Baker and Smith, 1975). These indirect subsidies aggregate to an average of 23 percent for pesticides, herbicides and farm machinery, and 25 percent for fertilizer and spraying equipment. The observed market clearing wage rate was 3.50 colones per man-day and it was assumed to be the social wage rate.

Government Price Regime (Assumption B)

This price regime represents a situation where the government through various implementing and service agencies, directly intervenes in the basic grain marketing system of Central El Salvador. In an effort to attain national self-sufficiency in basic grain production, stabilize grain prices and improve incomes of farmers, the government of El

Salvador is embarking on an intensified agricultural development program which includes direct market intervention to attain these objectives.

Through its Price Stabilization Institute (IRA), the government maintains a basic grain output price support program (corn, rice, beans and sorghum) as an incentive to increase grain production and stabilize grain prices. In the case of capital inputs (fertilizer, hybrid seeds, pesticides, spraying equipment and farm machinery), the government's Agricultural Development Bank (BFA) and various agencies of the Ministry of Agriculture (MAG) undertake direct importation and retail distribution of farm inputs to basic grain farmers. Therefore, the capital input prices were based on duty-free importation plus administration costs for handling and distribution. The labor price was based on the minimum wage law, set at 3.85 colones per day for the agricultural sector.

Since direct government market intervention programs are still in their early stages of implementation, their full impact to the basic grain sector cannot yet be felt at the present time. Hence, the evaluation of the short-run effects of these policies will provide useful information for policy review as the program implementation is continued and expanded to cover a major portion of the basic grain sector of El Salvador.

Observed Farm Price Regime (Assumption C)

Input and output prices used under this assumption were based on average farm prices paid and received by the representative sample farms of Central El Salvador. Output prices were based on average farm-gate prices received (1975-76). Capital input prices were based on observed retail market prices. The observed farm wage rate averaged to 3.50 colones per man-day on small and medium farms and 4.50 colones per man-day on the large farm and in off-farm employment.

The effects of indirect government intervention policies are reflected on capital input prices since inputs were imported at preferential import duties which were relatively lower than the general import duties on all other goods.

Weed Control System Costs

Weed control system costs are determined mainly by the quantities and relative prices of labor and herbicides employed. Previous experience indicated that there were no economies of size for manual or chemical weed control. All farm sizes employed backpack sprayers requiring relatively low capital investment. All farm sizes owned sprayers, which could also be rented from agricultural retail stores or, on a limited basis, from local agricultural extension agencies. The local agricultural extension service was able to provide technical information and guidance to farmers on basic herbicide application procedures.

Estimated weed control system costs are presented in Table V-10. Pure weed control systems (manual and chemical) were assumed to be employed in single (annual) cropping systems mainly by large and medium farms for corn, beans, and rice. The costs of pure chemical weed control were always higher than manual weed control regardless of price regime assumptions. This fact implies that even at distorted market prices (government price and observed farm price), herbicide is still relatively more expensive than manual weed control labor. The main exception was in rice, where pure chemical weed control was cheaper than pure manual weed control when herbicide prices were distorted.

Double (sequential) cropping with either mixed chemical-manual weed control and pure manual weed control systems were assumed to the alternative enterprise choices available to small and medium farms. The estimated weed control system costs of double cropping systems showed that the pure manual weed control system was always cheaper than mixed chemical-manual weed control, regardless of price assumption.

Table V-10. Weed Control Costs per Hectare by Crop/Weed Control Systems.

Item	Costs per Hectare (colones)			
	A[1/] (all farms)	B[2/] (all farms)	C[3/] (all farms)	C[4/] (large farm)
Single Cropping: Pure Weed Control Systems				
Corn				
manual[5/]	65.23	70.73	65.23	80.96
herbicide[6/]	155.43	106.59	130.58	135.44
Rice[9/]				
manual[5/]	88.45	96.85	--	112.45
herbicide[7/]	97.13	65.19	--	83.65
Beans				
manual[5/]	44.49	48.49	44.49	55.93
herbicide[8/]	106.86	68.37	87.79	89.92
Double Cropping Enterprises: Mixed Weed Control Systems				
Corn/Beans				
corn-herbicide/[6/] beans-manual[5/]	249.90	210.06	225.06	--
corn-manual/ beans-manual[5/]	159.67	174.18	159.67	--
Beans/Corn				
beans-manual/[5/] corn-herbicide[6/]	204.89	160.55	180.04	--
beans-manual/ corn-manual[5/]	114.66	124.66	114.66	--
Corn-Sorghum				
corn-herbicide/[6/] sorghum-manual[5/]	249.90	210.06	225.06	--
corn-manual/ sorghum-manual[5/]	153.95	174.17	153.95	--

one colon = $0.40 (U.S.)

[1/]Social prices: market clearing wage rate, ¢3.50/man-day (m-d). Herbicide and spraying costs with 23% and 25% indirect "subsidies" above farm retail prices.

[2/]Government prices: minimum wage rate, ¢3.85/m-d. Herbicide and spraying costs based on duty-free importation plus administrative costs.

[3/]Observed farm prices: market clearing wage rate, ¢3.50/m-d. Herbicide and spraying costs based on observed retail market prices.

[4/]Observed farm prices for large farm: wage rate, ¢4.50/m-d. Herbicide and spraying costs based on observed retail market prices.

Table V-10. (continued)

[5/]Include weed control labor and animal traction (for corn only) costs and equipment repairs.

[6/]Herbicide rates for corn: EPTC, 2kg/ha; Atrazine, 1 kg/ha.

[7/]Herbicide rates for rice: Propanil, 2 kg/ha; 2,4,5-T, 0.5 kg/ha.

[8/]Herbicide rates for beans: EPTC, 1.50 kg/ha; Linuron, 0.5 kg/ha.

[9/]Rice was grown mostly in large farms.

Net Returns to Management and Weed Control under Alternative Price Regimes

Net returns to management and weed control were estimated for each enterprise by deducting all variable costs from gross returns. However, the costs of weed control labor were excluded from the total cost estimate. The net returns per hectare for each enterprise weed control system under alternative price regimes are presented in Tables V-11 and V-12.

Table V-11 shows the net returns per hectare for each enterprise/weed control system under each farm-size type based on social prices (Assumption A) and alternative government price regimes.

Net return estimates for alternative government price regimes make five pricing assumptions.

Assumption B: all outputs and inputs based on government prices.

Assumption B1: outputs at social prices while labor and capital are at government prices.

Assumption B2: outputs and labor at social prices while capital is at government prices.

Assumption B3: outputs and capital at social prices while labor price is at legal minimum wage rate.

Table V-11. Net Returns to Management and Weed Control Based on Social Price and Alternative Government Prices (colones per hectare).

Enterprises	Weed Control System	Net Returns per Hectare[1] Pricing Assumptions A[2]	B[3]	B1[4]	B2[5]	B3[6]	B4[7]
Small Farm							
1) Corn Hybrid/Beans Hybrid	Manual	1,055.27	1,706.75	1,430.73	1,469.50	1,016.50	1,331.29
2) Corn Hybrid/Beans Hybrid	Herbicide/man.	927.97	1,640.04	1,364.02	1,402.29	889.70	1,203.99
3) Beans Native/Corn Hybrid	Manual	852.01	1,240.46	1,047.32	1,080.44	818.89	1,045.15
4) Beans Native/Corn Hybrid	man./herbicide	723.79	1,173.05	979.91	1,012.49	691.21	916.93
5) Beans/Native/Corn Native	manual	611.80	706.28	588.05	615.82	584.03	730.03
6) Corn Hybrid/Sorghum Native	manual	882.17	1,211.00	1,084.17	1,107.59	858.75	1,009.00
7) Corn Hybrid/Sorghum Native	herbicide/man.	732.70	1,121.62	994.79	1,018.21	709.28	859.53
8) Corn Native/Sorghum Native	manual	388.18	413.18	369.82	389.21	368.79	431.54
Medium Farm							
1) Corn Hybrid/	manual	420.97	726.53	609.20	631.94	398.23	538.30
2) Corn Hybrid	herbicide	290.26	672.49	555.16	577.07	268.53	407.59
3) Beans Hybrid	manual	803.38	1,152.93	959.73	981.03	782.08	996.58
4) Beans Hybrid	herbicide	678.85	1,088.58	895.38	915.65	658.58	872.05
5) Corn Hybrid/Beans Hybrid	manual	1,055.27	1,706.75	1,430.73	1,469.50	1,016.50	1,331.29
6) Corn Hybrid/Beans Hybrid	herbicide/man.	927.97	1,640.04	1,364.02	1,402.29	889.70	1,203.99
7) Beans Native/Corn Hybrid	manual	852.01	1,240.46	1,047.32	1,080.44	818.89	1,045.15
8) Beans Native/Corn Hybrid	man./herbicide	723.79	1,173.05	979.91	1,012.49	691.21	916.93
9) Beans Native/Corn Native	manual	611.80	706.28	588.05	615.82	584.03	730.03
10) Sorghum Hybrid	manual	130.72	355.24	323.04	344.30	109.46	162.92
11) Corn Native	manual	209.84	235.69	196.27	210.31	195.79	249.25
12) Beans Native	manual	378.21	450.01	366.71	380.69	364.23	461.51
13) Corn Hybrid/Sorghum Native	manual	882.17	1,211.00	1,084.17	1,107.59	858.75	1,009.00
14) Corn Hybrid/Sorghum Native	herbicide/man.	732.70	1,121.62	994.79	1,018.21	709.28	859.53
15) Corn Native/Sorghum Native	manual	388.18	413.18	369.82	389.21	368.79	431.54
16) Coffee	manual	1,841.42	1,990.31	1,990.31	2,046.45	1,785.37	1,841.42

Table V-11. (continued)

Enterprises	Weed Control System	Net Returns per Hectare[1/] Pricing Assumptions					
		A[2/]	B[3/]	B1[4/]	B2[5/]	B3[6/]	B4[7/]
<u>Large Farm</u>							
1) Corn Hybrid	manual	584.81	981.32	843.32	862.43	565.36	722.81
2) Corn Hybrid	herbicide	462.04	918.57	780.57	797.69	455.50	600.04
3) Rice Hybrid	manual	1,431.02	1,948.43	1,675.43	1,700.62	1,405.43	1,707.02
4) Rice Hybrid	herbicide	1,339.60	1,897.34	1,621.34	1,646.53	1,314.00	1,615.60
5) Beans Hybrid	manual	1,019.72	1,457.47	1,232.07	1,248.59	1,003.02	1,245.12
6) Beans Hybrid	herbicide	908.48	1,389.49	1,164.09	1,180.61	891.78	1,133.88
7) Sorghum Hybrid	manual	316.62	605.46	566.03	581.57	300.89	356.05
8) Coffee	manual	1,795.72	1,944.54	1,944.54	2,007.91	1,730.87	1,795.72

1/ Net returns = Gross crop incomes less variable costs (excludes weed control labor costs).

2/ Social price: output at commercial market prices; labor at market clearing wage rate; capital based on retail market prices corrected of indirect import subsidies.

3/ Government price: output, labor and capital at government subsidized prices.

4/ Output at social price; labor and capital at subsidized prices.

5/ Output and labor at social prices; capital at government subsidized prices.

6/ Output and capital at social prices; labor at subsidized (minimum wage rate) price.

7/ Output at subsidized prices; labor and capital at social prices.

Assumption B4: outputs at government subsidized prices while labor and capital are at their social prices.

The net returns for each enterprise/weed control system are highest under Assumption B (all outputs and inputs at government prices) since it reflects the relatively higher output price subsidies and lower subsidized input prices. Even when output subsidies were removed as in Assumptions B1 and B2, the net returns in each enterprise were still higher than under social net returns (Assumption A) since the social costs of capital were higher than the government subsidized prices.

The estimated net returns under alternative farm price regimes are presented in Table V-12. These assumptions are as follows:

Assumption C: outputs at their farm-gate prices while labor and capital are at their observed (distorted) retail market prices.

Assumption C1: outputs at their social price (i.e., commercial market price) while labor and capital are at their observed (distorted) retail market prices.

Assumption C2: outputs and labor at their social prices while capital inputs are at their observed (distorted) retail market price.

Table V-12. Net Returns to Management and Weed Control Based on Alternative Observed Farm Prices (colones per hectare).

Enterprises	Weed Control Systems	Net Returns Per Hectare[1/] Pricing Assumptions				
		C[2/]	C1[3/]	C2[4/]	C3[5/]	C4[6/]
Small Farm						
1) Corn Hybrid/Beans Hybrid	manual	953.75	1,266.57	1,055.27	1,266.57	742.45
2) Corn Hybrid/Beans Hybrid	herbicide/man.	857.61	1,170.43	1,170.43	927.97	615.15
3) Beans Native/Corn Hybrid	manual	743.54	973.48	973.48	852.10	622.07
4) Beans Native/Corn Hybrid	man./herbicide	645.56	875.50	875.50	723.79	493.85
5) Beans Native/Corn Native	manual	483.75	613.81	613.81	611.80	481.74
6) Corn Hybrid/Sorghum Native	manual	822.07	1,002.13	1,002.13	882.17	702.11
7) Corn Hybrid/Sorghum Native	herbicide/man.	702.68	882.74	882.74	732.70	552.64
8) Corn Native/Sorghum Native	manual	322.99	388.69	388.69	388.18	322.48
Medium Farm						
1) Corn Hybrid	manual	384.40	540.77	540.77	420.97	264.60
2) Corn Hybrid	herbicide	285.59	441.96	441.96	290.26	133.89
3) Beans Hybrid	manual	695.15	888.35	888.35	803.38	610.18
4) Beans Hybrid	herbicide	600.33	793.53	793.53	678.85	485.65
5) Corn Hybrid/Beans Hybrid	manual	953.75	1,266.57	1,266.57	1,055.27	742.45
6) Corn Hybrid/Beans Hybrid	herbicide/man.	857.61	1,170.43	1,170.43	927.97	615.15
7) Beans Native/Corn Hybrid	manual	743.54	973.48	973.48	852.10	622.07
8) Beans Native/Corn Hybrid	man./herbicide	645.56	875.50	875.50	723.79	493.85
9) Beans/Native/Corn Native	manual	483.75	613.81	613.81	611.80	481.74
10) Sorghum Hybrid	manual	180.31	244.71	244.71	130.72	66.32
11) Corn Native	manual	157.51	210.07	210.07	209.84	157.27
12) Beans Native	manual	297.27	379.45	379.45	378.21	296.03
13) Corn Hybrid/Sorghum Native	manual	822.07	1,002.13	1,002.13	882.17	702.11
14) Corn Hybrid/Sorghum Native	herbicide/man.	702.68	882.74	882.74	732.70	552.64
15) Corn Native/Sorghum Native	manual	322.99	388.69	388.69	388.18	322.48
16) Coffee	manual	1,904.79	1,904.79	1,960.91	1,785.10	1,841.42

Table V-12. (continued)

Enterprises	Weed Control Systems	Net Returns Per Hectare[1/] Pricing Assumptions				
		C[2/]	C1[3/]	C2[4/]	C3[5/]	C4[6/]
<u>Large Farm</u>						
1) Corn Hybrid	manual	497.85	681.85	733.87	531.86	400.81
2) Corn Hybrid	herbicide	410.35	594.35	640.96	412.21	278.04
3) Rice Hybrid	manual	1,170.97	1,492.97	1,564.95	1,357.90	1,109.02
4) Rice Hybrid	herbicide	1,098.94	1,420.94	1,492.92	1,266.47	1,017.16
5) Beans Hybrid	manual	860.47	1,085.87	1,133.08	972.03	794.32
6) Beans Hybrid	herbicide	770.95	996.35	1,043.56	860.78	683.08
7) Sorghum Hybrid	manual	336.06	414.92	459.30	271.71	237.76
8) Coffee	manual	1,837.87	1,837.87	1,922.37	1,709.26	1,795. 2

1/ Net returns = Gross crop incomes less variable costs (excludes weed control labor costs).

2/ Output, labor and capital at distorted farm prices.

3/ Output at social prices; labor and capital at distorted farm prices.

4/ Output and labor at social prices; capital at observed (distorted) farm prices.

5/ Output and capital at social prices; labor at observed distorted wage rate.

6/ Output at farm gate (distorted) price; labor and capital at social prices.

Assumption C3: outputs and capital at their social prices while labor prices are at observed farm wage rates.

Assumption C4: outputs at farm-gate prices, while labor and capital are at their social prices.

Variable Costs per Hectare under Alternative Price Regimes

The variable costs per hectare for each enterprise/ weed control system is the cash costs required for all production activities except weed control labor costs. In the case of small and medium farm enterprises, the only variable costs included are for capital inputs and services (seeds, fertilizer, pesticides, etc.) but exclude labor costs, since it was assumed that these two farm sizes have adequate family labor supply for crop production. For the large farm enterprises, the estimated variable costs include both labor and capital input costs except weed control labor costs, since it was assumed that the large farm hired all labor needed for crop production. The costs of weed control labor is accounted for in the labor-buying and selling activities of the programming model. The variable cost estimates under social prices and alternative government prices are presented in Table V-13.

Table V-13. Variable Cash Cost Per Hectare Based on Social Price and Alternative Government Prices (colones per hectare).

