INCENTIVES FOR FOOD CROP PRODUCTION IN TANZANIA: WITH SPECIAL REFERENCE TO THE MBEYA REGION

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by

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ABSTRACT

The objectives of this study were to determine the potential impacts of a) increased output prices, b) reduction of input costs, and c) improved technology on increasing food production, specifically marketable surplus in the Mbeya region of Tanzania.

A linear programming model was used to maximize net farm incomes given variable costs by comparison of two sets of technology, namely, Technology Set I and Technology Set II. Technology Set I (existing production conditions) is a proxy for traditional agriculture, and an inverse of the improved one. Technology Set II (improved production conditions) represents technology that has been determined to be physically possible in research trials for the region. It is assumed to be profitable and technically feasible but as yet it has not been adopted in the region by food producers.

Production activities under traditional technology entered the plan and a number of bottlenecks in the form of land preparation, weeding, and harvesting labour were encountered. Parametric programming, a post optimal analysis,

was used to see the impact of increased prices from current government price levels, reduced input costs, and improved technology.

Some agricultural economists have recommended increased output prices for food producers in order to stimulate an increased level of food production. In a labour surplus, hand hoe technology oriented economies, output prices paid to food producers affects total output up to a level dictated by physical and technical factors. Crude tool technology creates physical constraints upon the supply of food and limits the production capacity.

The study has indicated that little or no additional food production is likely to be forthcoming in the short run due to labour shortages at specific times for key activities during crop year, e.g., weeding, harvesting, etc. There is no single policy which is necessary and sufficient for increased food production and, hence, marketable surplus. However, in order to obtain sustained increases in food production in the region, it is necessary first to introduce bottleneck-breaking technology which will perform better than crude tool technology, now being used. Only after doing this will increased output prices have a positive impact on the level of food production and, hence, marketable surplus.

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CHAPTER I

THE FOOD PROBLEM IN TANZANIA

Most African countries have been experiencing negative rates of growth of agricultural output since the 1970s. Average annual growth rates of food production in most of these countries have not exceeded their population growth rates. In 1981, the U.S. Department of Agriculture pointed out that sub-Saharan Africa was the only region of the world where per capita food production declined over the past two decades.[1] Many of these countries, which were formerly self-sufficient in food, have increased substantially the ratio of food imports to total food production. This deterioration to the point of an agrarian crisis is sometimes called 'Africa's Food Crisis.'[2]

In 1981, per capita food production in Africa was only 86 percent of its 1969-71 level.[3] The volume and the cost of food imports soared in the 1970s. General imports rose more than 300 percent (from 2.3 million metric tons in 1970 to 8.6 million metric tons in 1980) while import costs rose more than 600 percent to $2.1 billion in 1980.[4] However, due to rapid worldwide inflation during this period, the cost increase in constant dollars was not nearly as great. Reliance on food aid had increased to some 1.5 million tons in 1980-81.[5]

An analysis of food aid needs in low income countries indicated that in 1981-82 sub-Saharan Africa would require some 2.7 million tons of food above commercial purchases to sustain recent consumption levels. Approximately 9.8 million tons of food would have been required to bring diets to minimally adequate levels.[6] The continent's chances of becoming self-sufficient in food production by the year 2000 are very limited. Thirty-seven low income countries in Africa suffer from chronic food shortages.

The complete stagnation, if not decline, in agricultural yields, and the high rate of population and urbanization growth have basically led to the situation. Ten cities in Africa now have more than 500,000 inhabitants, compared to one in 1960, Kinshasa, the Zaire capital. On the average, 3.7 farmers fed one city dweller 30 years ago, compared with two farmers in 1975, and according to forecasts, one in the year 2000.[7]

Tanzania: General Background

Tanzania has a population of approximately 21 million people with an annual natural increase of 3.2 percent. It has an area of 362,688 square miles, which includes 19,982 square miles of inland waters. The country extends from $1^{o}S$ to $12^{o}S$ and $30^{o}D$ to $39^{o}E$ in sub-Saharan East Africa.

Economically, the country is characterized by a low level of per capita income and gross domestic product. The figures for 1983 were $249 and $4,750 million, respectively.[8]

This places the country in the least developed category, according to the World Bank.

Agriculture is the mainstay of the economy and it accounts for about 40 percent of gross domestic product. The sector provides 80 percent of the country's commodities for export. Over 80 percent of the population is employed in agriculture. Approximately 18.1 million people are in rural areas, compared to 3.3 million in urban areas.[9] Agricultural production has failed to keep pace with the rate of population growth, making the country a net importer of food. The indices of production show that the per capita agriculture and per capita food production were both eighty-four for 1982, with the 1969-71 base period equal to one hundred.[10] Hence, during the prior ten years, food production per capita decreased. Weather and institutional constraints have contributed a great deal to this decline.