Enterprises	Weed Control System	Variable Costs per Hectare[1/] Pricing Assumptions A[2/]	B[3/]	B1[4/]	B2[5/]	B3[6/]	B4[7/]
Small Farm							
1) Corn Hybrid/Beans Hybrid	manual	1,111.47	752.39	752.39	752.39	1,111.47	1,111.47
2) Corn Hybrid/Beans Hybrid	herbicide/man.	1,248.18	837.07	837.07	837.07	1,248.18	1,248.18
3) Beans Native/Corn Hybrid	manual	661.70	465.45	465.45	465.45	661.70	661.70
4) Beans Native/Corn Nybrid	man./herbicide	798.59	550.15	550.15	550.15	798.59	798.59
5) Beans Native/Corn Native	manual	107.35	107.35	107.35	107.35	107.35	107.35
6) Corn Hybrid/Sorghum Native	manual	581.65	385.40	385.40	385.40	581.65	581.65
7) Corn Hybrid/Sorghum Native	herbicide/man.	718.36	470.10	470.10	470.10	718.36	718.36
8) Corn Native/Sorghum Native	manual	27.30	27.30	27.30	27.30	27.30	27.30
Medium Farm							
1) Corn Hybrid	manual	573.25	377.00	377.00	377.00	573.25	573.25
2) Corn Hybrid	herbicide	709.96	461.70	461.70	461.70	709.96	709.96
3) Beans Hybrid	manual	548.72	385.89	385.89	385.89	548.72	548.72
4) Beans Hybrid	herbicide	691.29	474.13	474.13	474.13	691.29	691.29
5) Corn Hybrid/Beans Hybrid	manual	1,111.47	752.39	752.39	752.39	1,111.47	1,111.47
6) Corn Hybrid/Beans Hybrid	herbicide/man.	1,248.18	837.08	837.08	837.08	1,248.18	1,248.18
7) Beans Native/Corn Hybrid	manual	661.70	465.45	465.45	465.45	661.70	661.70
8) Beans Native/Corn Hybrid	man./herbicide	798.59	550.15	550.15	550.15	798.59	798.59
9) Beans Native/Corn Native	manual	107.35	107.35	107.35	107.35	107.35	107.35
10) Sorghum Hybrid	manual	558.12	363.37	363.37	363.37	558.12	558.12
11) Corn Native	manual	18.90	18.90	18.90	18.90	18.90	18.90
12) Beans Native	manual	98.95	98.95	98.95	98.95	98.95	98.95
13) Corn Hybrid/Sorghum Native	manual	581.65	385.40	385.40	385.40	581.65	581.65
14) Corn Hybrid/Sorghum Native	herbicide/man.	718.36	470.10	470.10	470.10	718.36	718.36
15) Corn Native/Sorghum Native	manual	27.30	27.30	27.30	27.30	27.30	27.30
16) Coffee	manual	517.19	338.33	338.33	338.33	517.19	517.19

Table V-13. (continued)

Enterprises	Weed Control System	Variable Costs per Hectare[1/] Pricing Assumption A[2/]	B[3/]	B1[4/]	B2[5/]	B3[6/]	B4[7/]
Large Farm							
1) Corn Hybrid	manual	912.58	684.03	684.03	665.94	930.67	912.58
2) Corn Hybrid	herbicide	1,024.46	742.02	742.02	725.81	1,039.84	1,024.46
3) Rice Hybrid	manual	1,040.88	824.63	824.63	800.64	1,064.87	1,040.88
4) Rice Hybrid	herbicide	1,128.59	879.54	879.54	855.55	1,152.59	1,128.59
5) Beans Hybrid	manual	862.12	664.91	664.91	648.89	878.15	862.12
6) Beans Hybrid	herbicide	967.20	729.79	729.79	713.77	983.22	967.20
7) Sorghum Hybrid	manual	848.90	618.74	618.74	603.76	863.89	848.90
8) Coffee	manual	796.73	676.82	676.82	617.87	855.68	796.73

1/ For small and medium farms, variable costs exclude all labor costs. For large farm, it includes labor and operating capital costs, but excludes weed control labor costs.

2/ Social price: Labor costs based on market-clearing wage rate (¢3.50/man-day). Capital input prices are based on retail market price corrected of indirect import subsidies.

3/ Labor and capital at government subsidized prices.

4/ Labor and capital at subsidized government prices.

5/ Labor at social price (¢3.50/man-day). Capital at subsidized prices.

6/ Capital at social price. Labor at subsidized (minimum wage rate) price (¢3.85/man-day).

7/ Labor and capital at social prices.

It will be noted in Table V-13 that the variable costs estimated for each enterprise/weed control system are identical for small and medium farm enterprise under Assumptions B, B1 and B2. This occurs since it was assumed that these two farm sizes provided their own unpaid family labor for crop production activities. Therefore, the variable cost estimates are for capital inputs (seeds, fertilizers, pesticides, etc.) and are based on government subsidized prices. Variable costs estimated for each enterprise/weed control system in the small and medium farm enterprises are identical under Assumptions B3, B4 and Assumption A since it was assumed that these two farm size types provided their own unpaid family labor. In the case of large farm enterprises, variable cost estimates for each enterprise are identical under Assumptions B and B1 (labor and capital at government prices) since output prices were the only change. Also, variable costs for each enterprise are identical under Assumptions B4 and A (social price) for the same reason.

In Table V-14 the estimated variable costs under five alternative observed farm price regimes are presented. These price regimes correspond to the five alternative observed farm price regimes discussed before. The variable costs estimated for each small and medium farm enterprise are identical in Assumption C, C1 and C2 and the variable cost estimates for each enterprise are identical under

Table V-14. Variable Cash Costs Per Hectare based on Alternative Observed Farm Prices (colones per hectare).

Enterprises	Weed Control Systems	Variable Costs per Hectare[1] Pricing Assumptions				
		C[2]	C1[3]	C2[4]	C3[5]	C4[6]
Small Farm						
1) Corn Hybrid/Beans Hybrid	manual	931.15	931.15	931.15	1,111.47	1,111.47
2) Corn Hybrid/Beans Hybrid	herbicide/man.	1,031.79	1,031.79	1,031.79	1,248.18	1,248.18
3) Beans Native/Corn Hybrid	manual	558.45	558.45	558.45	661.70	661.70
4) Beans Native/Corn Hybrid	man./herbicide	669.60	669.60	669.60	798.59	798.59
5) Beans Native/Corn Native	manual	107.35	107.35	107.35	107.35	107.35
6) Corn Hybrid/Sorghum Native	manual	478.40	478.40	478.40	581.65	581.65
7) Corn Hybrid/Sorghum Native	herbicide/man.	589.54	589.54	589.54	718.36	718.36
8) Corn Native/Sorghum Native	manual	27.30	27.30	27.30	27.30	27.30
Medium Farm						
1) Corn Hybrid	manual	470.00	470.00	470.00	573.25	573.25
2) Corn Hybrid	herbicide	570.64	570.64	570.64	709.96	709.96
3) Beans Hybrid	manual	471.86	471.86	471.86	548.72	548.72
4) Beans Hybrid	herbicide	587.41	587.41	587.41	691.29	691.29
5) Corn Hybrid/Beans Hybrid	manual	931.15	931.15	931.15	1,111.47	1,111.47
6) Corn Hybrid/Beans Hybrid	herbicide/man.	1,031.79	1,031.79	1,031.79	1,248.18	1,248.18
7) Beans Native/Corn Hybrid	manual	558.45	558.45	558.45	661.70	661.70
8) Beans Native/Corn Hybrid	man./herbicide	669.60	669.60	669.60	798.59	798.59
9) Beans Native/Corn Native	manual	107.35	107.35	107.35	107.35	107.35
10) Sorghum Hybrid	manual	454.98	454.98	454.98	558.12	558.12
11) Corn Native	manual	18.90	18.90	18.90	18.90	18.90
12) Beans Native	manual	98.95	98.95	98.95	98.95	98.95
13) Corn Hybrid/Sorghum Native	manual	478.40	478.40	478.40	581.65	581.65
14) Corn Hybrid/Sorghum Native	herbicide/man.	589.54	589.54	589.54	718.36	718.36
15) Corn Native/Sorghum Native	manual	27.30	27.30	27.30	27.30	27.30
16) Coffee	manual	417.90	417.90	417.90	517.19	517.19

Table V-14. (continued)

Enterprises	Weed Control Systems	Variable Costs per Hectare[1/] Pricing Assumptions				
		C[2/]	C1[3/]	C2[4/]	C3[5/]	C4[6/]
Large Farm						
1) Corn Hybrid	manual	836.90	836.90	785.65	961.83	912.58
2) Corn Hybrid	herbicide	917.85	917.85	873.72	1,070.81	1,024.46
3) Rice Hybrid	manual	998.40	998.40	929.85	1,109.43	1,040.88
4) Rice Hybrid	herbicide	1,069.72	1,069.72	1,001.17	1,197.15	1,128.59
5) Beans Hybrid	manual	806.68	806.68	760.90	907.90	862.12
6) Beans Hybrid	herbicide	892.10	892.10	846.32	1,012.98	967.20
7) Sorghum Hybrid	manual	764.39	764.39	721.61	891.68	848.90
8) Coffee	manual	776.05	776.05	697.44	875.33	796.73

[1/] For small and medium farms, variable costs excludes all labor costs. For large farm, it includes labor and operating capital costs but excludes weed control labor costs.

[2/] Observed (distorted) farm prices: for all farms, output and capital at distorted farm prices, on medium and small farms, labor at market clearing wage rate (¢3.50/day) and for large farm, labor at distorted wage rate (¢4.50/day).

[3/] Labor and capital at distorted farm prices, except in small and medium farms where labor is at social price.

[4/] Labor at social price and capital at distorted farm prices.

[5/] Capital at social price and labor at distorted price, except in small and medium farms where labor is at social price.

[6/] Labor and capital at social prices.

Assumptions C3, C4 and under social price (Assumption A). In the large farm enterprises, variable costs for each enterprise are identical for Assumptions C and C1. The same reasoning applies as before.

The results and analysis of the programming runs under alternative price regimes and off-farm employment assumptions are presented in Chapter VI.

VI. ANALYSIS AND RESULTS OF BASIC GRAIN FARM CASE STUDY

The analysis of the programming results are presented in four main sections. The first section deals with the selection of enterprise/weed control systems under alternative social and private price regimes. The analysis of the effects of distorted and undistorted prices on income and employment is given in the second section. Predicted income and employment levels between the private and the social optimal solutions are compared in section three. The fourth section analyzes the efficiency losses and the net social costs of price distortions.

A total of 25 programming runs were made by employing the regional linear programming model given in Chapter IV with the base data established in Chapter V. Three are runs using social prices, eleven runs using alternative government prices, and eleven runs using alternative observed farm prices and off-farm labor demand assumptions.[14/]

Effects on Enterprise/Weed Control System Choices

Predicted Optimum Enterprise/Weed Control Systems Under Three General Alternative Input-Output Price Regimes

Social Price Regime (Assumption A)

The results are presented in Table VI-1. Using social prices, where input-output prices were corrected for market

[14/] In addition, nine programming runs were made for the individual farm optimization solutions. The results were basically identical with the corresponding regional optimization solutions.

Table VI-1. Predicted Optimum Enterprise Combination and Percent of Area with Manual and Chemical Weed Control under Alternative Off-Farm Labor Demand Situations where all Outputs and Inputs were at Social Prices and Distorted Prices.

Item	Zero (0) Off-Farm Labor Demand			50% Off-Farm Labor Demand			100% Off-Farm Labor Demand		
		Percent of Area with[2/]			Percent of Area with[2/]			Percent of Area with[2/]	
	Enterprise Combination[1/] (1)	Manual Control (2)	Chemical Control (3)	Enterprise Combination[1/] (4)	Manual Control (5)	Chemical Control (6)	Enterprise Combination[1/] (7)	Manual Control (8)	Chemical Control (9)
Assumption A: All outputs and inputs at Social prices									
Large farm	a,b	100	0	a,b	100	0	a,b	7.5	92.5
Medium farm	b,c,d,e,f	100	0	b,c,d,e,f	100	0	b,c,f	100.0	0
Small farm	c,d,e	100	0	c,d,e	100	0	c,d,e	100.0	0
All Farms	--	100	0	--	100	0	--	28.4	71.6
Assumption B: All outputs and inputs at government prices									
Large farm	a,b	12.7	87.3	a,b	12.7	87.3	a,b	7.5	92.5
Medium farm	b,c,d	100.0	0	b,c,d	100.0	0	b,c,f	100.0	0
Small farm	c,d	100.0	0	c,d	100.0	0	c,d	100.0	0
All Farms	--	32.4	67.6	--	32.4	67.6	--	28.4	71.6
Assumption C: All outputs and inputs at observed (distorted) farm prices									
Large farm	a,b	25.1	74.9	a,b	25.1	74.9	a,b	7.5	92.5
Medium farm	b,c,d	100.0	0	b,c,d	100.0	0	b,c,f	100.0	0
Small farm	b,c,d	100.0	0	b,c,d	100.0	0	b,c,d	100.0	0
All Farms	--	42.0	58.0	--	42.0	58.0	--	28.4	71.6

[1/] The enterprise name codes are as follows:
- a = rice hybrid
- b = coffee
- c = corn hybrid/beans hybrid
- d = beans native/corn hybrid
- e = corn hybrid/sorghum native
- f = beans hybrid

[2/] The total area under each farm is as follows:

Large farm . . .	20.19 ha
Medium farm. . .	4.20 ha
Small farm . . .	1.69 ha
All Farms	26.08 ha

distortions, show that the most socially efficient method for all enterprises and farm size types under both zero and 50 percent off-farm labor demand assumptions was manual weed control. Under the 100 percent assumption, the small and medium farms still adopted manual methods for all enterprises, however, the large farm employed mixed manual-chemical methods on the rice enterprise. About 92.5 percent of the farm area was under herbicide weed control. Identical enterprise/weed control system composition and area allocated between enterprises within each farm size type were observed for both the zero and 50 percent off-farm labor demand situations. In the case of the small farm, the enterprise/weed control system combination as well as area allocated between enterprises were identical under the three off-farm labor demand situations.

Government Price Regime (Assumption B)

When factor and product prices were distorted as in the government price regime, the privately efficient weed control method for small and medium farms was manual regardless of the selection of enterprises and regardless of off-farm labor demand situations. On the large farm, the predicted system was mixed chemical-manual weed control for rice, with herbicides being employed on 87.3 percent of total area, under both the zero and 50 percent off-farm labor demand solutions and 92.5 percent under the 100 percent off-farm labor demand solution (Table V1-1). As in the social price solution, the predicted enterprise/weed control system combination and area allocated between the selected enterprises in each farm size type, was identical in both zero and 50 percent off-farm labor demand solutions.

In the case of medium and small farms, the zero and 50 percent off-farm labor demand solutions, suggest that even distorted capital input prices (which would lower the capital/labor price ratio) were insufficient to offset relatively cheap weed control labor costs. The main effects of government price distortions and resource constraints on each size farm (as compared to the social price solution) was the tendency to reduce the number of enterprises. This trend was particularly evident on the medium and large farms.

The combined effects of full off-farm employment, resource constraints of each size farm, and government price distortions was to increase the area under chemical weed control (87.3 to 92.5 percent) in the large farm and to change the enterprise combination and area allocation (between selected enterprises) in the medium farm.

Observed Farm Price Regime (Assumption C)

Like the social and government price solutions, when factor and product prices were based on observed (distorted) farm prices, the predicted enterprise/weed control system combination and area allocated between enterprises within each size farm, was identical in both the zero and 50 percent off-farm labor demand solutions. Manual weed control was the predicted privately efficient method in small and medium farms for all selected enterprises regardless of off-farm labor demand assumptions. In the large farm, mixed chemical-manual weed control was employed for the rice area. Seventy five percent of total area was covered by herbicides for both zero and 50 percent off-farm labor demand solutions (Table VI-1). When off-farm employment was increased to 100 percent, the large farm used herbicide for the entire rice enterprise which amounts to 92.5 percent of total area.

To sum up, the predicted weed control system in the small and medium farms, was the use of manual method for all selected enterprises regardless of price regime assumptions and regardless of off-farm labor demand assumptions. The predicted enterprise/weed control system composition and area allocated between selected enterprises in each size farm was identical for both the zero and 50 percent off-farm labor demand solutions under each of the three general price regime assumptions.

It appears that in addition to factor-product price distortions and farm size-specific resource constraints, the availability of 50 percent off-farm employment induced (when compared with the social price solution) a change of weed control method from pure manual to mixed chemical-manual method in the large farm and reduced the number of selected enterprises in the medium farm. In the small farm, the availability of 50 percent off-farm employment induced reduction in the number of enterprises (from three to two) when factor-product prices were subject to government price distortions (Assumption B), but had no effect on enterprise/weed control choices and enterprise-area allocation when all inputs and outputs were under observed (distorted) farm prices (Assumption C).

When a 100 percent off-farm employment was available, it induced adoption of chemical weed control for rice in the large farm (92.5 percent of total area) whether input-output prices were distorted or not.

Effects of Removing Government Price Distortions

What would be the predicted enterprise/weed control system and area allocation when government price distortions are eliminated one at a time? The results are presented in Table VI-2. Since the zero and 50 percent off-farm labor demand solutions predicted identical results, it was decided to limit the analysis of results under the 50 and 100 percent off-farm labor demand assumptions.

When the output subsidies were eliminated (Assumption B1), the predicted enterprise/weed control system composition and enterprise-area allocation under the 50 and 100

Table VI-2. Predicted Optimum Enterprise Combination and Percent of Area with Manual and Chemical Weed Control under Alternative Government Prices and Off-Farm Labor Demand Situations.

	50% Off-Farm Labor Demand			100% Off-Farm Labor Demand		
		Percent of Area with[2]			Percent of Area with[2]	
Item	Enterprise Combination[1] (1)	Manual Control (2)	Chemical Control (3)	Enterprise Combination[1] (4)	Manual Control (5)	Chemical Control (6)
B1: Labor and Capital at subsidized prices while output at social price						
Large farm	a,b	12.7	87.3	a,b	7.5	92.5
Medium farm	b,c,f	100.0	0	b,c,d,f	100.0	0
Small farm	c,d	100.0	0	c,d	100.0	0
All farms	--	32.4	67.6	--	28.4	71.6
B2: Capital at subsidized prices while output and labor at social prices						
Large farm	a,b	25.1	74.9	a,b	7.5	92.5
Medium farm	b,c,d	100.0	0	b,c,d	100.0	0
Small farm	c,d,e	100.0	0	c,d	100.0	0
All farms	--	42.0	58.0	--	28.4	71.6
B3: Labor at subsidized price while output and capital at social prices						
Large farm	a,b	92.5	7.5	a,b	7.5	92.5
Medium farm	b,c,e,f	100.0	0	b,c,f	100.0	0
Small farm	c,d,e	100.0	0	c,d,e	100.0	0
All farms	--	71.6	28.4	--	28.4	71.6
B4: Output at subsidized price while labor and capital at social prices						
Large farm	a,b	100.0	0	a,b	7.5	92.5
Medium farm	b,c,f	100.0	0	b,c,f	100.0	0
Small farm	c,d,e	100.0	0	c,d,e	100.0	0
All farms	--	71.6	28.4	--	28.4	71.6

[1] The enterprise name codes are as follows:
a=rice
b=coffee
c=corn hybrid/beans hybrid
d=beans native/corn hybrid
e=corn hybrid/sorghum native
f=beans hybrid

[2] The total area under each farm is as follows:

Large farm . . .	20.19 ha
Medium farm. . .	4.20 ha
Small farm . . .	1.69 ha
All farms	26.08 ha

percent labor demand solutions for each size farm was identical to the solution obtained when all inputs and outputs were at government prices (Assumption B). The main exception was for the medium farm, where the predicted enterprise composition (when compared to Assumption B) was slightly different under each corresponding off-farm labor demand solution, although manual weed control was still the predicted method for all selected enterprises.

If both output and labor price subsidies were eliminated such that only capital input prices were subsidized (Assumption B2), the main effect on the large farm (compared with Assumptions B and B1) was to reduce rice area using chemical weed control to 74.9 percent (down from 87.3 percent) under the 50 percent off-farm labor demand solution. But the availability of 100 percent off-farm labor demand induced area expansion under chemical method to 92.5 percent, which is identical to the solutions obtained under Assumptions B and B1. On the medium sized farm, the same enterprise/weed control system composition and enterprise-area allocation was predicted in both the 50 and 100 percent off-farm labor demand solutions. On the small farm, manual weed control was the predicted privately efficient system for all selected enterprises, but the 50 percent off-farm labor demand solution selected three enterprises, while the 100 percent off-farm labor demand solution selected two enterprises.

With the elimination of output and capital subsidies (Assumption B3), the effect of legal minimum wage (¢3.85/day) alone was to reduce area under chemical weed control to 7.5 percent on the large farm for the 50 percent off-farm labor demand solution (compared with the corresponding solution in Assumption B, which was 87.3 percent), and under the 100 percent off-farm labor demand solution the area under chemical control was the same as the solution obtained under Assumption B. In the medium sized farm, the predicted number of enterprises was larger (four enterprises) as compared with the solution obtained in Assumption B (three enterprises), under the 50 percent off-farm labor demand solutions, whereas under the 100 percent off-farm labor demand solutions, identical enterprise/weed control system composition was predicted for both Assumptions B3 and B. In the small farm, the same enterprise/weed control system composition (three enterprises) was predicted for both the 50 and 100 percent off-farm labor demand solutions, but under the corresponding off-farm labor demand solutions in Assumption B, the predicted number of enterprises was only two.

When both labor and capital subsidies were removed such that only output prices were distorted (Assumption B4), the predicted weed control system was the use of pure manual method for all selected enterprises in all size farms under the 50 percent off-farm labor demand solution. Whereas under the 100 percent off-farm labor demand solution, the predicted enterprise/weed control system composition was the same as those obtained in Assumptions B and A. This result tends to indicate that output subsidies per se, did not directly influence weed control technology choice but may influence enterprise choice and resource allocation in favor of enterprises receiving the largest relative amount of subsidy, cit. paribus.

In summary, the elimination of government price distortions one at a time, did not induce any change in the predicted privately efficient weed control system (i.e., manual control) as compared with the social price solution (Assumption A) for both the small and medium farms under both 50 and 100 percent off-farm labor demand solutions. The price distortions had a tendency to reduce the number of selected enterprise/weed control systems (compared with the social price solution) on each farm size particularly on small and medium farms. In the case of the large farm, the effects of price distortions under the 50 percent off-farm labor demand solutions, was to shift rice weed control to either pure chemical or mixed chemical-manual control. Under the 100 percent off-farm labor demand solutions, mixed chemical-manual weed control was the most efficient system for the large farm with 92.5 percent of total area under chemical control under both the social price solution and all five alternative distorted price solutions.

Effects of Eliminating Observed Farm Price Distortions

The predicted enterprise/weed control system composition, when observed farm price distortions were removed one at a time are presented in Table VI-3.

Fifty Percent Off-Farm Labor Demand Solutions

For the large farm, identical enterprise/weed control system combination (rice/mixed chemical-manual; and coffee/manual) were predicted under Assumptions Cl (labor and capital prices distorted), C2 (capital at distorted price), and C3 (labor at distorted prices). Under these assumptions, the predicted area under chemical control was 74.9 percent. However, when only output prices were distorted (Assumption C4), the predicted area under chemical control was reduced to 7.5 percent.

On the small farm, manual weed control was the predicted privately efficient system for all selected enterprises under each of the five alternative farm price regimes. Identical enterprise composition and area allocation was predicted under Assumptions Cl (labor and capital prices distorted) and C2 (capital prices distorted). In the same manner, the same enterprise composition and area allocation was predicted under Assumptions C3 (labor at distorted price), and C4 (output at distorted prices). It should be pointed out that the assumed farm wage rate for

Table VI-3. Predicted Optimum Enterprise Combination and Percent of Area with Manual and Chemical Weed Control under Alternative Observed Farm Prices and Off-Farm Labor Demand Situations.

	50% Off-Farm Labor Demand			100% Off-Farm Labor Demand		
		Percent of Area with[2]			Percent of Area with[2]	
Item	Enterprise Combination[1] (1)	Manual Control (2)	Chemical Control (3)	Enterprise Combination[1] (4)	Manual Control (5)	Chemical Control (6)
C1: Labor and capital at distorted farm prices while output at social price						
Large farm	a,b	25.1	74.9	a,b	7.5	92.5
Medium farm	b,c,d	100.0	0	b,c,f	100.0	0
Small farm	c,d,e	100.0	0	c,d,e	100.0	0
All farms	--	42.0	58.0	--	28.4	71.6
C2: Capital at distorted farm price while output and labor at social prices						
Large farm	a,b	25.1	74.9	a,b	7.5	92.5
Medium farm	b,c,d	100.0	0	b,c,f	100.0	0
Small farm	c,d,e	100.0	0	c,d,e	100.0	0
All farms	--	42.0	58.0	--	28.4	71.6
C3: Labor at distorted wage rates while output and capital at social prices						
Large farm	a,b	25.1	74.9	a,b	7.5	92.5
Medium farm	b,c,d,e,f	100.0	0	b,c,f	100.0	0
Small farm	c,d,e	100.0	0	c,d,e	100.0	0
All farms	--	42.0	58.0	--	28.4	71.6
C4: Output at distorted prices while labor and capital at social prices						
Large farm	a,b	92.5	7.5	a,b	7.7	92.3
Medium farm	b,c,e,f	100.0	0	b,c,e,f	100.0	0
Small farm	c,d,e	100.0	0	c,d,e	100.0	0
All farms	--	71.6	28.4	--	28.6	71.4

1/ The enterprise name codes are as follows:
a=rice
b=coffee
c=corn hybrid/beans hybrid
d=beans native/corn hybrid
e=corn hybrid/sorghum native
f=beans hybrid

2/ The total area under each farm is as follows:

Large farm . . .	20.19 ha
Medium farm. . .	4.20 ha
Small farm . . .	1.69 ha
All Farms	26.08 ha

small and medium farms was the same as the social wage rate.

In the case of the medium farm, the predicted privately efficient weed control system was the use of manual method for all selected enterprises in each of the five alternative observed farm price regime solutions. Identical enterprise/weed control system composition but different area allocated between enterprises, was predicted under Assumptions C1 and C2 (coffee, corn hybrid/beans hybrid, and beans native/corn hybrid). Under Assumption C3, the predicted enterprise composition numbered five enterprises, while under Assumption C4, it consisted of four enterprises (Table VI-3).

<u>One Hundred Percent Off-Farm Labor Demand Solutions</u>

In the large farm, the predicted enterprise/weed control system compositions and enterprise-area allocations were approximately identical (rice/herbicide and coffee/manual), under Assumptions C1, C2, C3 and C4. These solutions predicted 92.5 percent of total area under chemical control.

For the medium farm, the same enterprise/weed control system combination but different enterprise-area allocation, was predicted under Assumptions C1, C2 and C3. Under Assumption C4 the predicted enterprise composition numbered four enterprises which was one enterprise more than under the three other alternative farm price solutions. Pure manual weed control was the predicted system for all selected enterprises.

In the case of the small farm, the same enterprise/ weed control system combination was predicted under all the four alternative farm price solutions. However, area allocated between selected enterprises varied. Approximately the same enterprise-area allocation was predicted under Assumptions C1 and C2, and approximately the same enterprise-area allocation was predicted under Assumptions C3 and C4. In all solutions, manual weed control was the predicted privately efficient system for all selected enterprises.

To summarize, the predicted privately efficient weed control system was the use of manual method for all selected enterprises in the small and medium farms regardless of price distortion present and regardless of off-farm labor demand assumptions. The main effects of price distortions under each off-farm labor demand solutions were variations in enterprise combination and enterprise-area allocation in the small and medium farms. In the case of the large farm, the alternative price distortions predicts herbicide-area diffusion averaging to 75 percent of total area under the 50 percent off-farm labor demand solution in Assumptions C1, C2 and C3, while under the 100 percent off-farm labor demand solutions, the predicted herbicide-area diffusion averaged 93 percent for each of the five alternative observed farm price regime solutions and in the social price solution (Assumption A).

Effects on Income and Employment

Predicted Income and Employment under the Three General Alternative Input-Output Price Regimes

The results are presented in Table VI-4 for the social price solutions and in Table VI-5 for the private price solutions.

Social Price Solutions

Under the zero (0) off-farm labor demand solutions, the predicted total incomes for all households was ¢35,408.85, consisting of ¢33,794.92 from crop incomes and ¢1,613.93 from weed control labor earnings (Table VI-4). The large farm accounted for the biggest income share of ¢27,832.71 and the smallest income share, by the landless laborers, ¢1,307.85. The predicted weed control employment totaled 655 man-days, with the landless labor-weed control employment accounting for the biggest share, 374 man-days.

In the 50 percent off-farm labor demand solution, the total incomes for all households was ¢41,201.35, of which crop incomes amounted to ¢33,794.92, while off-farm labor earnings was ¢5,792.50. The largest income was earned by

Table VI-4. Predicted Optimum Income and Employment Effects under Social Price Regime and Alternative Off-Farm Labor Demand Situations.

Item	Income				Employment		
	Net Crop Income (colon)	Weed Control Labor Earnings (colon)	Off-farm Labor Earnings (colon)	Total Family Income (colon)	Weed Control Labor (man-days)	Off-Farm Employment (man-days)	Total Employment (man-days)
A. Social Price (Assumption-A)							
Zero (0) Off-Farm Labor Demand							
1) Large farm	27,832.71	--	--	27,832.71	--	--	--
2) Medium farm	4,463.14	82.71	--	4,545.85	149.20	--	149.20
3) Small farm	1,499.07	223.37	--	1,722.44	132.19	--	132.19
4) Landless Labor	--	1,307.85	--	1,307.85	373.67	--	373.67
All Households	¢33,794.92	¢1,613.93	--	¢35,408.85	655.06	--	655.06
50% Off-Farm Labor Demand							
1) Large farm	27,832.71	--	--	27,832.71	--	--	--
2) Medium farm	4,463.14	82.71	--	4,545.85	149.20	--	149.20
3) Small farm	1,499.07	223.37	--	1,722.44	132.19	--	132.19
4) Landless labor	--	1,307.85	5,792.50	7,100.35	373.67	1,655	2,028.67
All Households	¢33,794.92	¢1,613.93	¢5,792.50	¢41,201.35	655.06	1,655	2,310.06
100% Off-Farm Labor Demand							
1) Large farm	27,507.28	--	--	27,507.28	--	--	--
2) Medium farm	4,420.72	13.79	216.16	4,650.67	88.09	61.91	150
3) Small farm	1,499.07	211.82	108.89	1,819.78	128.89	31.11	160
4) Landless Labor	--	6.93	10,493.07	10,500.00	1.98	2,998.02	3,000
All Households	¢33,427.07	¢232.54	¢10,818.12	¢44,477.72	218.96	3,091.04	3,310

the large farm, ¢27,832.71, followed by labor earnings of landless laborers, ¢7,100.35. The smallest income was earned by the small farm, ¢1,722.44. Total weed control employment of 655 man days was the same as the solution obtained under the zero off-farm labor demand solution. Total employment from all sources amounted to 2310 man-days of which 1655 man-days consisted of off-farm work and 655 man-days in weed control work. The landless laborers absorbed all of the available off-farm employment, while the small and medium farm laborers were limited to weed control work.

When off-farm employment was increased to 100 percent, the total income from all sources for all farms reached ¢44,477.73, of which ¢33,427.07 was from crop incomes; ¢232.54 from weed control labor earnings; and ¢10,812.12, was off-farm work. Again, the large farm accounted for the biggest income share, ¢27,507.28 while the small farm received the smallest income of ¢1,819.78. Total weed control employment was reduced to 219 man-days whereas under the zero and 50 percent off-farm labor demand solutions it was 655 man-days. This would indicate that the availability of full off-farm employment opportunities would induce the adoption of less labor-intensive enterprises even when factor-product prices were undistorted.

The predicted size of absolute incomes of each farm household indicate that it is positively associated with size of land area, capital and labor supply. Thus, even when all inputs and outputs were at social prices, the absolute income distribution would still be highly skewed in favor of the large farm.

Government Price Solutions

The predicted incomes and employment when all output and inputs were at government prices (distorted) are presented in Table VI-5. Under the zero off-farm labor demand solution, the predicted total incomes for all households was ¢48,590.86, which consists of ¢48,026.52 from crop incomes, and ¢564.34 from weed control labor earnings. The biggest income share was earned by the large farm, ¢38,091.75 and the smallest by the landless laborers, ¢164.09. Total weed control employment was only 294 man-days, of which the small and medium farm laborers absorbed 125 and 126 man-days, while the landless laborers worked for 43 man-days.

Under the 50 percent off-farm labor demand solution, total incomes for all households increased to ¢54,962.61, with crop incomes accounting for ¢48,026.52; off-farm work ¢6,371.75; and weed control labor earnings ¢564.34. As usual, the large farm earned the biggest income, ¢48,091.75 while the smallest income earned was by the small farm, ¢2,885.09. Total weed control employment of 294 man-days was the same as the zero off-farm labor demand solution,

Table VI-5. Predicted Optimum Income and Employment Effects under Alternative Off-Farm Labor Demand Situations when all Inputs and Outputs were at Distorted Government Prices and Observed Farm Prices.

Item	Income				Employment		
	Net Crop Income (colon)	Weed Control Labor Earnings (colon)	Off-Farm Labor Earnings (colon)	Total Family Income (colon)	Weed Control Labor (man-days)	Off-Farm Employment (man-days)	Total Employment (man-days)
B. Government Price (Assumption-B)							
Zero (0) Off-Farm Labor Demand							
1) Large farm	38,091.75	--	--	38,091.75	--	--	--
2) Medium farm	7,437.38	141.03	--	7,578.41	125.19	--	125.19
3) Small farm	2,497.39	259.22	--	2,756.61	126.63	--	126.63
4) Landless labor	--	164.09	--	164.09	42.62	--	42.62
All Households	¢48,026.52	¢564.34	--	¢48,590.86	294.44	--	294.44
50% Off-Farm Labor Demand							
1) Large farm	38,091.75	--	--	38,091.75	--	--	--
2) Medium farm	7,437.38	77.77	--	7,515.15	108.70	--	108.70
3) Small farm	2,497.39	322.48	64.99	2,884.86	143.12	16.88	160.00
4) Landless labor	--	164.09	6,306.76	6,470.85	42.62	1,638.12	1,680.74
All Households	¢48,026.52	¢564.34	¢ 6,371.75	¢54,962.61	294.44	1,655.00	1,949.44
100% Off-Farm Labor Demand							
1) Large farm	38,123.25	--	--	38,123.25	--	--	--
2) Medium farm	6,979.74	67.76	192.50	7,240.00	100.00	50.00	150.00
3) Small farm	2,497.39	280.28	107.42	2,885.09	132.10	27.90	160.00
4) Landless labor	--	139.79	11,410.21	11,550.00	36.31	2,963.69	3,000.00
All Households	¢47,600.38	¢487.83	¢11,710.13	¢59,798.34	268.41	3,041.59	3,310.00
C. Observed Farm Price (Assumption-C)							
Zero (0) Off-Farm Labor Demand							
1) Large farm	22,929.81	--	--	22,929.81	--	--	--
2) Medium farm	4,132.74	288.18	--	4,420.92	149.41	--	149.41
3) Small farm	1,440.87	287.19	--	1,728.06	132.19	--	132.19
4) Landless labor	--	206.62	--	206.62	55.19	--	55.19
All Households	¢28,503.42	¢781.99	--	¢29,285.41	336.69	--	336.69
50% Off-Farm Labor Demand							
1) Large farm	22,929.81	--	--	22,929.81	--	--	--
2) Medium farm	4,132.74	288.18	--	4,420.92	149.41	--	149.41
3) Small farm	1,440.87	287.19	125.46	1,853.63	132.12	27.88	160.00
4) Landless labor	--	206.62	7,322.04	7,528.66	55.16	1,627.12	1,682.28
All Households	¢28,503.53	¢781.99	¢ 7,447.50	¢36,733.02	336.69	1,655.00	1,991.69
100% Off-Farm Labor Demand							
1) Large farm	23,011.79	--	--	23,011.79	--	--	--
2) Medium farm	4,254.42	39.78	225.00	4,519.20	100.00	50.00	150.00
3) Small farm	1,379.37	325.67	102.42	1,807.46	137.24	22.76	160.00
4) Landless labor	--	1.47	13,498.11	13,499.58	0.42	2,999.58	3,000.00
All Households	¢28,645.58	¢366.92	¢13,825.53	¢42,838.03	237.66	3,072.34	3,310.00

but total employment from all sources was higher, 1949 man-days, due to the availability of off-farm work.

When off-farm work was increased to 100 percent, total incomes for all households reached a peak of ¢59,798.34, which consists of ¢47,600.38 from crop incomes, ¢11,710.13 from off-farm work, and ¢478.83 from weed control work. The large farm earned the biggest income, ¢38,123.25, while the smallest income of ¢2,885.09 was earned by the small farm. Total weed control employment (268 man-days) was slightly lower than the solutions obtained under the zero and 50 percent off-farm labor demand assumption (294 man-days). This result suggests that the availability of full off-farm employment induces selection of less labor intensive enterprise/weed control system combinations.

Observed Farm Price Solutions

The predicted incomes and employment under a regime of distorted input-output farm prices are presented in Table VI-5. When there was no off-farm employment available, the predicted total incomes for all households was ¢29,285.41, consisting of ¢28,503.42 from crop incomes and ¢781.99 from weed control labor earnings. The smallest income was earned by the landless labor group, ¢206.62, and the highest by the large farm (¢22,929.81). Total weed control employment reached 337 man-days, with the landless laborers working for 55 man-days, and the medium and small farm family labor working for 150 and 132 man-days, respectively.

As off-farm employment was increased to 50 percent, total incomes for all households also increased to ¢36,733.02. Crop incomes of ¢28,503.00 and weed control earnings of ¢782 were the same as the solution obtained under zero off-farm labor demand. Total weed control employment of 337 man-days and its distribution among labor-supplying households was the same as the predicted solution under the zero off-farm labor demand assumptions. The largest income was still earned by the large farm (¢22,929.91) but the smallest income (¢1,853.63) was earned by the small farm.

When off-farm employment was increased to 100 percent, the total incomes for all households reached a peak of ¢42,838.03; crop incomes, ¢28,645.58; off-farm labor earnings, ¢13,825.53; and weed control labor earnings, ¢366.92. Total weed control employment was reduced to 238 man-days as compared to the zero and 50 percent off-farm labor demand solutions, with 337 man-days.

To sum up, total incomes for all households under each off-farm labor demand solution was highest under the government price solution (Assumption B) due to the relatively high output price subsidies and relatively lower input price subsidies. The lowest level of total incomes were obtained under the observed (distorted) farm price solutions because the farm-gate output prices were lower than under the government prices and social prices. Total weed control employment was highest under the zero and 50 percent off-farm labor demand solutions of the social price regime (655 man-days). Identical crop incomes, weed control labor earnings and weed control employment were predicted in the zero and 50 percent off-farm labor demand solutions under each of the three general price regime assumptions. The 100 percent off-farm labor demand solutions under each of the three general price regimes, predicted lower total weed control employment (219 to 238 man-days) compared to the zero and 50 percent off-farm labor demand solutions (294 to 655 man-days).