Inadequate Food Crop Production

Tanzania's food production has declined resulting in a considerable import bill. The unavailability of substantial foodstuffs for extended periods, especially in urban areas, and the strong imbalance between growth in the food supply and population growth describes the major problems for the Tanzania food crop sub-sector. Performance of the food production sector has not been satisfactory for some time, especially the last four years.

During 1981-82, food demand in the country was estimated at 660,000 tons. However, there was a shortfall of 270,000 tons, worth Shs. 700 million, for the period ending June 1982.[11]

In 1982-83, the government had to again import food grain. The government's projected food production target (maize, rice, and wheat) was estimated to be 527,000 tons. Domestically, 135,400 tons were produced, a short-fall of 391,600 tons. Tables 1.1, 1.2, and 1.3 show the country's food requirements through imports and Table 1.4 shows regional estimates of marketable surplus. Food insufficiency clearly is a high priority problem for the country. The problem for this inquiry, therefore, is how can the country generate a marketable surplus of food grain.

A distinction needs to be made between marketable surplus and marketed surplus. Marketable surplus represents the surplus available for the disposal with the producer, left over after his own uses of family consumption, feed, seed, and wastage have been met. Marketed surplus represents only that portion of the marketable surplus which is actually marketed and is placed at the disposal of non-producers.[13] John Stuart Mill sees the difference between gross product and what is required to support those involved in the production as the marketable surplus.[14]

Table 1.1

TANZANIAN MAIZE IMPORTS AND EXPORTS
1975-76 to 1981-82
(1,000 tons)

Year	Imports Commercial	Imports Aid	Imports Total	Exports	Trade Balance	Gross Imports (Shs. M)
1975/76	79.5	27.0	106.5	-	(106.5)	107
1976/77	34.6	7.0	41.6	-	(41.6)	57
1977/78	-	34.3	34.3	-	(34.3)	44
1978/79	-	-	-	49.0	49.0	-
1979/80	32.5	-	32.5	28.0	(4.5)	50
1980/81	188.1	86.5	274.6	-	274.6	452
1981/82	14.5	217.1	231.6	-	231.6	369

Notes: Imports and exports are here recorded on National Milling Corporation purchasing year basis, i.e., June 1-May 31.

SOURCE: The United Republic of Tanzania: Ministry of Agriculture. Price Policy Recommendations for the July 1982 Agricultural Price Review Annex 1, Maize, Rice, and Wheat. (Prices for 1983/84 marketing season.) Marketing Development Bureau, Dar-es-Salaam, July 1982 R 1/82.

Table 1.2

QUANTITY AND VALUE OF TANZANIAN RICE IMPORTS
1975-76 to 1981-82
(1,000 Tons, Shs. Million)

YEAR	COMMERCIAL IMPORTS Quantity	COMMERCIAL IMPORTS Value	AID IMPORTS Quantity	AID IMPORTS Value	TOTAL Quantity	TOTAL Value
1975/76	20.8	69.2	-	-	20.8	69.2
1976/77	5.3	11.3	-	-	5.3	11.3
1977/78	26.5	N/A	21.6	N/A	48.1	112.6
1978/79	21.0	N/A	20.2	N/A	41.2	122.8
1979/80	4.6[a]	N/A	50.1	N/A	54.7	187.0
1980/81	14.2[b]	N/A	51.0	N/A	65.2	271.8
1981/82	-	-	66.5	304.9	66.5	304.9

[a]Exchanged for 9000t Tanzanian Maize through World Food Program.

[b]Exchanged for 28000t Tanzanian Maize through USAID.

SOURCE: Marketing Development Bureau, Dar-es-Salaam, July 1982
R 1/82.

Table 1.3

QUANTITY AND VALUE OF TANZANIAN WHEAT AND FLOUR IMPORTS
1975-76 to 1981-82
(1,000 tons wheat flour; Shs. Million)

	COMMERCIAL IMPORTS		AID IMPORTS		TOTAL	
YEAR	Quantity	Value	Quantity	Value	Quantity	Value
1975/76	14.5	N/A	45.7	N/A	60.2	80.8
1976/77	-	-	33.6	38.4	33.6	38.4
1977/78	-	-	40.5	37.7	40.5	37.7
1978/79	15.8	N/A	45.5	N/A	61.3	78.7
1979/80	-	-	32.5	59.6	32.5	59.6
1980/81	-	-	48.7	107.4	48.7	107.4
1981/82	-	-	70.9	138.9	70.9	138.3

SOURCE: Marketing Development Bureau, Dar-es-Salaam, July 1982
R 1/82.