Private Optimal Solutions Compared with Social Optimal Solutions. . .The Distributional Issue

As defined in the theoretical framework set forth in the last section of Chapter IV, the distributional gains and losses induced by factor-product price distortions, can be measured by comparing the private price solutions with the social price solutions. The results, expressed in terms of net percentage difference between the private price solutions and the social price solutions, are presented in Tables VI-6, VI-7, VI-8, VI-9 and VI-10.

Gains and Losses under Two General Price Regimes

The income and employment gains and/or losses under the two general price regimes are presented in Table VI-6.

Government price regime. When all output and input prices were based on subsidized prices (Assumption B), the predicted total incomes for all households under the zero off-farm labor demand solution was 37 percent higher than the corresponding social optimum solution. This was obtained mainly by a 42 percent gain in crop incomes, since weed control labor earnings declined by 65 percent. The medium and small farms obtained the highest total income gains (67 and 60 percent), followed by the large farm with 37 percent, while the landless labor group suffered income losses of 87 percent. Total weed control employment declined by 55 percent, with the landless laborers absorbing an 89 percent reduction, while the small and medium farm labor experienced relatively lower employment losses - 4 percent and 16 percent, respectively .

When off-farm employment was increased to 50 percent, total incomes from all sources for all farm households registered a 33 percent gain above the social optimum solution. This gain was mainly due to gains in crop incomes (42 percent) and off-farm employment (10 percent), weed control labor earnings were reduced by 65 percent. Total employment from all sources declined by 16 percent below

Table VI-6. Percent Gains and Losses: Social Income and Employment Solutions Compared with Alternative Distorted Input-Output Price Solutions under Alternative Off-Farm Labor Demand Assumptions.[1]

Item	Income Gain (+)/Loss(-) Net Crop Income (1)	Weed Control Labor Earnings (2)	Off-Farm Labor Earnings (3)	Total Family Income (4)	Employment Gain (+)/Loss(-) Weed Control Labor (5)	Off-Farm Employment (6)	Total Employment (7)
Government Price (Assumption-B)							
Zero (0) Off-Farm Labor Demand							
1) Large farm	+37			+37			
2) Medium farm	+67	+71		+67	-16		-16
3) Small farm	+67	+16		+60	- 4		- 4
4) Landless labor		-87		-87	-89		-89
All Households	+42	+37		+37	-55		-55
50% Off-Farm Labor Demand							
1) Large farm	+37			+37			
2) Medium farm	+67	- 6		+60	-27		-27
3) Small farm	+69	+44	(+)[2]	+67	+ 8	(+)[2]	+21
4) Landless labor		-87	+ 9	- 9	-89	- 1	-17
All Households	+42	-65	+10	+33	-55	0	-16
100% Off-Farm Labor Demand							
1) Large farm	+39			+39			
2) Medium farm	+58	+391	-11	+56	+13	-19	0
3) Small farm	+67	+32	- 1	+59	+ 2	-10	0
4) Landless labor		+1917	+ 9	+10	+1734	- 1	0
All Households	+42	+110	+ 8	+34	+23	- 2	0
Observed Farm Price (Assumption-C)							
Zero (0) Off-Farm Labor Demand							
1) Large farm	-18			-18			
2) Medium farm	- 7	+248		- 3	0		0

Table VI-6. (continued)

Item	Net Crop Income (1)	Weed Control Labor Earnings (2)	Off-Farm Labor Earnings (3)	Total Family Income (4)	Weed Control Labor (5)	Off-Farm Employment (6)	Total Employment (7)
	Income Gain (+)/Loss (-)				Employment Gain (+)/Loss(-)		
3) Small Farm	- 4	+29		0	0		0
4) Landless Labor		-84		-84	-85		-85
All Households	-16	-52		-17	-49		-49
50% Off-Farm Labor Demand							
1) Large farm	-18			-18			
2) Medium farm	- 7	+248		- 3	0		0
3) Small farm	- 4	+29	(+)3/	+ 8	0	(+)3/	0
4) Landless labor		-84	+26	+ 6	-85	- 2	-17
All Households	-16	-52	+29	-11	-49	0	-14
100% Off-Farm Labor Demand							
1) Large farm	-16			-16			
2) Medium farm	- 4	+188	+ 4	- 3	+13	-19	0
3) Small farm	- 8	+54	- 6	- 1	+ 6	-27	0
4) Landless labor		-79	+29	+29	-79	0	0
All Households	-14	+58	+28	- 4	+ 8	- 1	0

1/ Source of basic data: Tables VI-4 and VI-5.

$$\text{Percent gains or loss} = [(\frac{\text{Distorted Price Solution}}{\text{Undistorted Price (Social) Solution}}) - 1] \times 100$$

2/ Off-farm labor earnings and employment amounts to ¢64.99 and 16.88 man-days, while social solution is zero (0).

3/ Off-farm labor earnings and employment amounts to ¢125.46 and 27.88 man-days, while social solution is zero (0).

the social optimal employment level, and this was primarily due to a 55 percent reduction in weed control employment. Total employment reduction for the landless laborer was by 17 percent, mainly due to an 89 percent decrease in weed control employment. The small farm laborer also experienced employment reduction of 27 percent mainly from reduced weed control employment. The medium farm labor experienced total employment gains of 21 percent. The largest total income gains were obtained by the medium and small farms (60 and 67 percent), followed by the large farm (37 percent), while the landless was the only group that had income losses (nine percent).

Under the 100 percent off-farm labor demand solution, total incomes from all sources for all households were 34 percent higher than the corresponding social optimal solution. This was obtained from a 42 percent increase in crop incomes, a 110 percent increase in weed control labor earnings, and an eight percent increase in off-farm labor income. All households obtained total income gains ranging from 56 to 59 percent in medium and small farms, 39 percent in the large farm and 9 percent for the landless labor group. Total weed control employment was 23 percent higher, but total employment from all sources was equal to the corresponding social optimal solution.

Observed farm price regime. When all input-output prices were at distorted farm prices (Assumption C), the predicted total incomes for all households under the three off-farm labor demand solutions were lower than the corresponding social optimum solutions because of lower farm-gate output prices and in spite of the fact that the distorted input prices were relatively lower than their social prices.

Under the zero off-farm labor demand solution, total incomes for all households was 17 percent lower than the social optimum solution brought about by a 16 percent decrease in crop incomes and a 52 percent reduction in weed control labor earnings. All households, except the small farm, received total income losses ranging from 3 to 18 percent on medium and large farms, to 84 percent for the landless labor group. Total weed control employment was 49 percent lower than the social optimum solution and the landless laborer group experienced employment losses of 85 percent.

When off-farm employment was set to 50 percent, total incomes from all sources for all households declined by 11 percent below the social optimal solution. However, the total income losses were mainly among the medium and large farms (3 to 18 percent) since the landless laborers and small farm obtained income gains (six to eight percent). Total employment from all sources was 14 percent lower than the social optimal solution which occurred primarily from a 49 percent reduction in weed control employment. The only group that experienced total employment reduction was the landless laborers, with a 17 percent decline.

When off-farm employment was further increased to 100 percent, the predicted total incomes from all sources for all households was reduced by only four percent. This reduction is attributed to a 14 percent decrease in crop incomes since weed control earnings and off-farm labor earnings increased. It was only the landless labor group that obtained total income gains of 29 percent mainly from off-farm work, while the three farm size types experienced total income reductions ranging from one percent in the small farm to 16 percent in the large farm. Total employment from all sources was equal to the social optimal solution, however, weed control employment gained by eight percent at the sacrifice of a one percent reduction in off-farm work.

To summarize, the predicted total income gains under the government price solution was positive for the three farm size types under each off-farm employment demand solutions. Relatively larger income gains went to the small and medium farms (56 to 67 percent) and relatively lower gains were obtained by the large farm (37 to 39 percent). On the other hand, the landless labor group, suffered total income losses ranging from 9 to 87 percent under the 50 percent and zero off-farm labor demand solutions to an income gain of 10 percent under the 100 percent off-farm labor demand solution. Total weed control employment reduced by 55 percent under the zero and 50 percent off-farm labor demand solutions, while under the 100 percent off-farm labor demand solution, weed control employment increased by 23 percent. The largest weed control employment reduction was experienced by the landless labor group (89 percent), under both the zero and 50 percent off-farm labor demand solutions.

Total income losses were registered for all households, ranging from 11 to 17 percent under the 50 percent and zero off-farm labor demand solutions to 4 percent under the 100 percent off-farm labor demand solution. Total weed control employment for all labor-supplying households registered a 49 percent reduction under both the zero and 50 percent off-farm labor demand solutions to an 8 percent increase under the 100 percent off-farm labor demand solution. The results show that the landless labor group was the only one affected by reductions in weed control employment, and this ranged from 85 percent in both the zero and 50 percent off-farm labor demand solutions, to 89 percent under the 100 percent off-farm labor demand solution.

Effects of Alternative Government Policies

Effects under 50 percent off-farm labor demand. Table VI-7 shows the results of comparing the predicted income and employment between the four alternative government policies

Table VI-7. Percent Gains and Losses: Social Income and Employment Solutions Compared with Alternative Government Price Solutions under 50 Percent Off-Farm Labor Demand Assumption.[1]

Item	Income Gains (+)/Losses (-) Net Crop Income % (1)	Weed Control Labor Earnings % (2)	Off-Farm Labor Earnings % (3)	Total Family Income % (4)	Employment Gains (+)/Losses(-) Weed Control Labor % (5)	Off-Farm Employment % (6)	Total Employment % (7)
Assumption-B1: (output at social price, labor and capital at subsidized prices)							
1) Large farm	+18			+18			
2) Medium farm	+36	+71		+36	-15		-15
3) Small farm	+40	+16		+37	- 4		- 4
4) Landless labor		-18	+10	- 8	-89	0	-16
All Households	+22	-65	+10	+17	-55	0	-16
Assumption-B2: (output and labor at social prices; capital at subsidized prices)							
1) Large farm	+20			+20			
2) Medium farm	+40	+57		+40	-17		-17
3) Small farm	+49	+ 5		+43	0		0
4) Landless labor		-73	0	-13	-73	0	-13
All Households	+24	-56	0	+18	-45	0	-13
Assumption-B3: (output and capital at social prices; labor at subsidized price)							
1) Large farm	- 3			- 3			
2) Medium farm	- 4	+23	(+)[3]	0	-20	(+)[3]	0
3) Small farm	- 3	+10	(+)[4]	+ 5	0	(+)[4]	0
4) Landless labor		+ 9	+ 6	+ 7	- 1	- 4	- 3
All Households	- 3	+10	+10	0	- 5	0	- 1
Assumption-B4: (output at subsidized price; labor and capital at social prices)							
1) Large farm	+19			+19			
2) Medium farm	+17	+17	(+)[5]	+19	-25	(+)[5]	0

Table VI-7. (continued)

Item	Income Gains (+)/Losses(-) Net Crop Income % (1)	Weed Control Labor Earnings % (2)	Off-Farm Labor Earnings % (3)	Total Family Income % (4)	Employment Gains (+)/Losses (-) Weed Control Labor % (5)	Off-Farm Employment % (6)	Total Employment % (7)
3) Small farm	+16	0	(+)[6/]	+19	0	(+)[6/]	+21
4) Landless labor		- 1	- 4	- 3	- 1	- 4	- 3
All Households	+18	0	0	+15	- 4	0	- 2

[1/] Source of basic data: Table VI-4 and Appendix Table A-1. See footnote no. 1, Table VI-6 for percentage formula.

[2/] Off-farm labor earnings of ¢64.99 and off-farm employment of 16.88 man-days. Social solution is zero (0).

[3/] Off-farm labor earnings of ¢119.16 and off-farm employment of 30.95 man-days. Social solution is zero (0).

[4/] Off-farm labor earnings of ¢107.07 and off-farm employment of 27.81 man-days. Social solution is zero (0).

[5/] Off-farm labor earnings of ¢133.56 and off-farm employment of 38.16 man-days. Social solution is zero (0).

[6/] Off-farm labor earnings of ¢97.34 and off-farm employment of 27.81 man-days. Social solution is zero (0).

and the social optimal solutions under the 50 percent off-farm labor demand solutions.

Total income gains for all households were obtained under Assumptions B, B1, B2 and B4, while under Assumption B3 (only wage rate was subsidized) total income for all households was the same as the social optimal solution (Tables VI-6 and VI-7, column 4). Total income gains obtained by each farm size type, ranging from 19 to 67 percent were predicted under Assumptions B, B1, B2 and B4. In each of the three private optima solutions (Assumptions B, B1 and B2), the medium and small farms obtained larger relative total income gains (36 to 67 percent) than those obtained by the large farm (18 to 37 percent). Equal relative total income gains (19 percent) were obtained by each size farms only under Assumption B4 (output prices were subsidized). In the case of the landless labor group, relative total income losses (3 to 13 percent) were predicted under four alternative government price solutions (Assumptions B, B1, B2, and B4), and only under Assumption B3 (only wage rate was subsidized) was there a predicted income gain of 7 percent. It was only under Assumption B3 that relative total income gains were obtained by the small farm and landless laborer (5 to 7 percent), while the large farm obtained an income loss (3 percent), and the medium farm had no income change.

Total weed control employment reductions were highest under Assumptions B, B1 and B2 (45 to 55 percent) and lowest under Assumptions B3 and B4 (4 to 5 percent). The largest weed control employment reductions were predicted for the landless laborers (73 to 89 percent) under Assumptions B, B1 and B2 and the lowest (one percent) were predicted under Assumptions B3 and B4 (Tables VI-6 and VI-7, column 5). Reduction of total employment from all sources were highest (13 to 16 percent) under Assumptions B, B1 and B2, and were lowest (one to two percent) under Assumptions B3 and B4 (Tables VI-6 and VI-7, column 7). The results indicate that whenever direct capital subsidies were present in any policy mix (Assumptions B, B1 and B2) weed control employment and total employment reductions tend to be relatively large, while relatively small reductions in weed control employment and total employment from all sources were predicted when only labor or output price distortions were present in the policy mix (Assumptions B3 and B4).

Effects under 100 percent off-farm labor demand situation. The comparison between the predicted income and employment under four alternative government price regimes and the social optimal solution is presented in Table VI-8. The medium and small farms obtained relatively higher total income gains (37 to 59 percent) than the large farm (20 to 39 percent) in the private optima solutions, Assumptions B, B1 and B2 (Tables VI-6 and VI-8, column 4). It was only

Table VI-8. Percent Gains and Losses: Social Income and Employment Solutions Compared with Alternative Government Price Solutions under 100 Percent Off-Farm Labor Demand Assumption.[1/]

	Income Gains (+)/Losses (-)				Employment Gains (+)/Losses (-)		
Item	Net Crop Income % (1)	Weed Control Labor Earnings % (2)	Off-Farm Labor Earnings % (3)	Total Family Income % (4)	Weed Control Labor % (5)	Off-Farm Employment % (6)	Total Employment % (7)
Assumption-B1: (output at social price; labor and capital at subsidized prices)							
1) Large farm	+20			+20			
2) Medium farm	+37	+734	-33	+35	+27	-39	0
3) Small farm	+40	+10	+42	+37	- 3	+29	0
4) Landless labor		+1917	+ 9	+10	+1734	- 1	0
All Households	+23	+110	+ 8	+20	+23	- 2	0
Assumption-B2: (output and labor at social prices; capital at subsidized prices)							
1) Large farm	+22			+22			
2) Medium farm	+42	+843	-59	+39	+41	-59	0
3) Small farm	+44	-12	+52	+38	-13	+52	0
4) Landless labor		+1730	- 1	0	+1730	- 1	0
All Households	+26	+91	- 2	+19	+25	- 2	0
Assumption-B3: (output and capital at social prices; labor at subsidized price)							
1) Large farm	- 2			- 2			
2) Medium farm	- 3	+558	-25	- 2	+23	-32	0
3) Small farm	- 3	-26	+81	- 1	-16	+64	0
4) Landless labor		+10	+10	+10	0	0	0
All Households	- 2	+10	+10	+ 1	0	0	0

Table VI-8. (continued)

	Income Gains (+)/Losses (-)				Employment Gains (+)/Losses (-)		
Item	Net Crop Income % (1)	Weed Control Labor Earnings % (2)	Off-Farm Labor Earnings % (3)	Total Family Income % (4)	Weed Control Labor % (5)	Off-Farm Employment % (6)	Total Employment % (7)
Assumption B4: (output at subsidized price; labor and capital at social prices)							
1) Large farm	+19			+19			
2) Medium farm	+18	0	0	+17	0	0	0
3) Small farm	+16	0	0	+13	0	0	0
4) Landless labor		0	0	0	0	0	0
All Households	+18	0	0	+14	0	0	0

1/ Source of basic data: Tables VI-4 and Appendix Table A-2. See footnote no. 1, Table VI-6 for percentage formula.

under Assumption B3 that each of the three farm size types obtained relative total income losses (one to two percent), while the landless laborers had an income gain of 10 percent. In addition, it was only under Assumption B4 that the large farm had a slightly higher relative total income gain (19 percent) than the small and medium farms (13 to 17 percent). In the case of the landless laborers, their predicted total income gains were positive (10 percent) under Assumptions B, B1 and B3, and were equal to their corresponding social optimum solution under Assumptions B2 and B4.

Total weed control employment were predicted to be higher (by 23 to 25 percent) than the social optimal solution under Assumptions B, B1 and B2 and were approximately equal to the social optimal solution under Assumptions B3 and B4 (Tables VI-6 and VI-8, column 5).

To sum up, under the 50 percent off-farm labor demand solutions, each of the three farm size types obtained relative total income gains whenever the policy mix included direct capital and/or output subsidies alone or in combination with distorted wage rate (Assumptions B, B1, B2 and B4). While the presence of distorted wage rate alone (Assumption B3) induced relative total income losses to the large and medium farms and income gains to the small farm and landless laborers. Total weed control employment reductions were relatively large whenever the policy mix included capital subsidies alone or in combination with output subsidies and/or distorted minimum wage rate (Assumptions B, B1 and B2) and a relatively small weed control employment reduction occurred whenever either distorted wage rate alone or output subsidies alone were present (Assumptions B3 and B4). The landless laborers were the group most adversely affected by weed control employment reductions when off-farm employment was set at 50 percent of available weed control labor supply under Assumptions B, B1 and B2.

Under the 100 percent off-farm labor demand solutions, each of the three farm size types obtained relative total income gains whenever the policy mix included capital subsidies alone or in combination with output and labor subsidies (Assumption B, B1 and B2). The presence of distorted minimum wage rate (Assumption B3) alone induced small income losses to each of the three farm size types, while the landless laborers obtained income gains. Total weed control employment levels predicted by each of the five alternative government price solutions were relatively higher than the social-price weed control employment solution under a full off-farm employment situation. Relatively higher total weed control employment gains were predicted under Assumptions B, B1 and B2, while total weed control employment levels were approximately equal to the social optimum solution under Assumptions B3 and B4.

Effects of Alternative Observed Farm Price Distortions

Effects under the 50 percent off-farm labor demand situation. The results of comparing the income and employment effects of five alternative observed farm price regimes with the corresponding social optimal solutions are presented in Tables VI-6 and VI-9. Relative total income gains for all households were predicted to be negative (3 to 17 percent) in Assumptions C, C3 and C4, and positive total income gains (7 to 8 percent) were predicted in Assumptions Cl and C2 (Tables VI-6 and VI-9, column 4). Each of the three farm size types obtained relative total income gains (4 to 29 percent) under Assumptions Cl and C2. Relative total income losses (one to 22 percent) were obtained by each of the three farm size types under Assumptions C and C4. It was only under Assumption C3 (only wage rates were distorted) that the small farm and landless laborers obtained relative total income gains (7 to 10 percent), while the large farm had an income loss (3 percent) and the medium farm had no income change. In the case of the landless laborers, relative total income gains (7 to 29 percent) were predicted for them under Assumptions C, Cl and C3, while an income loss was predicted under Assumption C2 and no income gain or loss under Assumption C4.

Total weed control employment losses were highest (49 percent) under Assumptions C, Cl, C2 and C3 and lowest (5

Table VI-9. Percent Gains and Losses: Social Income and Employment Solutions Compared with Alternative Observed Farm Price Solutions under 50 Percent Off-Farm Labor Demand Assumption.[1/]

Item	Income Gains (+)/Losses (-)				Employment Gains (+)/Losses (-)		
	Net Crop Income % (1)	Weed Control Labor Earnings % (2)	Off-Farm Labor Earnings % (3)	Total Family Income % (4)	Weed Control Labor % (5)	Off-Farm Employment % (6)	Total Employment % (7)
Assumption-C1: (output at social price; labor and capital at observed (distorted) farm prices)							
1) Large farm	+ 4			+ 4			
2) Medium farm	+18	+32		+18	- 3		- 3
3) Small farm	+20	+43	(+)[3/]	+29	+ 3	(+)[3/]	+21
4) Landless labor		-81	+27	+ 7	-85	- 1	-17
All Households	+ 7	-58	+29	+ 7	-49	0	- 3
Assumption-C2: (output and labor at social prices; capital at distorted farm prices)							
1) Large farm	+10			+10			
2) Medium farm	+19	+ 3		+19	- 3		- 3
3) Small farm	+20	+13	(+)[4/]	+23	+ 3	(+)[4/]	+21
4) Landless labor		-85	- 1	-17	-85	- 1	-17
All Households	+11	-67	0	+ 8	-49	0	-14
Assumption-C3: (output and capital at social prices; labor at observed (distorted) wage rate)							
1) Large farm	- 3			- 3			
2) Medium farm	- 1	+33		0	0		0
3) Small farm	0	+29	(+)[5/]	+10	0	(+)[5/]	+21
4) Landless labor		-81	+26	+ 7	-86	- 2	-17
All Households	- 6	-60	+29	- 3	-49	0	-14

Table VI-9. (continued)

Item	Income Gains (+)/Losses (-)				Employment Gains (+)/Losses (-)		
	Net Crop Income % (1)	Weed Control Labor Earnings % (2)	Off-Farm Labor Earnings % (3)	Total Family Income % (4)	Weed Control Labor % (5)	Off-Farm Employment % (6)	Total Employment % (7)
Assumption-C4: (output at farm-gate price (distorted); labor and capital at social prices)							
1) Large farm	-22			-22			
2) Medium farm	-19	+15		-18	-20		-20
3) Small farm	-21	0		-19	0		0
4) Landless labor		- 1	0	0	- 1	0	0
All Households	-21	0	0	-17	- 5	0	- 1

1/ Source of basic data: Table VI-4 and Appendix Table A-3. See footnote no. 1, Table VI-6 for percentage formula.

2/ Off-farm labor earnings of ¢125.46 and off-farm employment of 29.88 man-days. Social solution is zero (0).

3/ Off-farm labor earnings of ¢104.63 and off-farm employment of 23.25 man-days. Social solution is zero (0).

4/ Off-farm labor earnings of ¢81.38 and off-farm employment of 23.25 man-days. Social solution is zero (0).

5/ Off-farm labor earnings of ¢124.83 and off-farm employment of 27.74 man-days. Social solution is zero (0).

percent) under Assumption C4 (Tables VI-6 and VI-9, column 5). The landless laborer was the only group who obtained the largest weed control labor displacement (85 percent) under Assumptions C, C1, C2 and C3, while under Assumption C4 (distorted output prices), they had the least labor displacement (one percent). Total employment losses from all sources (weed control and off-farm) were predicted to be highest (14 percent) under Assumptions C, C1, C2 and C3, and lowest (one percent) under Assumption C4 (Tables VI-6 and VI-9, column 7). The landless laborers suffered the largest total employment losses from all sources (17 percent) under all alternative distorted farm price solutions except in Assumption C4 (no gain or loss).

Effects under 100 percent off-farm labor demand situation. The results are presented in Tables VI-6 and VI-10. Relative total income gains for all households were positive (3 to 13 percent) under Assumptions C1, C2 and C3, and were negative (4 to 16 percent) under Assumptions C and C4 (Tables VI-6 and VI-10, column 4). Relative total income losses (1 to 22 percent) in each of the three farm sizes were predicted under Assumptions C and C4, and income gains (6 to 21 percent) were predicted for each of them under Assumptions C1 and C2. It was only under Assumption C3 (only wage rate was distorted) that the large farm obtained a total income loss (six percent), while the three other farm households had income gains (1 to 29 percent). In the

Table VI-10. Percent Gains and Losses: Social Income and Employment Solutions Compared with Alternative Observed Farm Price Solutions under 100 Percent Off-Farm Labor Demand Assumption.[1/]

Item	Income Gains (+)/Losses (-)				Employment Gains (+)/Losses (-)		
	Net Crop Income % (1)	Weed Control Labor Earnings % (2)	Off-Farm Labor Earnings % (3)	Total Family Income % (4)	Weed Control Labor % (5)	Off-Farm Employment % (6)	Total Employment % (7)
Assumption C1: (output at social price; labor and capital at observed (distorted) farm prices)							
1) Large farm	+ 6			+ 6			
2) Medium farm	+17	+175	+ 4	+17	+14	-19	0
3) Small farm	+18	+54	- 6	+21	+ 6	-27	0
4) Landless labor		-72	+29	+29	-78	0	0
All Households	+ 8	+57	+28	+13	+ 9	- 1	0
Assumption-C2: (output and labor at social prices; capital at distorted farm price)							
1) Large farm	+11			+11			
2) Medium farm	+18	+622	-51	+17	+36	-52	0
3) Small farm	+18	- 7	+38	+16	- 9	+38	0
4) Landless labor		-78	0	0	-78	0	0
All Households	+12	+29	- 1	+ 9	+ 8	- 1	0
Assumption-C3: (output and capital at social prices; labor at observed (distorted) wage rate)							
1) Large farm	- 6			- 6			
2) Medium farm	- 1	+93	+30	+ 1	0	+ 1	0
3) Small farm	0	+29	+29	+ 5	0	0	0
4) Landless labor		+ 3	+29	+29	+ 3	0	0
All Households	- 5	+32	+29	+ 3	0	0	0

Table VI-10. (continued)

Item	Income Gains (+)/Losses (-)				Employment Gains (+)/Losses (-)		
	Net Crop Income % (1)	Weed Control Labor Earnings % (2)	Off-Farm Labor Earnings % (3)	Total Family Income % (4)	Weed Control Labor % (5)	Off-Farm Employment % (6)	Total Employment % (7)
Assumption C-4: (output at farm-gate price (distorted); labor and capital at social prices)							
1) Large farm	-22			-22			
2) Medium farm	-18	+95	-18	-18	+13	-19	0
3) Small farm	-21	- 1	+ 4	-18	- 1	+ 4	0
4) Landless labor		(-)[2/]	0	0	(-)[2/]	0	0
All Households	-21	+ 2	0	-16	+ 4	0	0

[1/] Source of basic data: Tables VI-4 and Appendix Table A-4. See footnote no. 1, Table VI-6 for percentage formula.

[2/] Social solution predicts off-farm labor earnings of ¢6.93 and off-farm employment of 1.98 man-days while private (assumption-C4) solution predicts zero (0) off-farm employment.

case of the landless laborers, total income gains of 29 percent were each obtained under three alternative farm price solutions (Assumptions C, C1 and C3), while no income gains or losses were predicted for them under Assumptions C2 and C4 (only wage rate or only output prices were distorted).

Total employment from all sources under each of the five alternative farm price solutions were identical with the corresponding social price solution (Tables VI-6 and VI-10, column 7). But total weed control employment gains (four to nine percent) were predicted under four alternative farm price solutions, namely, Assumptions C, C1, C2 and C4 (Tables VI-6 and VI-10, column 5).

Efficiency Losses and Net Social Costs of Price Distortions

It should be pointed out that the efficiency losses predicted for small and medium farms as induced by output-input price distortions, were mainly due to variations in the predicted private optimal enterprise combinations and enterprise-area allocation, since the predicted socially efficiency and privately efficient weed control system for all selected enterprises was the use of manual method. On the other hand, the efficiency losses (if present) predicted for the large farm, were mainly due to variations in the predicted rice area allocated to either manual and/or chemical weed control.

Efficiency Losses of Alternative Government Policies

In the last section of the theoretical framework of Chapter IV, efficiency loss induced by market distortions was defined as the difference between the social resource costs of the distorted price solution and the resource costs of the undistorted price solution. The predicted efficiency losses in terms of value and percentages, under five alternative government price solutions are presented in Table VI-11 (columns 1 to 3 and columns 6 to 8). Identical relative efficiency losses for all farms were predicted in both Assumptions B and B1 under the 50 percent off-farm labor demand solutions (6.9 percent) and in both price assumptions under the 100 percent off-farm labor demand solutions (6.4 percent). Likewise, the relative efficiency losses were the same for each of the three farm sizes for both Assumptions B and B1 under each of the two off-farm labor demand solutions.

Under both the 50 and 100 percent off-farm labor demand solutions, larger relative efficiency losses (6.4 to 7.1 percent) for all farms were predicted whenever the policy mix included capital subsidies (Assumptions B, B1, and B2). The predicted social costs of utilized resources for all farms were slightly smaller (less than one percent) than the social price solution under the 50 percent off-

Table VI-11 Predicted Efficiency Losses and Net Subsidies under Alternative Government Price Solutions and Off-Farm Labor Demand Assumptions.

Item	50% Off-Farm Labor Demand: Resource Costs at Social Prices (1)	50%: Efficiency Loss: Value[1] (2)	50%: Efficiency Loss: Percent[2] (3)	50%: Net Subsidy[3]: Value (4)	50%: Net Subsidy[3]: Percent Distribution (5)	100% Off-Farm Labor Demand: Resource Costs at Social Prices (6)	100%: Efficiency Loss: Value[1] (7)	100%: Efficiency Loss: Percent[2] (8)	100%: Net Subsidy[3]: Value (9)	100%: Net Subsidy[3]: Percent Distribution (10)
All outputs and inputs at subsidized prices (assumption B)										
Large farm	22,499.99	241.81	1.1	8,981.69[4]	73.7	22,513.99	0	0	10,008.19[4]	75.7
Medium farm	4,617.55	1,178.05	34.3	2,318.33[4]	19.0	4,594.05	1,299.35	39.4	2,324.26[4]	17.6
Small farm	1,712.83	441.53	34.7	891.67[4]	7.3	1,712.83	441.43	34.7	891.67[4]	6.7
All farms	¢28,830.37	¢1,861.39	6.9	¢12,191.69	100.0	¢28,820.85	¢1,740.78	6.4	¢13,224.12	100.0
Labor and capital at subsidized prices and output at social price (assumption B1)										
Large farm	22,499.99	241.81	1.1	3,828.77	67.4	22,513.97	0	0	4,855.27	72.1
Medium farm	4,608.40	1,168.90	34.0	1,379.62	24.3	4,594.05	1,299.35	39.4	1,381.38	20.5
Small farm	1,712.83	441.53	34.7	473.07	8.3	1,712.83	441.43	34.7	494.00	7.4
All farms	¢28,821.22	¢1,852.24	6.9	¢5,681.46	100.0	¢28,820.85	¢1,740.78	6.4	¢6,730.65	100.0
Capital at subsidized price while output and labor at social prices (assumption B2)										
Large farm	22,465.61	207.43	0.9	5,253.08	74.2	22,513.97	0	0	5,369.15	74.6
Medium farm	4,642.49	1,202.99	35.0	1,338.99	18.9	4,642.49	1,347.79	40.9	1,336.61	18.6
Small farm	1,767.91	496.61	39.1	491.61	6.9	1,712.83	441.43	34.7	494.00	6.8
All farms	¢28,876.01	¢1,907.03	7.1	¢7,083.68	100.0	¢28,868.59	¢1,789.22	6.6	¢7,199.76	100.0
Labor at subsidized price while output and capital at social prices (assumption B3)										
Large farm	22,258.18	0	0	698.88	92.0	22,513.97	0	0	561.31	91.3
Medium farm	3,319.97	-119.53[5]	-3.3[5]	36.54	4.8	3,294.70	0	0	29.47	4.8
Small farm	1,271.30	0	0	24.04	3.2	1,271.40	0	0	23.94	3.9
All farms	¢26,849.45	-¢119.53	-0.4	¢ 759.46	100.0	¢27,080.07	0	0	¢ 614.72	100.0
Output at subsidized price while labor and capital at social prices (assumption B4)										
Large farm	22,258.18	0	0	5,152.92[4]	83.6	22,513.97	0	0	5,152.92	83.6
Medium farm	3,291.78	- 147.72[5]	-4.3[5]	781.38[4]	12.7	3,294.70	0	0	781.38	12.7
Small farm	1,271.30	0	0	233.13[4]	3.7	1,271.40	0	0	233.13	3.7
All farms	¢26,821.26	-¢147.75	-0.6	¢6,167.43	100.0	¢27,080.07	0	0	¢6,167.43	100.0

1/ Efficiency loss (value) = (social resource costs of distorted price solution)-(resource costs of undistorted price (social) solution).

2/ Percent efficiency loss = $[(\frac{\text{social resource costs of distorted price solution}}{\text{resource costs of undistorted price solution}}) - 1] \times 100$

Resource Costs of Undistorted Price (social) Solutions (weed control labor costs included)

	50% Off-farm labor demand (colones [¢])	100% Off-farm labor demand (colones [¢])
Large farm	22,258.18	22,513.97
Medium farm	3,439.50	3,294.70
Small farm	1,271.30	1,271.30
All farms	¢26,968.98	¢27,080.07

3/Net subsidy = (social resource costs of distorted price solution)-(private resource costs of distorted price solution)

4/Include the difference between government subsidized output prices and commercial market price.

5/The resource costs of undistorted price (social) solution was actually higher than the corresponding private resource costs of the distorted price solution.

farm labor demand situation and were equal to the social price solution under the 100 percent off-farm labor demand situation in Assumptions B3 and B4.

Under the 50 percent off-farm labor demand solutions, the medium and small farms obtained larger relative efficiency losses (34 to 39 percent), and the large farm, the least (0.9 to 1.1 percent) under Assumptions B, B1 and B2 (Table VI-11, column 3). Under Assumptions B3 and B4, the large and small farms had no efficiency losses, while the medium farm obtained small efficiency gains (3.3 to 4.3 percent). The presence of resource constraints and off-farm employment constraints for the medium farm partly explains why it had obtained small efficiency gains rather than efficiency losses as the theoretical hypothesis would have predicted.

Under the 100 percent off-farm labor demand solutions, the large farm had no efficiency losses in each of the five alternative government price regimes. On the other hand, the medium and small farms obtained large relative efficiency losses (35 to 41 percent) under Assumptions B, B1 and B2, while they had no efficiency losses under Assumptions B3 and B4 (Table VI-11, column 8).

Efficiency Losses of Alternative Observed Farm Prices

Table VI-12 (columns 1 to 3 and 6 to 8) presents the predicted value and percentage efficiency losses under five alternative observed farm price regimes. The predicted relative efficiency losses for all farms were higher (3.1 to 2.8 percent) under both off-farm labor demand situations whenever the policy mix included indirect capital subsidies (Assumptions C, C1 and C2). It was relatively small (0.8 to 0.1 percent) when only wage rate was distorted (Assumption C3- 50 percent off-farm solution), and when only output prices were distorted (Assumption C4 - 100 percent off-farm solution). Small relative efficiency gains (0.03 and 0.4 percent) for all farms were predicted under Assumption C3 (100 percent off-farm solution) and Assumption C4 (50 percent off-farm solution).

Under the 50 percent off-farm labor demand solutions, large relative efficiency losses (12 to 16 percent) were predicted for the medium and small farms, and small efficiency losses (0.9 percent) for the large farm in Assumptions C, C1 and C2. In each of these alternative farm price regimes indirect capital subsidies were present. On the other hand, the large farm obtained a small efficiency loss (0.9 percent) under Assumption C3 and no loss under Assumption C4. In Assumption C4, a small efficiency loss (0.4 percent) was predicted for the small farm and an efficiency gain (3.4 percent) for the medium farm. The reasons for the predicted efficiency gains in the medium farm and for all farms was already explained under the alternative government price solutions (Table VI-12, column 3).

Table VI-12 Predicted Efficiency Losses and Net Indirect Subsidies / Added Costs under Alternative Observed Farm Price Solutions and Off-Farm Labor Demand Assumptions.