Table 1.4

REGIONAL ESTIMATES OF MARKETABLE SURPLUSES OF MAIZE IN TANZANIA FOR THE 1982-83 MARKETING YEAR ('000 MT)

	Net Production	Rural Consumption	Marketable Surplus[1]	Rural Deficit[2]
Dodoma	19.0	26.0	0.0	-7.0
Arusha	123.9	84.9	39.0	0.0
Kilimanjaro	70.7	44.8	25.9	0.0
Tanga	151.5	123.3	28.2	0.0
Morogoro	91.4	120.4	0.0	-29.0
Coast	34.6	30.0	4.6	0.0
Lindi	17.3	35.4	0.0	-18.1
Mtwara	25.5	27.9	0.0	-2.4
Ruvuma	113.9	75.3	38.6	0.0
Iringa	252.1	209.7	42.4	0.0
Mbeya	189.2	133.7	55.5	0.0
Singida	22.8	91.1	0.0	-68.3
Tabora	57.5	119.7	0.0	-62.2
Rukwa	207.9	92.9	115.0	0.0
Kigoma	38.2	33.4	4.8	0.0
Shinyanga	113.3	101.8	11.5	0.0
Kagera	38.7	38.6	0.1	0.0
Mwanza	27.6	75.8	0.0	-48.2
Mara	58.5	3.8	54.7	0.0
Tanzania	1,653.6	1,468.5	420.3 (25.4%)[3]	-235.2

[1]Net production less rural consumption. If rural consumption exceeds net production, marketable surplus is taken to be zero.

[2]Net production less rural consumption for those regions in which the latter exceeds the former; zero in all other regions.

[3]Marketed surplus as percentage of net production.

SOURCE: Sigma One Corporation.

The Traditional Nature of Agriculture in Food Production

Tanzania's agriculture, especially its food crop production, is mainly characterizied by traditional agriculture. Subsistence production dominates. Farms are geared essentially to produce farm family food requirements. With low levels of production, consumption/survival considerations over-rule commercial ones in decision-making for most individual producers. The objective function of each producer is, therefore, to minimize the risk of crop failure in terms of family subsistence requirements.

The traditional nature of the food crop sub-sector in Tanzania distinguishes itself from a modern progressive one in the sense that a progressive high productivity agriculture utilizes a wide range of inputs, many of which are highly complementary to each other. These include conventional inputs such as land, labor, and certain forms of capital. Other complementary inputs represent forms less conventionally noted by agriculturalists and economists. These are largely of a technical, educational, and institutional sort. The degree of representation of these latter inputs distinguishes a modern agriculture from a traditional one.[15]

Family labor and land are the basic factors of production in the traditional production process in Tanzania. The level of production, i.e., the family's output, is therefore largely a function of the size of the family's land base and the number of family members working on the farm. Farm sizes are small. Over 80 percent of the land holdings are less than, or equal to, two hectares.

Ghai, et al., note that in Tanzania crop yields and production have continued to be low. Land and labor resources are under-utilized. Commitment to collective undertakings is generally low and non-farm communal activities have not grown rapidly.[16] Hence, a number of reasons appear to exist to explain the low productivity of Tanzanian traditional agriculture. One that deserves special attention is technology.

Levels of Technology

Producers utilize low levels of technology on farms in Tanzania. Despite the strong need for modernized agriculture for sound economic development, in the majority of cases agriculture is carried on according to the traditional practices, without the advantage of modern knowledge or modern tools. The handhoe, bush knife, and axes – all hand tools – still dominate the production methods. These farm implements have not enabled producers to bring more land under cultivation for food production. Of the given total cultivable land, 39 million hectares, only six million hectares, or 15.4 percent of cultivable land is under production.[17]

For example, a handhoe enables a producer to cultivate only two hectares of land per year while the same area can be cultivated in five days or one day using animal power or a small tractor, respectively. Animal power is used on 10 percent of the cultivated area while only 5 percent of the land is cultivated using tractors. The inability of the country to supply farming inputs and implements portrays a supply problem which directly affects producers' operations. In 1982-83, of the needed 4.8 million handhoes, 70,000 plows, 3,300 new tractors, 5,995 tons of better seed, and 191,913 tons of fertilizers; only 1.6 million handhoes, 16,500 plows, 3,720 tons of seed, 81,295 tons of fertilizers, and 198 tractors were available.[18]

Income Levels

Low farm income levels have been a characteristic feature of traditional producers. Low farm incomes have been associated with poor standards of living. The Tanzanian Country Development Strategy Statement, prepared by USAID in 1982, indicated the following:

1. On the average, annual income per holding from export crops is approximately 775 Tz. Shs. which is equivalent to U.S. $64.50,

2. Annual average income per holding from major food crops is approximately Tz. Shs. 750 which is equivalent to U.S. $62.50,

3. Average return to labor for export crops per day is approximately Tz. Shs. 7.81 which is equivalent to U.S. $0.65,

4. Average return to labor for major food crops is approximately Tz. Shs. 9.5, which is equivalent to U.S. $0.79, and

5. Equivalent average monthly wage rates of heads of holdings is approximately Tz. Shs. 415 per month. This is equivalent to U.S. $34.50.[19]

With such low incomes, producers' latitude for decision-making is limited. Investment in high income payoff activities such as fertilizers and the use of better seeds, etc., is limited. Credit is not adequate and productive technology has not yet been developed.

A Note on Uniform Pricing

The government fixes product prices for most of the major food crops in Tanzania. The policy of pan territorial prices was adopted in Tanzania to satisfy equity objectives among areas. It served as a means of increasing the incomes of producers in the remote areas. It has also been justified on the basis of 'fairness': a producer should get the same price for a bag of maize without regard to geographical location. The same fairness argument is also pervasive in setting uniform consumer prices. However, these policies have had unintended effects on different regional locations of production. Negative effects of these policies on reducing the level of marketable surplus are exemplified through the occurrence of the following:

1. Black marketing* which leads to the division

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*Black marketing pertains to marketing arrangements outside the official marketing channels.

between the official and unofficial markets in the country (See Table 1.5).

2. Inability to get enough food from rural areas through the official channels, hence creating parallel market for food demand** in urban areas. The problem is aggravated by trade movements outside the official government agencies, in the form of food crops.

3. The occurrence of unexplained food crop disappearance due to:

(a) The probability of over-estimating the level of food production or under-estimating the level of food consumption, resulting from lack of proper data on food and trade flows.

(b) Illegal international trade (border trade).

(c) Intra-rural unofficial trade.

(See Tables 1.6 and 1.7)

Clearly, uniform pricing itself can have a very uneven effect on raising farm incomes in the rural areas. The size of benefit it provides varies in direct relationship to the remoteness of the food producer and the amount of food he, in fact, grows and sells.[20]

Instead of helping producers in remote parts of the country, uniform pricing has prevented them from getting necessary inputs. These inputs are supposed to be purchased by incomes accrued from selling products. When respective

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**Parallel Market for Food Demand is the difference between total food demand and available official supplies.

Table 1.5

QUANTITIES OF MAIZE ENTERING THE OFFICIAL AND UNOFFICIAL MARKETS IN TANZANIA IN THE 1982-83 MARKETING YEAR ('000 MT)

	Marketable Surplus	NMC Purchases[1]	Unofficial Marketings[2]
Dodoma	0.0	4.0	0.0
Arusha	39.0	2.0	37.0
Kilimanjaro	25.9	0.0	25.9
Tanga	28.2	1.0	27.2
Morogoro	0.0	1.0	0.0
Coast	4.6	0.0	4.6
Lindi	0.0	0.0	0.0
Mtwara	0.0	0.0	0.0
Ruvuma	38.6	20.0	18.6
Iringa	42.4	30.0	12.4
Mbeya	55.5	7.0	48.5
Singida	0.0	0.0	0.0
Tabora	0.0	2.0	0.0
Rukwa	115.0	18.0	97.0
Kigoma	4.8	0.0	4.8
Shinyanga	11.5	0.0	11.5
Kagera	0.1	0.0	0.1
Mwanza	0.0	0.0	0.0
Mara	54.7	0.0	54.7
Tanzania	420.3	85.0	342.3

[1]Source: Stainburn, Production Costs of Major Agricultural Commodities in Tanzania, MDB, 1982. These figures are projections and are probably over-estimates. It is currently believed that total NMC purchases for 1982-83 will not exceed 70,000 tons.

[2]Marketable surplus less NMC purchases. Unofficial marketings taken to be zero if NMC purchases exceed marketable surplus. National totals do not balance because in some regions NMC purchases exceeded marketable surplus (see text).

Table 1.6

PARALLEL MARKET DEMAND FOR MAIZE IN URBAN TANZANIAN AREAS: 1982-83 MARKETING YEAR
('000 MT grain equivalents)

	Urban Demand	Projected NMC Sales[1]	Parallel Market Demand[2]	NMC "Over-Supply"[3]
Dodoma*	1.8	25.0	0.0	23.2
Arusha*	11.1	20.0	0.0	8.9
Kilimanjaro	1.1	5.0	0.0	3.9
Tanga	15.7	30.0	0.0	14.3
Morogoro	24.8	10.0	14.8	0.0
Dar-es-Salaam	138.6	144.0	0.0	5.4
Lindi*	0.9	3.0	0.0	2.1
Mtwara*	2.2	6.0	0.0	3.8
Ruvuma	9.8	1.0	8.8	0.0
Iringa	14.2	7.0	7.2	0.0
Mbeya	6.9	3.0	3.9	0.0
Singida*	1.5	2.0	0.0	0.5
Tabora	22.8	10.0	12.8	0.0
Rukwa	28.7	4.0	24.7	0.0
Kigoma	22.4	2.0	20.4	0.0
Shinyanga*	11.7	11.0	0.7	0.0
Kagera	0.4	5.0	0.0	4.6
Mwanza*	33.1	21.0	12.1	0.0
Mara*	7.4	13.0	0.0	5.6
Tanzania	355.1	322.0	105.4	72.3

*Indicates regions in which substantial quantities of grain have in some years been sold in rural areas as famine relief.

[1]Source: Stainburn, Production Costs of Major Agricultural Commodities in Tanzania, MDB, 1982.

[2]Urban demand less NMC sales. In regions in which NMC sales exceed urban demand, parallel market demand is taken to be zero.