	50% Off-Farm Labor Demand					100% Off-Farm Labor Demand				
	Resource Costs at Social Prices	Efficiency Loss		Social Resource Costs-Private Costs[3/]		Resource Costs at Social Prices	Efficiency Loss		Social Resource Costs-Private Costs[3/]	
Item	(1)	Value[1/] (2)	Percent[2/] (3)	Value (4)	Percent Distribution (5)	(6)	Value[1/] (7)	Percent[2/] (8)	Value (9)	Percent Distributions (10)
All outputs and inputs at distorted farm prices (assumption C)										
Large farm	22,465.61	207.43	0.9	7,225.56[4/]	77.6	22,513.97	0	0	7.208.72[4/]	75.5
Medium farm	3,855.61	416.11	12.1	1,496.39[4/]	16.1	3,879.39	584.86	17.8	1,754.60[4/]	18.4
Small farm	1,482.86	211.46	16.6	584.81[4/]	6.3	1,444.40	173.10	13.6	588.66[4/]	6.1
All farms	¢27,804.08	¢835.00	3.1	¢9,306.76	100.0	¢27,837.76	¢757.96	2.8	¢9,551.98	100.0
Output at social price while labor and capital at distorted farm prices (assumption C1)										
Large farm	22,465.61	207.43	0.9	1,213.82	60.2	22,513.97	0	0	1,196.98	61.1
Medium farm	3,999.10	559.60	16.0	577.21	28.6	3,879.39	584.86	17.8	560.40	28.6
Small farm	1,465.69	194.29	15.3	207.94	11.2	1,444.40	173.10	13.6	200.16	10.3
All farms	¢27,930.40	¢961.32	3.6	¢2,016.97	100.0	¢27.837.76	¢757.96	2.8	1,957.54	100.0
Capital at distorted price while output and labor at social prices (assumption C2)										
Large farm	22,465.61	207.43	0.9	2,471.65	75.9	22,513.97	0	0	2,529.48	78.5
Medium farm	3,999.10	559.60	16.0	577.21	17.7	3,879.39	584.86	17.8	492.46	15.3
Small farm	1,465.69	194.29	15.3	207.94	6.4	1,444.40	173.10	13.6	200.16	6.2
All farms	¢27,930.40	¢961.32	3.6	¢3,256.80	100.0	¢27,837.76	¢757.96	2.8	¢3,222.10	100.0
Labor at distorted wage rate while output and capital at social prices (assumption C3)										
Large farm	22,465.61	207.43	0.9	1,540.94	100.0	22,513.97	0	0	1,466.30	100.0
Medium farm	3,439.50	0	0	0	0	3,285.09	-9.44[5/]	-0.3[5/]	0	0
Small farm	1,271.40	0	0	0	0	1,271.30	0	0	0	0
All farms	¢27,176.51	¢207.43	0.8	¢1,540.94	100.0	¢27,070.36	-¢ 9.44	-0.03	¢1,466.30	100.0
Output at subsidized price while labor and capital at social prices (assumption C4)										
Large farm	22,258.18	0	0	6,011.74[4/]	77.3	22,513.97	0	0	6,011.74[4/]	79.8
Medium farm	3,325.53	-113.97[5/]	-3.4[5/]	1,180.76[4/]	15.2	3,321.83	27.30	0.8	1,203.98[4/]	16.0
Small farm	1,275.91	4.51	0.4	588.78[4/]	7.5	1,271.30	0	0	320.58[4/]	4.2
All farms	¢26,859.62	-¢109.46	-0.4	¢7,781.28	100.0	¢27,107.10	¢27.30	0.1	¢7,536.30	100.0

1/ For efficiency loss (value) formula see footnote no. 1, Table VI-11.

2/ For percent efficiency loss formula and resource costs at undistorted price (social) solutions see footnote no. 2, Table VI-11

3/ The difference between social resource costs of distorted price solution and private resource costs of distorted price solution represents cost savings of farm operators or net indirect government subsidies if it is due to capital price distortions, while the difference, due to distorted wage rates, and distorted output prices, represents added production costs and lost income from lower private output price, respectively.

4/ Includes the difference between social output price and farm-gate output price.

5/ The resource costs of undistorted price (social) solution was actually higher than the corresponding private resource costs of the distorted price solution.

Under the 100 percent off-farm labor demand solutions, the large farm had no efficiency losses in each of the five alternative distorted farm price regimes. While the small and medium farms had large relative efficiency losses (14 to 18 percent) under Assumptions C, C1 and C2, and small efficiency losses or gains (-0.3 to 0.8 percent) were obtained under Assumptions C3 and C4 (Table VI-12, column 8).

To summarize, the results indicate that under both alternative government price and observed (distorted) farm price solutions in the 50 percent off-farm labor demand situation, the small and medium farms almost always obtained relatively large efficiency losses (12 to 39 percent) and the large farm, the least (0.9 to 1.1 percent) or no efficiency losses, whenever capital price distortions were present alone or in combination with output and/or labor price distortions. It was only under a situation when either output prices alone or wage rates alone were distorted that the small and medium farms obtained either small relative efficiency losses, no losses or small efficiency gains.

Under the 100 percent off-farm labor demand situation for both alternative government price and observed farm price solutions, the large farm always obtained no efficiency losses regardless of price distortions present. On the other hand, the small and medium farms always obtained relatively large efficiency losses (14 to 41 percent) whenever capital price distortions were present alone or in combination with output and/or labor price distortions. Whenever either output prices alone or wage rates alone were distorted, the small and medium farms obtained either no efficiency losses, small losses or small efficiency gains.

Finally, the results appear to indicate that a relatively more efficient resource allocation could be obtained in a policy mix that does not include direct or indirect government subsidies on capital inputs.

Net Social Costs of Price Distortions

Another way of measuring the distributional effects induced by price distortions among the three farm size types, is to compare the private costs using distorted prices and the social costs of utilized resources. This was done here by estimating the difference between the private costs and the social resource costs of each distorted price solution. If the social costs of utilized resources exceeds their private costs, the difference would represent cost savings of farm operators or lost earnings of resource owners, and in the case of direct and indirect output and input subsidies, added costs borne by the government to support government policies. On the other hand, if the private costs exceed social resource costs, the difference would represent added costs to farm operators, or the net costs of inefficient resource allocation and distorted output prices. The net social costs and their relative distribution among the three size farms are presented in Tables VI-11 and VI-12, columns 4 to 5 and 9 to 10.

Net Social Costs of Government Policies

Table VI-11 (columns 4 to 5 and 9 to 10) presents the net social costs of five alternative government price regimes under each off-farm labor demand solution.

The largest total net social costs (¢12,191.96 to ¢13,224.22) for all farms were predicted under Assumption B for both off-farm labor demand solutions because it includes both input and output subsidies. The second largest net social costs (¢5,682 to ¢7,200) for all farms under both off-farm labor demand solutions were predicted under Assumptions B1, B2 and B4. In two policy mix, direct capital subsidies were present alone (Assumption B2) or in combination with distorted wage rate (Assumption B1) and in one policy mix (Assumption B4), output prices alone were subsidized. The smallest amounts of net social costs (¢560 to ¢615) for all farms were predicted for Assumption B3 (only wage rate was distorted) under both the 50 and 100 percent off-farm labor demand solutions (Table VI-11, columns 4 and 9).

In all alternative government price solutions under both the 50 and 100 percent off-farm labor demand situations, the large farm always absorbed the biggest portion of total net social costs (67 to 92 percent), while the smallest (3.2 to 8.3 percent), was accounted by the small farm (Table VI-11, columns 5 and 10). This net social costs distribution occurred because the large farm owned the largest area (77.4 percent of total area for all farms) and largest operating capital compared to small and medium farms.

The results suggest that whenever either capital and/or output subsidies were present in a particular policy mix, the net social costs for all farms were relatively large, and that it was always the large farm who absorbed the biggest share of total net social costs.

Net Social Costs of Distorted Farm Prices

The predicted net social costs of five alternative farm price regime solutions are presented in Table VI-12 (columns 4 to 5 and 9 to 10).

The biggest net social costs for all farms was obtained when all inputs and outputs were at distorted farm prices (Assumption C).

The second largest total net social costs were predicted under Assumption C4 (only output prices were distorted). It amounted to ¢7,781 under the 50 percent off-farm solution, and ¢7,536 under the 100 percent off-farm solution (Table VI-12, columns 4 and 9). As usual, the biggest share of total net social costs was absorbed by the large farm (77 to 80 percent), while the smallest share (3 to 8 percent), was accounted by the small farm (Table VI-12, columns 5 and 10).

The smallest total net social costs (¢1,466 to ¢1,541) was predicted when only wage rate was distorted (Assumption C3). In this case, only the large farm absorbed the net social costs, because in the small and medium farms, their wage rate was assumed to be the same as the social wage rate (i.e. market clearing wage rate).

To summarize, the analysis shows that the largest amount of total net social costs for all farms (¢9,307 to ¢7,536) were obtained whenever output price distortions were present alone and/or in combination with labor and capital price distortions. As in the government price solutions, the large farm always obtained the largest share of total net social costs due to the fact that it owned the biggest amount of land and capital resources compared to the resources owned by medium and small farms.

VII. CONCLUSIONS AND POLICY IMPLICATIONS

Summary and Conclusions

The objective of this thesis was to determine the effects of alternative government policies and observed farm price distortions on enterprise/weed control system choices and associated income-employment outcomes. A case study of 12 representative basic grain farms arbitrarily divided into three different size classes (small, medium, and large) with three labor supplying households (small and medium farm family labor, and landless labor) was made. An attempt was made to measure the effects of price distortions not only on weed control but also the effects of off-farm employment demand, output price distortions and input price distortions of complementary crop production practices on the choice of crop enterprises and weed control systems, and associated income-employment effects.

This approach appears to be practical and realistic since in the actual situation, basic grain farmers in El Salvador have to consider simultaneously output and input prices and off-farm employment opportunities in making farm decisions such as the types of enterprises, weed control systems and levels of other types of complementary agricultural technology to adopt, in order to maximize incomes and satisfy other farm objectives.

Effects of Price Distortions on Weed Control Technology Choice

A major conclusion of the study was that the presence of input-output price distortions and off-farm employment opportunities were not sufficient to induce changes in weed control technology of small and medium farms in the enterprises studied. The privately efficient and socially efficient system for all selected enterprises was the same (manual control). The principal effect of price distortions and off-farm labor demand constraints on the small and medium farms (when compared with the social price solutions) were the tendencies to reduce the number of selected enterprises and to cause variations in the area allocated among the selected enterprises.

On the other hand, the capital-labor substitution on the large farm was sensitive to distorted wage rates, and to direct and indirect government subsidies on capital inputs when off-farm employment demand was between zero and 50 percent. Under the three alternative government price solutions (Assumptions B, B1 and B2), where the policy mix includes capital subsidies, herbicide-area diffusion ranged from 75 to 87 percent of total area on the large farm. While under two alternative policies (Assumptions B3 and B4), where either wage rate or the output price was subsidized, herbicide-area diffusion ranged from 0 to 7.5 percent of total area on the large farm. However, under the 100 percent off-farm labor demand solutions, the privately and socially efficient weed control system for the large farm was the use of a mixed chemical-manual method. Under each of the five alternative government price solutions, the selected rice enterprise employed pure chemical control (92.5 percent of total farm area), which was identical with the social price solution for the large farm. This implies that the presence of 100 percent off-farm labor demand diminished the effects of price distortions, and intensified competition for the fixed labor supply between weed control work and off-farm employment. Thus, even when prices were undistorted (social price), pure chemical control for rice became the socially efficient system for the large farm.

Under the four alternative observed farm price solutions, herbicide-area diffusion averaged 75 percent of all farm area on the large farm, when the distorted price mix included either capital or labor price distortions (for 0 and 50 percent off-farm labor demand solutions). Only 7.5 percent of total area on the large farm was under chemical control when only output prices were distorted (Assumption C4). Under the 100 percent off-farm labor demand solutions, the privately and socially efficient weed control system for the rice enterprise on the large farm was chemical (92 percent of total area) regardless of price distortions present.

Weed Control Employment Effects of Price Distortions

Table VII-1 presents the classification of effects of price distortions based on the relative size of total weed control employment losses and gains induced by the alternative private price solutions when compared with the social price solutions.

Relatively large total weed control employment reductions (45 to 55 percent) occurred only under the 50 percent off-farm labor demand solutions, where capital price distortions were present alone or in combinations with output and labor price distortions. Relatively small weed control employment reductions occurred where either wage rates alone or output prices alone were distorted. No weed control employment reductions occurred under the 100 percent off-farm labor demand solutions, when either labor alone or output alone were at distorted prices. Total weed control employment gains occurred in all alternative policy mix that includes either all output-input price distortions, labor and capital price distortions, capital input price distortions, and output at distorted farm-gate prices.

These results tend to indicate that the presence of 100 percent off-farm labor demand induced total weed control employment equal to or relatively larger than the social price-employment solution.

Table VII-1. Classification of Effects of Distorted Prices by Size of Percentage Gains and Losses in Weed Control Employment under Alternative Off-Farm Labor Demand Assumptions.

Type of Effect	Type of Price Distortion[1/]		Percent Weed Control Employment Gains (+) or Losses (-)[2/]
	50% Off-Farm Labor Demand	100% Off-Farm Labor Demand	
1) Price distortions that induced relatively large weed control employment reductions	Assumptions: B, B1, B2, C, C1, C2 and C3	--	-45 to -55
2) Price distortions that induced relatively small weed control employment reductions	Assumptions: B3, B4 and C4	--	- 4 to - 5
3) Price distortions that induced no weed control employment reduction (i.e., identical with the social price solution)	--	Assumptions: B3, B4 and C3	0
4) Price distortions that induced weed control employment increases	--	Assumptions: B, B1, B2, C, C1, C2, and C4	+ 4 to +25

1/ Types of price distortions:

Government Price Assumptions:

B : all outputs and inputs at government prices

B1: labor and capital at government prices and outputs at social prices

B2: capital at government prices while output and labor at social prices

B3: labor at government price while outputs and capital at social prices.

B4: outputs at government prices while labor and capital at social prices

Observed Farm Price Assumptions:

C : all outputs and inputs at observed farm prices.

C1: labor and capital at observed farm prices and outputs at social prices.

C2: capital at observed farm prices while outputs and labor at social price.

C3: labor at observed farm prices while outputs and capital at social prices.

C4: outputs at observed farm-gate prices while labor and capital at social prices.

2/ Source of data: Tables VI-6, VI-7, VI-8, VI-9, and VI-10 (column 5).

In cases where weed control labor displacement occurred among the three labor-supplying households, it was usually the landless laborers who were displaced. Were it not for the availability of off-farm employment opportunities, the labor displacement effects of government policies and observed farm price distortions, particularly direct and indirect subsidies present alone or combined with output and labor price distortions, would further exacerbate the already impoverished economic conditions of the large masses of landless laborers in El Salvador.

Absolute and Relative Income Distribution Effects of Price Distortions

Comparisons of the private price solutions with the social price solutions suggest several interesting conclusions. Whenever a particular private price distortion induced total income gains for each of the four farm households, the large farm obtained the largest absolute income gain. This result was generally observed under the alternative government price solutions. On the other hand, when a particular private price distortion induced total income losses to each of the farm households, it was usually the large farm that obtained the biggest absolute income loss. This result was generally observed under the alternative observed farm price solutions. These results were expected because the large farm owned the largest portion of land

and capital resources, and incomes were positively associated with absolute size of resource holdings.

However, when the income gains or losses of each household were expressed in terms of percentage difference between their private price solutions and the corresponding social price solutions, a different picture emerged (Table VII-2). Whenever direct or indirect capital subsidies were present alone or in combination with output and/or labor subsidies, the three sized farms obtained larger relative total income gains while the landless laborers obtained relatively smaller income gains or in some cases total income losses. Whenever direct or indirect capital subsidies were present alone or in combination with labor and/or output price distortions the small and medium farms obtained relatively larger total income gains than the large farm. Relative total income gains or losses among the three sized farms tended to be equal or with relatively small differences whenever output prices alone were distorted. The small farm and landless laborers tend to obtain larger relative total income gains, and the medium and large farm with small income gains or losses, whenever only wage rates were distorted.

Efficiency Losses Induced by Price Distortions

By comparing the social resource costs of distorted price solutions with the corresponding resource costs of

Table VII-2. Classification of Effects of Distorted Prices by Size of Percentage Gains and Losses in Total Income of Each Household under Alternative Off-Farm Labor Demand Assumptions.

Type of Effect	Type of Price Distortion[1/] 50% Off-Farm Labor Demand	100% Off-Farm Labor Demand	Percentage Total Income Gains (+) or Losses (-)[2/]
1) Price distortions that induced large relative total income gains to the three sized farms and small income gains or losses to the landless laborers	Assumptions: B, B1, B2, B4, and C2	Assumptions: B, B1, B2, B4, and C2	Three sized farms: +10 to +67 Landless laborers: -84 to +10
2) Price distortions that induced larger relative total income gains to the medium and small farms and lower relative income gains to the large farm	Assumptions: B, B1, B2, B4, C1 and C2	Assumptions: B, B1, B2, C1 and C2	Small/medium farms: +16 to +67 Large farm: +4 to +39
3) Price distortions that induced equal relative total income gains or small difference in relative income gains or losses between the three sized farms and no income gain or small income loss to the landless laborers.	Assumption: B4 Assumption: C4	Assumption: B4 Assumption: C4	Three sized farms: +19 Landless Laborer: -3 Three sized farms: +13 to +19 Landless laborer: 0 Three sized farms: -18 to -22 Landless laborer: 0
4) Price distortions that induced larger total income gains only to the small farm and landless laborers; very small income gain or small income loss to the medium farm; and income losses to the large farm.	Assumption: B3, C and C3	Assumption: C3	Small farm and landless laborer: +5 to +29 Medium and large farms: -6 to +1

Table VII-2. (continued)

Type of Effect	Type of Price Distortion[1]		Percentage Total Income Gains (+) or Losses (-)[2]
	50% Off-farm Labor Demand	100% Off-farm Labor Demand	
5) Price distortions that induced no relative total income loss or income gains only to the landless laborers and income losses to the three sized farms		Assumptions: B3 and C	Landless laborer: +10 to +29 Three sized farms: -1 to -16

[1] For detailed description of alternative distorted price regimes, see footnote no. 1, Table VII-1.

[2] Source of data: Tables VI-6, VI-7, VI-8, VI-9 and VI-10 (column 4).

undistorted price solutions the relative efficiency losses induced by price distortions were estimated (Table VII-3). Relatively large efficiency losses were obtained by the medium and small farms, and relatively small efficiency losses by the large farm, whenever direct or indirect capital subsidies were present alone or in combination with output and/or labor price distortions. Relatively small efficiency losses or no efficiency losses were obtained by each of the size farms whenever either labor or output price distortion alone was present.

Net Social Costs of Price Distortions

By comparing the social resource costs of each distorted price solution with its corresponding private resource costs, the net social costs of price distortions were obtained (Table VII-4). The major conclusion derived from the total net social costs analysis was that relatively larger total net social costs were predicted whenever output price distortions were present alone or in combination with labor and/or capital price distortions. While relatively lower total net social costs were predicted whenever wage rate distortions were present alone or in combination with indirect capital subsidies.

In both the alternative government prices and observed farm price solutions, the large farm always obtained the

Table VII-3. Classification of Effects of Distorted Prices by Size of Percentage Efficiency Losses from Crop Production in Each Size Farm under Alternative Off-Farm Labor Demand Assumptions.