[3]NMC sales less urban demand for those regions in which NMC sales exceed urban demand. Based on the assumption that 100 percent of NMC sales take place in urban areas.

Table 1.7

UNOFFICIAL FLOWS OF MAIZE INTO URBAN TANZANIAN AREAS: 1982-83 MARKETING YEAR
('000 MT grain equivalents)

	Urban Parallel Market Demand[1]	Parallel Market Supply[2]	Unofficial Intra-Regional Trade	Unofficial Inter-Regional Trade	
				Exports	Imports
Dodoma	0.0	0.0	0.0	0.0	0.0
Arusha	0.0	37.0	0.0	37.0	0.0
Kilimanjaro	0.0	25.9	0.0	25.9	0.0
Tanga	0.0	27.2	0.0	27.2	0.0
Morogoro	14.8	0.0	0.0	0.0	14.8
Coast	0.0	4.6	0.0	4.6	0.0
Lindi	0.0	0.0	0.0	0.0	0.0
Mtwara	0.0	0.0	0.0	0.0	0.0
Ruvuma	8.8	18.6	8.8	9.8	0.0
Iringa	7.2	12.4	7.2	5.2	0.0
Mbeya	3.9	48.5	3.9	44.6	0.0
Singida	0.0	0.0	0.0	0.0	0.0
Tabora	12.8	0.0	0.0	0.0	12.8
Rukwa	24.7	97.0	24.7	72.3	0.0
Kigoma	20.4	4.8	4.8	0.0	15.6
Shinyanga	0.7	11.5	0.7	10.8	0.0
Kagera	0.0	0.1	0.0	0.1	0.0
Mwanza	12.1	0.0	0.0	0.0	12.1
Mara	0.0	54.7	0.0	54.7	0.0
Tanzania[3]	105.4	342.3	50.1	292.2	55.3

[1]Total urban demand less NMC sales.

[2]Marketable surplus less NMC purchases.

[3]The difference between the national parallel market supply and national parallel market demand is identical to the sum of unofficial exports less the sum of unofficial imports.

SOURCE: Sigma One Corporation.

government agencies in the distant regions were not able to bear the loss from selling inputs at government prices after all transportation costs were met, they stopped handling their quota.[21]

Such a situation acts as a disincentive on the part of the farmers in purchasing modern inputs and, hence, affects the level of food output produced in areas with high marketing costs. The objective of giving every producer who grows a food crop the same price for it in order to achieve "fairness" is a very costly policy in view of its detrimental effect on economic efficiency. Uniform pricing completely ignores all considerations of marketing costs as well as inter- and intra-regional comparative advantage. Since it provides a transport subsidy equal to 100 percent of cost, it provides the highest subsidy rate to goods with the largest weight to value ratio – particularly inefficient in Tanzania where transportation costs are high.

The Price Policy Dilemma

Price policies are associated with a conspicuous dilemma. High producer prices are set to encourage production, and at the same time, policymakers want low consumer prices to protect low income consumers. In Tanzania for many years the consumer price for food, especially maize, has been subsidized. The urban dweller does not pay a price which covers both the cost of production by the producer and the cost of distribution incurred by the processor, the National Milling Corporation. The difference between the farm gate price and that at the retail level is artifically low as a result of increasing government subsidies. For example, in the 1980-81 season, maize meal sold for Tsh. 1.25 per kg. Yet the actual cost of the National Milling Corporation, to collect and process that maize, was estimated at Tsh. 3.17. Subsidies to the National Milling Corporation, by the government, were approximately Tz. Shs. 140 million – 7 percent of the internally generated government revenue. By the 1981 season, while the producer price was Tsh. 1,000 a ton, NMC's marketing cost has risen to Tsh. 2,360 a ton, exceeding the estimated cost of importing maize at Tsh. 2,157 a ton.[22] Despite these costs, the dilemma is reflected in a comment by one agricultural expert in Tanzania. "We have to consider the social relationship between the farmer and the consumer, and strike a balance. If you consider only the farmer and you forget the consumer, you may have social problems and a consumer revolt. If you give too little to the producer, he may become apathetic and not produce at all. Price covers economic, political, and social aspects. We must beware of spoiling the consumer by giving him highly-subsidized food."[23] Although consumer subsidies are undertaken, the primary problem rests in increasing food production.

The implication for incentives is, therefore, suggestive of those which relate to supply response on the part of producers to encourage increased food production.

Objectives of the Study

The overall objective of this study is to analyze the potential impact of incentives and technology on increasing food production, especially a marketable surplus. Incentives considered are in the form of a decrement of input costs and increment of output prices.

Producers use economic information in calculating their expected costs, including risks, against the return they expect to receive. The result of this calculation is the incentive. In this context, an incentive is the product of economic information from which the producer derives his expectations. Cost expectations involve production expenditures such as input prices. Returns expectations encompass the value placed on the farm products to be utilized by individual producers and the expected price of that part of production to be sold, i.e., output prices. Optimum economic incentive provides information that leads producers to allocate resources in ways that result in a maximum of production that will clear the market at the price that maximizes the utility of consumers.[24]

Specific Objectives

The specific objectives of this study are:

1. To determine the potential impact of product and input prices and/or technology on increasing food crop production, especially to allow marketable surplus in Mbeya region, and

2. To determine whether there is enough capacity of regional input systems to handle the needed volume of purchased inputs if economically optimum quantities were used, in Mbeya region.

Hypothesis

Hypotheses serve as the directors of an inquiry. An operational hypothesis is a deductive statement based on theory and logic which suggests relationships between variables. It provides guidelines for data collection and techniques to be used in analyzing the problem. Hypotheses, therefore, should be capable of verifying or rejecting a relationship within probable limits. They should be stated in a manner that provides some directions for the inquiry.

Specific Hypotheses

The study is guided by the following hypotheses stated in null form:

Hypothesis A. If output prices for Mbeya region producers were to be increased, increases in food production to allow a marketable surplus will not occur.

Generally there have been two schools of thought based on the issue of agricultural prices in traditional agricultural setting.

Medani acknowledges that output price is a significant determinant of producers decision-making on producing marketable surplus from traditional agriculture. Marketable surplus is positively associated with market prices at all phases. The surplus food enjoyed in most of the developed countries has resulted from increased producer prices.[25]

Evidence suggests that real prices received by producers in developing countries are substantially lower than those in the developed nations. Estimates of a long run aggregate agricultural supply elasticity from cross-sectional data of a number of developing countries reveal that it is relatively elastic, i.e., in the range of 1.25 to 1.66. Hence, with more favorable prices, agricultural output in most of the developing areas could have been 40 percent to 60 percent greater. However, governments in developing countries do not appear to be ready to reverse policies that have kept the real prices of farm products artifically low. But, unless they are reversed, perhaps gradually over a period of time, there is little hope for these countries to produce an adequate supply of food for their people or to achieve sustained economic growth.[26] Hassel concludes that producers are as price- and income-responsive as consumers, and higher product prices will result in larger quantities marketed.[27] A policy of attempting to stimulate output through higher prices will also be consistent with eliciting a larger proportion of marketable surplus for non-farm consumers. Higher output prices stimulate increased agricultural food production by:

1. Encouraging the use of more labor and other variable resource inputs, and

2. Inducing investments via the discovery and adoption of new agricultural technologies that result in new, higher production functions and result in lower costs per unit of output.

A number of studies have examined producers' supply responses in relation to output prices. These include the work of Reca,[28] Bale and Lutz,[29] Behram,[30] Dandekar,[31] de Janvry,[32] Hossein, Askari and Cummings,[33] Huang,[34] Krishna,[35] Dobb and Foster,[36] and Falcon.[37] All of these studies have concluded that an increase in output prices, other things being equal, has a strong positive impact on the increase of marketable surplus.

However, another school of thought contends that a rise in agricultural prices, other things being equal, does not lead to increased production among subsistence producers. The reasons given are:

1. Traditional agriculture barely produces to reach consumption requirements, and

2. Producers' cash needs are relatively fixed, as they need cash to purchase only the necessary items they cannot produce.

The studies, therefore, assume traditional producers will produce less if they are given higher prices, and distinguish between marketed surplus as opposed to marketable surplus. In such a situation the marketed output is considered as a forced-sale. Khatkhate calls this a "stinted consumption paradox."[38] Enke[39] and Neumark[40] have also advocated the idea of producers' fixed demand for money. Hence, for them, the marketable surplus of a subsistence crop is inversely related to prices.

Krishran[41] and Olson[42] argue differently. They contend that an increased market price for a subsistence crop may increase producers' incomes sufficiently so that the income effect on his demand for consumption of the crop outweighs the substitution effect in production and consumption. Consequently, the marketable surplus will vary inversely with market price.

This school of thought assumes that the marginal utility of money for producers equals zero. However, a number of studies have shown producers respond to higher prices by increasing the level of output produced and, hence, facing a positive supply curve. In the Phillipines, rice producers have responded positively to prices. Moreover, the introduction of new non-farm products in the market has led to effective demand for cash among producers.

Hypothesis B. If new production technology is available for Mbeya region producers, for example, if more inputs were made available through the marketing system, more production to allow marketable surplus will not occur.

Technological improvement in the form of farm implements and chemical inputs via subsidies, is among the best forms of incentives for producers. Subsidies on inputs might have some merit where producers have not used these inputs before and the objective is to stimulate their adoption.