Type of Effect	Type of Price Distortion[1/] 50% Off-Farm Labor Demand	100% Off-Farm Labor Demand	Percent Efficiency Losses[2/]
1) Price distortions that induced relatively large efficiency losses to the small and medium farms and relatively small or no efficiency losses to the large farm	Assumptions: B, B1, B2, C, C1 and C2	Assumptions: B, B1, B2, C, C1 and C2	Small and medium farms: 12 to 41 Large farm: 0 to 2
2) Price distortions that induced very small efficiency losses or none to each of the three sized farms	Assumptions: B3, B4, C3 and C4	Assumptions: B3, B4, C3 and C4	-3[3/] to +0.8

[1/] For detailed description of alternative distorted price regimes, see footnote no. 1, Table VII-1.

[2/] Source of data: Tables VII-11 and VII-12 (columns 3 and 8).

[3/] Implies an efficiency gain.

Table VII-4. Classification of Effects of Distorted Prices by Size of Net Social Costs of Crop Production under Alternative Off-farm Labor Demand Assumptions.

Price Regime Assumption[1]		50 and 100 Percent Off-Farm Labor Demand[2] colon (¢)
1) Assumptions:	B and C	¢13,224 to ¢9,307
2) Assumptions:	B1, B2, B4 and C4	¢ 7,000 to ¢5,000
3) Assumptions:	C1 and C2	¢ 3,500 to ¢2,000
4) Assumptions:	B3 and C3	¢ 1,600 to ¢ 600

[1] For detailed description of alternative distorted prices see footnote no. 1, Table VII-1.

[2] Source of data: Tables VII-11 and VII-12 (columns 4 and 9).

largest share of total net social costs since it owned the biggest amount of land and capital resources.

Policy Implications

Limitations of Local Case Studies for Policy Evaluations

At the outset, it should be recognized that isolated case studies are not sufficient alone to determine the desirability of national policies. Expanding farm employment, attaining food grain self-sufficiency, and improving the income distribution in Central El Salvador are only three of the many objectives pursued by the government. These objectives might well be overridden by other desires. However, evaluating the consequences of government policies and observed farm price distortions in Central El Salvador may provide the needed incentives to assess their impact on other regions of the country. In addition, the analysis of local case studies can provide useful guidelines for designing more regionally specific policies or of devising offsetting policies to ease painful adjustments.

Policy Reforms and Suggested Areas for Government Intervention

As Young (1977) pointed out, countries which have let natural resource endowments dictate the phase and nature of technological change, have generally undergone the most successful agricultural development experiences. If the social optimum solutions (free market) were used as bases for policy evaluations, the following policy reforms and areas for government intervention should be considered.

Under the prevailing situation in Central El Salvador (50 percent off-farm labor demand assumption), an argument can be made for eliminating direct and indirect subsidies on capital inputs particularly herbicides since these policies tend to increase unemployment and exacerbate the already inequitable income distribution, and intensify resource misallocation. As previously indicated, a policy mix that includes direct and indirect capital subsidies induced large relative distributional income gains to the landholders (i.e., the three size farms) and income losses to the landless laborers - the least privileged group in the Salvadorean society. In addition, these policies induced relatively large efficiency losses to the three farm size types.

The two policies that tend to approximate the social optimal solutions are those where only wage rates were distorted and where only output prices were distorted. It is in these two policy areas where direct and/or indirect government intervention appears to induce minimum resource misallocation, and relative income and employment distributions that closely approximate the social optimal solution. Fixing farm wage has the least effect on resource allocation and net social costs requirements, while the relative income gains tended to favor the small farmers and landless laborers. This policy dovetails with the stated national objectives of increasing employment and improving relative income distribution (MAG, 1972).

The second most socially desirable government intervention policy would be in the area of subsidizing output prices and/or fixing output price levels. Resource misallocation appears to be relatively small and income-employment generation tends to approximate the social optimal solution. Although the total net social costs of this policy would be larger than when only wage rate was distorted, this policy would be consistent with the national objective of attaining self-sufficiency in basic grains since output price support would provide incentives for increasing grain production.

By freeing capital inputs from direct and indirect subsidies, the government can earn additional tax incomes which could well be spent on strengthening and improving the efficiency of government institutions that are directly engaged in promoting the modernization of the basic grain sector of El Salvador.

The third best policy is through the removal of direct and/or indirect subsidies on herbicide alone, while maintaining subsidies on improved seeds, fertilizers and pesticides, until the transition to modernized agriculture has stabilized in the basic grain sector. While this policy mix would induce some resource misallocation and increase net social costs, it would be consistent with the long-run national objective of modernizing the agricultural sector of El Salvador. In addition, capital favoring policies (on fertilizer, improved seeds and insecticides) excluding herbicides and mechanized farm machinery, have been found to increase labor requirement, and expand grain output by three to four fold in El Salvador (Cutie, 1975).

In conclusion, by liberating capital prices from policy induced distortions, particularly of herbicides and mechanized farm machinery, natural market forces could dictate the phase of technological change. This process should help sustain employment in the agricultural sector until alternatives are available elsewhere.

Research Planning Implications and Priority Areas

The breadth of this study was not adequate to determine full impacts of government policies on enterprise/weed control system choice and its associated distributional and efficiency effects. Research aimed at measuring the distributional impacts of new technology can be most fruitfully conducted by incorporating both the basic grain and export crop subsectors in the research model. It is in the large food grain farms and export crop plantation subsectors where labor-saving technology is most likely to be adopted on a wide scale. The most impoverished group in developing countries are the operators of subsistence farms and landless agricultural workers whose livelihood is primarily dependent on large food grain farms and plantations. This numerically important group is most vulnerable to technological displacement, but unfortunately often have been overlooked by researchers concerned primarily with commercial farmers.

In some areas the plantation and small farm/landless laborer sectors may be linked by seasonal migration of small farm labor/landless labor to plantations. This interrelationship should be recognized where it exists. In many situations, research and policies aimed at maintaining or improving seasonal plantation or non-agricultural employment of small farmers and landless laborers may have more bearing on their welfare than any marginal improvements in technology that might be recommended. For research aimed at assisting basic grain farmers, it is not sufficient to focus on a single preselected problem area such as weed control. In the basic grain sector of El Salvador, the weed control problem is amenable to solution with abundant farm labor. Other means appear more promising. For example, in the basic grain sector of El Salvador, possibilities for improving rural welfare include institutional reforms, improvement and/or development of input-output marketing system and infrastructures, and off-farm employment generation.

Results from this type of research can provide policy makers with the necessary guidelines for developing policy programs, guiding legislative enabling acts and program implementation through appropriate administrative channels. There is a need to link governmental regulatory programs with incentive programs which encourage development of private sector marketing facilities and institutions (including business oriented associations and cooperatives).

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APPENDIX

Table A-1. Predicted Income and Employment Effects of Alternative Government Policies under 50 Percent Off-Farm Labor Demand Assumption.

Item	Income				Employment			
	Net Crop Income (colon)	Weed Control Labor Earnings (colon)	Off-Farm Labor Earnings (colon)	Total Family Income (colon)	Weed Control Labor (man-days)	Off-Farm Employment (man-days)	Total Employment (man-days)	Total[1/] Variable Costs (colon)
Assumption - B: (output, labor, and capital at subsidized prices)								
1) Large Farm	38,091.75	--	--	8,091.75	-	--	--	17,733.10
2) Medium Farm	7,437.38	77.77	--	7,515.15	108.70	--	108.70	3,340.69
3) Small Farm	2,497.39	322.48	64.99	2,884.86	143.12	16.88	160.00	1,260.54
4) Landless Labor	--	164.09	6,306.76	6,470.85	42.62	1,638.12	1,680.74	--
All Households	¢ 48,026.52	¢ 564.34	¢ 6,371.75	¢ 54,962.61	294.44	1,655.00	1,949.44	¢ 22,334.33
Assumption - B1: (output at social prices; labor and capital at subsidized prices)								
1) Large Farm	32,941.95	--	--	32,941.95	--	--	--	17,333.10
2) Medium Farm	6,052.95	141.26	--	6,194.21	126.01	--	126.01	3,340.69
3) Small Farm	2,099.71	259.22	--	2,358.93	126.69	--	126.69	1,260.70
4) Landless Labor	--	161.24	6,371.75	6,532.99	41.88	1,655.00	1,696.88	--
All Households	¢ 41,094.61	¢ 561.72	¢ 6,371.75	¢ 48,028.08	294.58	1,655.00	1,949.58	¢ 22,334.33
Assumption - B2: (output and labor at social prices; capital at subsidized prices)								
1) Large Farm	33,489.57	--	--	33,489.57	--	--	--	17,212.53
2) Medium Farm	6,256.16	130.10	--	6,386.26	124.43	--	124.43	3,303.58
3) Small Farm	2,233.83	233.44	--	2,467.27	132.20	--	132.20	1,271.40
4) Landless Labor	--	352.31	5,792.50	6,144.81	100.66	1,655.00	1,755.66	--
All Households	¢ 41,979.56	¢ 715.85	¢ 5,792.50	¢ 48,487.91	357.29	1,655.00	2,012.29	¢ 21,787.51
Assumption - B3: (output and capital at social prices; labor at subsidized [minimum wage rate] price)								
1) Large Farm	27,094.99	--	--	27,094.99	--	--	--	22,957.06
2) Medium Farm	4,303.08	101.41	119.16	4,523.65	118.89	30.95	149.84	3,356.51
3) Small Farm	1,457.16	245.71	107.07	1,809.94	132.19	27.81	160.00	1,295.34
4) Landless Labor	--	1,428.20	6,145.52	7,573.72	370.96	1,596.24	1,967.20	--
All Households	¢ 32,855.23	¢ 1,775.32	¢ 6,371.75	¢ 41,002.30	622.04	1,655.00	2,277.04	¢ 27,608.91
Assumption - B4: (output at subsidized prices; labor and capital at social prices)								
1) Large Farm	32,985.63	--	--	32,985.63	--	--	--	22,258.18
2) Medium Farm	5,202.10	96.39	133.56	5,432.05	111.69	38.16	149.85	3,294.53
3) Small Farm	1,732.47	223.37	97.34	2,053.18	132.19	27.81	160.00	1,271.40
4) Landless Labor	--	1,294.16	5,561.61	6,855.77	369.96	1,589.03	1,958.79	--
All Households	¢ 39,920.20	¢ 1,613.92	¢ 5,792.51	¢ 47,326.63	613.64	1,655.00	2,268.64	¢ 25,674.08

[1/] Includes weed control labor costs.

Table A-2. Predicted Income and Employment Effects of Alternative Government Policies under 100 Percent Off-Farm Labor Demand Assumption.

Item	Income				Employment			
	Net Crop Income (colon)	Weed Control Labor Earnings (colon)	Off-Farm Labor Earnings (colon)	Total Family Income (colon)	Weed Control Labor (man-days)	Off-Farm Employment (man-days)	Total Employment (man-days)	Total 1/ Variable Costs (colon)
Assumption - B: (output, labor, and capital at subsidized prices)								
1) Large Farm	38,123.25	--	--	38,123.25	--	--	--	17,705.57
2) Medium Farm	6,979.74	67.76	192.50	7,240.00	100.00	50.00	150.00	3,312.57
3) Small Farm	2,497.39	280.28	107.42	2,885.09	132.10	27.90	160.00	1,260.69
4) Landless Labor	--	139.79	11,410.21	11,550.00	36.31	2,963.69	3,000.00	--
All Households	¢ 47,600.38	¢ 487.83	¢ 11,710.13	¢ 59,798.34	¢ 268.41	3,041.59	3,310.00	¢ 22,278.83
Assumption - B1: (output at social prices; labor and capital at subsidized prices)								
1) Large Farm	32,970.33	--	--	32,970.33	--	--	--	17,705.57
2) Medium Farm	6,036.85	115.04	145.22	6,297.11	112.28	37.72	150.00	3,312.57
3) Small Farm	2,099.71	233.00	154.69	2,487.40	119.82	40.18	160.00	1,260.69
4) Landless Labor	--	139.79	11,410.21	11,550.00	36.31	2,963.69	3,000.00	--
All Households	¢ 41,106.89	¢ 487.83	¢ 11,710.12	¢ 53,304.84	268.41	3,041.59	3,310.00	¢ 22,278.83
Assumption - B2: (output and labor at social prices; capital at subsidized prices)								
1) Large Farm	33,560.20	--	--	33,560.20	--	--	--	17,144.82
2) Medium Farm	6,256.16	130.10	89.50	6,475.76	124.43	25.57	150.00	3,305.58
3) Small Farm	2,160.54	186.27	165.97	2,512.78	112.58	47.42	160.00	1,260.69
4) Landless Labor	--	126.84	10,373.16	10,500.00	36.24	2,963.76	3,000.00	--
All Households	¢ 41,976.90	¢ 443.21	¢ 10,628.63	¢ 53,048.74	273.25	3,036.75	3,310.00	¢ 21,711.09
Assumption - B3: (output and capital at social prices; labor at subsidized [minimum wage rate] price)								
1) Large Farm	26,907.51	--	--	26,907.51	--	--	--	23,075.28
2) Medium Farm	4,284.76	92.17	161.35	4,538.28	108.09	41.91	150.00	3,324.17
3) Small Farm	1,457.16	156.00	196.77	1,809.93	108.89	51.11	160.00	1,295.34
4) Landless Labor	--	7.62	11,542.38	11,550.00	1.98	2,998.02	3,000.00	--
All Households	¢ 32,639.43	¢ 255.79	¢ 11,900.50	¢ 44,805.72	218.96	3,091.04	3,310.00	¢ 27,694.79
Assumption - B4: (output at subsidized prices; labor and capital at social prices)								
1) Large Farm	32,660.20	--	--	32,660.20	--	--	--	25,513.97
2) Medium Farm	5,202.10	13.79	216.69	5,432.58	88.09	61.91	150.00	3,294.70
3) Small Farm	1,732.49	211.82	108.89	2,053.18	128.89	31.11	160.00	1,271.40
4) Landless Labor	--	6.93	10,493.07	10,500.00	1.98	2,998.02	3,000.00	--
All Households	¢ 39,594.77	¢ 232.54	10,818.65	¢ 50,645.96	218.96	3,091.04	3,310.00	¢ 30,080.07

1/ Includes weed control labor costs.

Table A-3. Predicted Income and Employment Effects of Alternative Observed (distorted) Farm Prices under 50 Percent Off-Farm Labor Demand Assumption.

Item	Income				Employment			
	Net Crop Income (colon)	Weed Control Labor Earnings (colon)	Off-Farm Labor Earnings (colon)	Total Family Income (colon)	Weed Control Labor (man-days)	Off-Farm Employment (man-days)	Total Employment (man-days)	Total 1/ Variable Costs (colon)
Assumption - C: (output, labor and capital at distorted farm prices)								
1) Large Farm	22,929.81	--	--	22,929.81	--	--	--	21,534.75
2) Medium Farm	4,132.74	288.18	--	4,402.92	149.41	--	149.41	3,299.10
3) Small Farm	1,440.87	287.19	125.46	1,853.63	132.12	27.88	160.00	1,271.40
4) Landless Labor	--	206.62	7,322.04	7,528.66	55.16	1,627.12	1,682.28	--
All Households	¢ 28,503.53	¢ 781.99	¢ 7,447.50	¢ 36,733.02	336.69	1,655.00	1,991.69	¢ 26,105.25
Assumption - C1: (output at social price; labor and capital at observed [distorted] farm prices)								
1) Large Farm	28,941.55	-	--	28,941.55	--	--	--	21,534.75
2) Medium Farm	5,267.59	109.04	--	5,376.63	144.77	--	144.77	3,421.89
3) Small Farm	1,792.35	320.51	104.63	2,217.49	136.73	23.25	159.98	1,257.75
4) Landless Labor	--	242.79	7,342.88	7,585.67	55.21	1,631.75	1,686.96	--
All Households	¢ 36,001.49	¢ 672.34	¢ 7,447.51	¢ 44,121.34	336.71	1,655.00	1,991.71	¢ 26,214.14
Assumption - C2: (output and labor at social prices; capital at distorted farm prices)								
1) Large Farm	30,555.34	--	--	30,555.34	--	--	--	19,993.96
2) Medium Farm	5,306.88	84.81	--	5,391.69	144.77	--	144.77	3,421.89
3) Small Farm	1,792.35	252.84	81.38	2,126.57	136.74	23.25	159.99	1,257.75
4) Landless Labor	--	193.20	5,711.13	5,904.33	55.20	1,631.75	1,686.95	--
All Households	¢ 37,654.57	¢ 530.85	¢ 5,792.51	¢ 43,977.93	336.71	1,655.00	1,991.71	¢ 24,673.60
Assumption - C3: (output and capital at social prices; labor at observed [distorted] wage rate)								
1) Large Farm	25,931.00	--	--	25,931.00	--	--	--	24,006.55
2) Medium Farm	4,423.72	109.94	--	4,533.66	149.20	--	149.20	3,439.50
3) Small Farm	1,499.07	287.51	124.83	1,911.41	132.26	27.74	160.00	1,271.40
4) Landless Labor	--	242.82	7,322.67	7,565.49	53.96	1,627.26	1,681.22	--
All Households	¢ 31,853.79	¢ 640.27	¢ 7,447.50	¢ 39,941.56	335.42	1,655.00	1,990.42	¢ 28,717.45
Assumption - C4: (output at farm-gate [distorted] prices; labor and capital at social prices)								
1) Large Farm	21,820.97	--	--	21,820.97	--	--	--	22,258.18
2) Medium Farm	3,617.73	94.93	--	3,712.66	120.00	--	120.00	3,325.53
3) Small Farm	1,178.18	223.37	--	1,401.55	132.05	--	132.05	1,270.81
4) Landless Labor	--	1,296.12	5,792.50	7,088.62	370.32	1,655.00	2,025.32	--
All Households	¢ 26,616.88	¢ 1,614.42	¢ 5,792.50	¢ 34,023.80	622.37	1,655.00	2,277.37	¢ 26,855.52

1/ Includes weed control labor costs.