A recent World Bank publication has produced an outstanding literature review on price policies and input subsidies for developing countries. The publication notes that the scope of price incentives is likely to be a function of elasticity of input supplies. Benefits from price supports depend on the ease with which producers can obtain additional inputs in response to the price incentive. A fertilizer subsidy would have little effect on production if the fertilizer supply were limited. To the extent that the access to new technology can be significantly improved by making more inputs available, price incentives may provide more substantial long term benefits by facilitating adoption of new technology in a dynamic context. If sufficient quantities of fertilizer are available to meet the increased demand and if additional fertilizer is properly applied, a fertilizer subsidy will increase food production substantially.[43] In their study on the Phillipines, Barker and Hayami have demonstrated that a subsidy applied to modern inputs can be more beneficial than supporting producer prices, in achieving food self-sufficiency.[44]

There has been considerable concern in Tanzania about how to deal with the lack of sufficient incentives in agriculture. The New Agriculture Policy has indicated the need to set producer prices high enough for farm producers to have income for purchasing essential items. Producer prices are to be set with minimum fluctuations and should meet the crops' production costs. Subsidization of some of the agricultural inputs and price stabilization schemes are among several methods intended to give incentives to producers to increase production. A price differential system for different areas and crops will be emphasized.[45]

Conclusively, the literature at large suggests that agricultural pricing policies have a considerable effect on the incentive to produce more food to allow a marketable surplus; and the ability of governments to establish and maintain food reserves.

Arrangement of the Analysis

Chapter 2 presents the guiding model of the study. A rural-urban model is developed to show how surplus food might be produced in rural areas and transferred to urban areas. Theoretical constructs are developed to show different alternative scenarios indicating the impact of output prices, input costs, and technology on increasing food production. Mbeya region is taken as a case study. Chapter 3 gives a brief explanation of Mbeya region which is taken as a case study.

In Chapter 4, the methodology of the analysis is presented. The linear programming technique is applied to determine the normative supply curve of food producers in Mbeya region. Post optimal analysis options, which include parametric programming on the objective function and sensitivity analysis on constraints are undertaken. These are to determine: (a) how great is the advantage of activities applied in the programs; (b) how would increasing or decreasing one or more resources affect the optimum mix of activities and the value of the programs; and (c) how would changes in price relationships affect the solution.[46] The issue centers on the generation of marketable surplus from farm producers to non-farm consumers, given different output prices, input costs, and levels of technologies.

Chapter 5 focuses on analytical results from linear programming given different programs applied in the study. The last chapter, Chapter 6, focuses on the following aspects before the conclusions are presented: (a) recommendations based on the research findings; (b) implications of the analysis for policy; and (c) a suggestion of additional research needed to solve the problem.

FOOTNOTES

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CHAPTER II

THE CONCEPTUAL ECONOMIC FRAMEWORK

The conceptual economic framework is based on model building reflecting the transfer of marketable surplus from rural to the urban areas. The impact of producer prices, input costs and technological changes is investigated on increased agricultural production. Implicitly the chapter suggests there are many necessary but no individually sufficient conditions for increasing Tanzania's food agricultural production.

Theoretical Constructs

Theoretical constructs are designed to form a basis for analysis and as a method of organizing thoughts. The specific purpose in this analysis is to conceptualize how agricultural producers in the rural sector can supply more food and transfer it to the urban section, given different policy options.

A set of possible government policies, in terms of input costs, output prices and technological changes are illustrated. The free market solution, based on world market prices, is analyzed in relation to government intervention policies in food production and marketing. Intervention is through subsidies on prices of the inputs and fixing product prices. Technological change is analyzed to determine its impact on increased food production, especially in terms of allowing a marketable surplus. The role of the exercise is not to choose or identify which is the best or optimal set of policy options. Instead the aim is to analyze the different scenarios and let policy makers decide on which is the "best or optimal" set given their criteria. Decisions will be guided by the different expected outcomes such as (a) the reduction of government importation costs in terms of foreign exchange; (b) raising the level of producers' farm incomes; (c) increased food output through increased productivity, etc.

Empirical and qualitative results based on the scenarios could be used by policy makers to adopt consistent policies. The study does not, implicitly or explicitly, give the criteria for identifying which is the best or optimal policy.

Production and Marketing by the Farm Sector

The economic framework of marketable surplus from agricultural producers in the rural sector to the urban sector can be shown in Figure 1. In the model, the left panel indicates the rural or farm sector. OM represents the marketing costs on the food market. S_O is the producer's supply curve. The vertical line D_SQ_S represents the subsistence requirements of agricultural producers. D_SD is the subsistence diet from producers' own farm production.