Table A-4. Predicted Income and Employment Effects of Alternative Observed (distorted) Farm Prices under 100 Percent Off-Farm Labor Demand Assumption

Item	Income				Employment			
	Net Crop Income (colon)	Weed Control Labor Earnings (colon)	Off-Farm Labor Earnings (colon)	Total Family Income (colon)	Weed Control Labor (man-days)	Off-Farm Employment (man-days)	Total Employment (man-days)	Total 1/ Variable Costs (colon)
Assumption C: (output, labor and capital at distorted farm prices)								
1) Large Farm	23,011.79	--	--	23,011.79	--	--	--	21,450.25
2) Medium Farm	4,254.42	39.78	225.00	4,519.20	100.00	50.00	150.00	3,318.99
3) Small Farm	1,379.37	325.69	102.42	1,807.56	137.24	22.76	160.00	1,244.24
4) Landless Labor	--	1.47	13,498.11	13,499.58	0.42	2,999.58	3,000.00	--
All Households	¢ 28,645.58	¢ 366.92	¢ 13,825.53	¢ 42,838.03	237.66	3,072.54	3,310.00	¢ 26,013.48
Assumption C1: (output at social prices; labor and capital at distorted farm prices)								
1) Large Farm	29,023.53	--	--	29,023.53	--	--	--	21,450.25
2) Medium Farm	5,189.28	37.98	225.00	5,452.26	100.00	50.00	150.00	3,318.99
3) Small Farm	1,767.89	325.54	102.60	2,196.03	137.20	22.80	160.00	1,244.24
4) Landless Labor	--	1.94	13,498.06	13,500.00	0.43	2,999.57	3,000.00	--
All Households	¢ 35,980.70	¢ 365.46	¢ 13,825.66	¢ 50,171.82	237.63	3,072.37	3,310.00	¢ 26,013.48
Assumption C2: (output and labor at social prices; capital at distorted farm prices)								
1) Large Farm	30,562.28	--	--	30,562.28	--	--	--	19,984.49
2) Medium Farm	5,228.57	99.54	105.00	5,433.11	120.00	30.00	150.00	3,318.99
3) Small Farm	1,767.61	197.96	150.22	2,115.79	117.08	42.92	160.00	1,244.24
4) Landless Labor	--	1.50	10,498.50	10,500.00	0.43	2,999.57	3,000.00	--
All Households	¢ 37,558.46	¢ 299.00	¢ 10,753.72	¢ 48,611.18	237.51	3,072.49	3,310.00	¢ 24,547.72
Assumption C3: (output and capital at social prices; labor at observed [distorted] wage rate)								
1) Large Farm	25,944.09	--	--	25,944.09	--	--	--	23,980.27
2) Medium Farm	4,371.64	26.64	280.22	4,678.50	87.73	62.27	150.00	3,294.53
3) Small Farm	1,499.09	272.34	140.00	1,911.41	128.89	31.11	160.00	1,271.30
4) Landless Labor	--	7.14	13,490.82	13,497.96	2.04	2,997.96	3,000.00	--
All Households	¢ 31,814.80	¢ 306.12	¢ 13,911.04	¢ 46,031.96	218.66	3,091.34	3,310.00	¢ 28,546.10
Assumption C4: (output at farm-gate [distorted] prices; labor and capital at social prices)								
1) Large Farm	21,488.06	--	--	21,488.06	--	--	--	22,513.97
2) Medium Farm	3,616.10	26.88	176.30	3,819.28	99.63	50.37	150.00	3,294.53
3) Small Farm	1,178.18	209.69	112.91	1,500.78	127.74	32.26	160.00	1,274.30
4) Landless Labor	--	--	10,500.00	10,500.00	--	3,000.00	3,000.00	--
All Households	¢ 26,282.34	¢ 236.57	¢ 10,789.21	¢ 37,308.12	227.37	3,082.63	3,310.00	¢ 27,079.80

1/ Includes weed control labor costs.

Table A-5. Typical Example of Costs and Returns Schedule: Corn Hybrid/ Beans Hybrid - Mixed Chemical/Manual Weed Control.

Item	Price Assumption		
	A[1]	B[2]	C[3]
	(colones per hectare)		
I. Gross Returns	2,828.52	3,104.54	2,515.70
II. Variable Costs			
A. Materials used:			
Seed	166.53	148.98	166.53
Fertilizers	503.19	320.60	402.51
Insecticides	378.82	236.98	307.77
Herbicide	77.50	48.52	63.00
B. Labor[4]			
Family labor	382.73	421.00	382.73
Hired labor			
Animal labor owned	35.44	35.44	35.44
Animal labor hired			
C. Custom work			
Seedbed preparation			
Herbicide incorporation	52.70	32.14	42.85
D. Rents			
Land rental	131.25	131.25	131.25
Equipment rental	6.84	6.84	6.84
Sprayer rental	2.50	1.50	2.00
E. Repairs and maintenance of equipment	10.00	10.00	10.00
F. Contingencies (5% of A, C, E)	59.44	39.86	49.13
G. Interest on operating capital	93.61	31.39	58.04
Total Variable Costs (sum of II)	¢1,900.55	¢1,464.50	¢1,658.09
III. Net Returns to Weed Control and Management (I-II)	¢1,248.18	¢1,640.04	¢1,031.79

[1] All outputs and inputs at social prices.

[2] All outputs and inputs at government prices.

[3] All outputs and inputs at observed farm prices.

[4] Excludes weed control labor costs.

Table A-6. Yield, Product Price and Gross Returns per Hectare.

	Unit Price (¢/kg)			Yield/ ha kg.	Gross Returns (¢/ha)		
	A[1]/	B[2]/	C[3]/		A[1]/	B[2]/	C[3]
Small and Medium Farms							
Corn Hybrid	0.37	0.40	0.33	3,910	1,446.67	1,564.00	1,290.30
Corn Native	0.37	0.40	0.33	1,314	486.18	525.60	433.62
Beans Hybrid	1.24	1.38	1.10	1,380	1,711.20	1,904.40	1,518.00
Beans Native	1.24	1.38	1.10	591	732.84	815.58	650.10
Coffee (medium farm only)	2.17	2.17	2.17	1,314	2,851.38	2,851.38	2,851.38
Sorghum Hybrid	0.33	0.34	0.31	3,220	1,062.60	1,094.80	998.20
Corn Hybrid-Beans Hybrid							
Corn Hybrid	0.37	0.40	0.33	3,680	1,361.60	1,472.00	1,214.40
Beans Hybrid	1.24	1.38	1.10	1,183	1,466.92	1,632.54	1,301.30
					2,828.52	3,104.54	2,515.70
Beans Native-Corn Hybrid							
Beans Native	1.24	1.38	1.10	591	732.84	815.58	650.10
Corn Hybrid	0.37	0.40	0.33	3,680	1,361.60	1,472.00	1,214.40
					2,094.44	2,287.58	1,864.50
Beans Native-Corn Native							
Beans Native	1.24	1.38	1.10	591	732.84	815.58	650.10
Corn Native	0.37	0.40	0.33	1,183	437.71	473.20	390.39
					1,170.55	1,288.78	1,040.49
Corn Hybrid-Sorghum Native							
Corn Hybrid	0.37	0.40	0.33	3,680	1,361.60	1,472.00	1,214.40
Sorghum Native	0.33	0.34	0.31	1,643	542.19	558.62	509.33
					1,903.79	2,030.62	1,723.73
Corn Native-Sorghum Native							
Corn Native	0.37	0.40	0.33	1,051	388.87	420.40	346.83
Sorghum Native	0.33	0.34	0.31	1,183	390.39	402.22	366.73
					779.26	822.62	713.56

Table A-6. (continued)

	Unit Price (¢/kg)			Yield/ ha kg.	Gross Returns (¢/ha)		
	A[1]	B[2]	C[3]		A[1]	B[2]	C[3]
Large Farm							
Corn Hybrid	0.37	0.40	0.33	4,600	1,702.00	1,840.00	1,518.00
Rice Hybrid	0.58	0.64	0.51	4,600	2,668.00	2,944.00	2,346.00
Beans Hybrid	1.24	1.38	1.10	1,610	1,996.40	2,221.80	1,771.00
Sorghum	0.33	0.34	0.31	3,943	1,301.19	1,340.62	1,222.33

1/ Social price (i.e., commercial market price, 1975-76 average).

2/ Government subsidized prices (1975-76 support price level).

3/ Observed farm-gate prices (1975-76 average).

Table A-7. Seeding Rate and Price Assumptions.

Crop/Variety	Seeding Rate (kg/ha)	Price Assumptions A1/ (¢/kg)	Price Assumptions B2/ (¢/kg)	Price Assumptions C3/ (¢/kg)	Costs/ha (¢) A1/ (¢)	Costs/ha (¢) B2/ (¢)	Costs/ha (¢) C3/ (¢)
Corn Hybrid	19.5	1.74	1.56	1.74	33.93	30.42	33.93
Corn Native	19.5	0.41	0.41	0.41	8.00	8.00	8.00
Beans Nybrid	78.0	1.70	1.52	1.70	132.60	118.56	132.60
Beans Native	78.0	1.08	1.08	1.08	84.24	84.24	84.24
Rice Hybrid	130.0	1.47	1.30	1.47	191.11	169.00	191.11
Sorghum Hybrid	16.0	1.22	1.09	1.22	19.52	17.44	19.52
Sorghum Native	16.0	0.50	0.50	0.50	8.00	8.00	8.00

1/Retail market price. Source: Market Survey, 1975-76.

2/Government produced hybrid seed price. Source: Agricultural Development Bank (BFA).

3/Retail market price. Average farm survey price and market survey price, 1975-76.

Note: Native seed varieties are usually produced by farmers themselves (selected seeds from previous years' harvest). Source: Farm survey average price.

Table A-8. Fertilizer Application Rates and Price Assumptions.

	Quintals[1/] per Hectare	Price Assumptions A[2/] (¢/qq)	B[3/] (¢/qq)	C[4/] (¢/qq)	Costs/Hectare (¢) A[1/]	B[2/]	C[3/]
1) Corn Hybrid							
21-0-0 (N-P-K)	6	31.88	20.37	25.50	191.28	122.22	153.00
20-20-0 (N-P-K)	3	46.88	30.00	37.50	140.64	90.00	112.50
Total					331.92	212.22	265.50
2) Rice Hybrid							
21-0-0	3	31.88	20.37	25.50	95.64	61.11	76.50
20-20-0	2	46.88	30.00	37.50	93.76	60.00	75.00
Total					189.40	121.11	151.50
3) Sorghum Hybrid							
21-0-0	6	31.88	20.37	25.50	191.28	122.22	153.00
20-20-0	3	46.88	30.00	37.50	140.64	90.00	112.50
Total					331.92	212.22	265.50
4) Beans Hybrid							
Foliar	2.86/liter	10.71/liter	6.48/liter	8.57/liter	30.63	18.38	24.31
20-20-0	3	46.88	30.00	37.50	140.64	90.00	112.50
Total					171.27	108.38	137.01
5) Coffee							
21-0-0	6	31.88	20.37	25.50	191.28	122.22	153.00
20-20-20	6	46.88	30.00	37.50	281.28	180.00	225.00
Total					472.56	302.22	378.00

1/ One quintal (qq) = 46 kilograms

2/ Social price: Retail market price plus net subsidy, 1975-76 average.

3/ Government subsidized price: Source: Agricultural Development Bank (BFA), 1975-76 average.

4/ Retail market price paid by farmers. Source: Average of farm survey and market survey, 1975-76.

Table A-9. Pesticide Application Rates and Price Assumptions.

Crop/Variety/Pesticide		Qty/ha[1/]	Price Assumptions A[2/] (¢/ha)	B[3/] (¢/ha)	C[4/] (¢/ha)
1) Corn Hybrid					
Herbicides					
EPTC		2 kg	44.90	28.11	36.50
Atrazine		1 kg	32.60	20.41	26.50
	Total		77.50	48.52	63.00
Pesticides					
Volaton 2.5%		66 kg	83.03	51.90	67.40
Dipterex 95%		1.43 kg	34.30	21.48	27.89
Lannate		0.65 kg	52.77	33.03	42.90
	Total		170.10	106.41	138.19
2) Rice Hybrid					
Herbicides					
Propanil		2.0 kg	65.09	40.75	52.92
2,4,5-T		0.5 kg	18.45	11.55	15.00
	Total		83.54	52.30	67.92
Pesticides					
Volaton 2.5%		66 kg	83.03	51.90	67.40
Lannate		0.65 kg	52.77	33.03	42.90
Dipterex 95%		1.43 kg	34.30	21.48	27.89
Dithane m-45		1.30 kg	16.43	10.29	13.36
	Total		186.53	116.70	151.55
3) Beans Hybrid					
Herbicides					
EPTC		1.50 kg	33.83	21.18	27.50
Linuron		0.5 kg	13.53	8.47	11.00
	Total		83.03	51.90	67.40
Pesticides					
Volaton 2.5%		66 kg	83.03	51.90	67.40
Folidol		16 kg	21.97	13.75	17.86
Lannate		0.65 kg	52.77	33.03	42.90
Diflotan		0.65 kg	21.11	13.21	17.16
Ortho B		6.50 kg	1.72	1.08	1.40
Afrecho		26.0 kg	28.12	17.60	22.86
	Total		208.72	130.57	169.58
4) Sorghum Hybrid					
Volaton 2.5%		66 kg	83.03	51.90	67.50
Dipterex 95%		1.43 kg	34.30	21.48	27.89
Lannate		0.65 kg	52.77	33.03	42.90
	Total		170.10	106.41	138.29

[1/] Recommended rates are from Ministry of Agriculture (MAG) and OSU/USAID Weed Control Project in El Salvador.

[2/] Social Prices: Retail market price plus net subsidy (1975-76 average)

Table A-9. (continued)

3/ Government subsidized prices (1975-76 average)

4/ Average of observed farm prices paid (farm survey) and retail market price (1975-76)

Table A-10. Typical Schedule for Crop-Labor Requirement: Corn hybrid/ Bean hybrid - Mixed Chemical/Manual Weed Control.

Requirements	Man Days	Animal Days	Weed Control Labor		Date of Weeding
			Man	Animal	
1st Crop (May): Corn Hybrid					
Land clearing	11.44				
Plowing	2.86	5.72			
Harrowing					
Herbicide (pre-emergence) (custom work)					May
Furrowing	1.43	2.86			
Seeding & fertilization	2.86				
1st appl. of insecticide	2.86				
1st cultivation					
2nd appl. of insecticide					
Weeding (spraying)			2.0		May
2nd fertilization	1.43				
2nd cultivation			2.86	5.72	June
Bird pest control					
Bending corn stalk	3.69				
Weeding			12.86		July
2nd Crop Seeding/Fertilizing: Beans Hybrid	8.58				
Appl. of insecticide	5.72				
Weeding			12.86		Aug.
Fertilization	1.79				
Harvesting (corn)	7.50				
Husking (corn)	10.0				
Drying, shelling, sacking (corn)	6.87				
Pulling plants (beans)	18.3				
Drying, shelling, winnowing (beans)	19.45				
Internal transport	1.71	3.42			
Total	109.35	12.00	30.58	5.72	

Table A-11. Total Crop-Labor Requirements and Costs per Hectare Excluding Weed Control Labor.

	Weed Control System	Total Man Labor (man-days/ha)	Total Animal Labor (A-days/ha)	Labor/Animal Costs/Hectare (¢) A[1/] (¢)	B[2/] (¢)	C[3/] (¢)
Small and Medium Farms[4/]						
Corn hybrid	manual	64.98	22.93	273.29	296.03	273.29
Corn hybrid	herbicide	62.12	16.76	250.94	272.68	250.94
Beans hybrid	manual	60.76	22.88	258.42	279.69	258.42
Beans hybrid	herbicide	57.9	14.30	231.25	251.52	231.25
Corn native	manual	40.13	12.85	166.16	180.20	166.16
Beans native	manual	39.94	8.58	156.95	170.93	156.95
Sorghum hybrid	manual	60.74	20.02	252.63	273.89	252.63
Corn hybrid/Beans hybrid	manual	110,78	26.30	440.33	479.10	440.33
Corn hybrid/Beans hybrid	herbicide/man	109.35	17.72	418.17	456.44	418.17
Beans native/Corn hybrid	manual	94.63	31.46	394.13	427.25	394.13
Beans native/Corn hybrid	man/herbicide	93.09	15.72	372.70	405.28	372.70
Beans native/Corn native	manual	79.37	14.29	306.38	334.15	306.38
Corn hybrid/Sorghum native	manual	74.08	26.30	311.88	337.81	311.88
Corn hybrid/Sorghum native	herbicide/man	71.23	17.72	284.75	309.68	284.75
Coffee	manual	74.85	2.13	266.33	322.37	341.83
Large Farm						
Corn hybrid	manual	49.25	13.90	200.18	217.41	249.43
Corn hybrid	herbicide	44.13	11.04	176.54	191.88	220.67
Rice hybrid	manual	65.29	5.02	238.56	261.41	303.85
Rice hybrid	herbicide	65.29	5.02	238.56	261.41	303.85
Beans hybrid	manual	43.60	11.44	175.48	190.74	219.08
Beans hybrid	herbicide	43.60	11.44	175.48	190.74	219.08
Coffee	manual	74.85	2.13	266.23	322.37	341.09

[1/] Social price: market clearing wage rate (¢3.50/day).
[2/] Government price: legal minimum wage rate (¢3.85/day).
[3/] Observed farm price: small and medium farms - ¢3.50/day; large farm - ¢4.50/day.
[4/] The small farm is constrained to double cropping enterprises only.

Table A-12. Wage Rate, Interest Rate and Custom Service Price Assumptions.

Item	Price Assumptions A[1/] (¢)	B[2/] (¢)	C[3/] (¢)
I. Daily Wage Rate (8-hour day)			
Small Farm	3.50	3.85	3.50
Medium Farm	3.50	3.85	3.50
Large Farm	3.50	3.85	4.50
Off - Farm Employment	3.50	3.85	4.50
Animal Labor/Day	2.00	2.00	2.00
II. Interest Rate (%/Annum)			
Small Farm	10.0	5.0	7.5
Medium Farm	10.0	5.0	7.5
Large Farm	10.0	7.5	7.5
III. Custom Services			
Tractor Seedbed Preparation			
Plowing (1 pass/ha)	70.29	42.86	57.15
Disking (1 pass/ha)	52.70	32.14	42.85
Backpack sprayer rental (per day)	1.25	0.75	1.00

1/ Social Prices:
wage rate: average market rate (farm survey and market survey data)
interest rate: average market rate (1975-76)
custom plowing and sprayer rental: observed farm price plus net subsidy.

2/ Government Prices:
wage rate: minimum wage law as of Oct. 21, 1974 for agricultural sector. (Source: Ministry of Labor and Social Security Institute).

interest rate: government subsidized rate for basic grain farms.
custom services: subsidized rate

3/ Observed Farm Wage Rate Variations (from farm survey data):
a) for medium and large farms the basic cash wage is ¢3.00/day plus food wage of ¢0.50 and ¢1.50, respectively.
b) for off-farm employment: average wage rate for export crops sector, as of Oct. 21, 1974 (Ministry of Labor).
interest rate: observed farm rate (from farm survey data).
custom services: observed farm rate (from farm survey data).

Table A-13. Effective Subsidy Rates on Farm Inputs and Services.

Item	Percent Subsidy
Commercial fertilizer[1/]	25
Insecticides and other pesticides[2/]	23
Herbicides[2/]	23
Farm machinery and equipment services	
Backpack sprayer[3/]	25
Tractor services[4/]	23

	(%)
[1/] Duties on all goods:	30
Less: duty on fertilizer	- 5
Net subsidy	25

[2/] Duties on all goods:	30
Less: duty on pesticides	- 7
Net subsidy	23

[3/] Duties on all goods:	30
Less: duty on sprayers	- 5
Net subsidy	25

[4/] Duties on all goods:	30
Less: duty on tractors. . .	- 7
Net subsidy	23