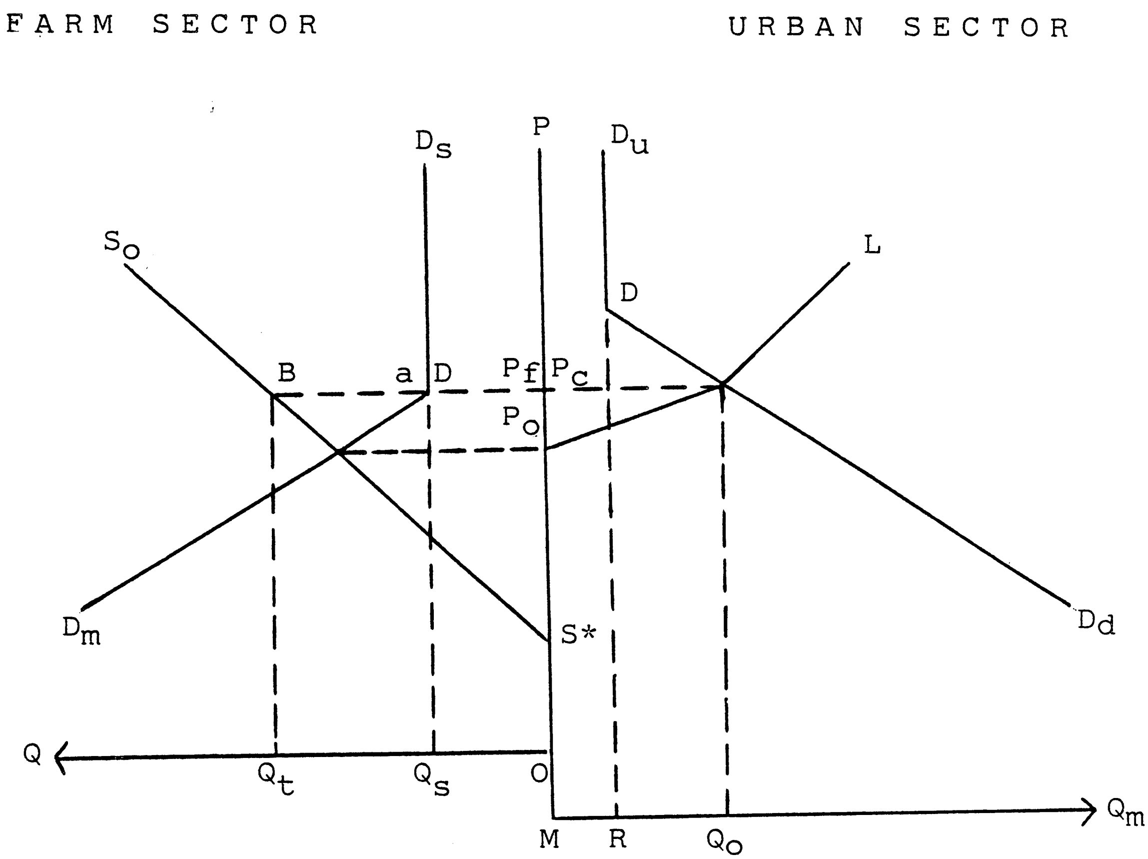


Figure 1. Free market Policy Without Food Imports.

It is the absolute minimum of food consumption. DD_m represents the demand for food by agricultural producers beyond their subsistence requirements. D_sDD_m represents the total demand for food by agricultural producers.

The Urban Sector

The right panel of Figure 1 indicates the urban sector. D_uD is the minimum food requirement for urban workers necessary to protect them from starvation. A vertical extension of D_uD below point D to a point like R, suggests that at any price level food rationing will be inevitable. D_uD_d is the market demand of non-farm workers for additional food. P_o represents the price intercept of marketable surplus curve. P_oL illustrates the marketable surplus curve at alternative prices. A point on P_oL will illustrate the marketed surplus.

The marketable surplus curve P_oL, which is determined by the difference between the supply curve S_o and the demand curve represented by D_sDD_m, is drawn with a kink. There are several reasons for this:

1. In Figure 1, as producer prices are increased from P_o to the P_f level, producers will be induced to produce more food and achieve a marketable surplus. Given higher prices, producers will be willing to consume less until they reach the point of subsistence requirements. As a result, beyond point D on the total agricultural sectors' demand curve for food, one cannot expect substantial

marketable surplus due to further reduction in producers' demand and, hence, the marketable surplus curve will develop a kink. Moreover, price levels beyond point D make the increase in marketable surplus to be determined by the increase in the slope of the supply curve alone. The demand curve is perfectly inelastic from point D towards D_S.

2. As producers get more income they will not be content with subsistence diet. Given high incomes, producers can start buying food from the market, hence, affecting to an extent the level of marketable surplus to be produced.

3. As producers get more income, marginal utility of income could be sufficiently high for non-food alternatives. If this is the case, producers might regress in their food habits to the point of subsistence. Empirically, the income elasticity of demand for food is high at low income levels. When incomes go up, the income inelasticity of demand becomes one of the shifters of the demand curve. In this case, the demand curve DD_m, could shift to the left in the left side panel of Figure 1. The kink to be established on the total producers' demand will cause a kink in the marketable surplus curve.

4. In the traditional agricultural setting, the marginal propensity to consume is very high. The income elasticity of demand for food grains is also very high—much higher than in developed countries. Given increased

incomes, producers would tend to consume more of their farm incomes. Alternatively, they will switch to consumption of superior cereals. This would result in the reduction of the marketable surplus, and hence a kink on the marketable surplus curve.

The position of P_oL in Figure 1, demonstrates that there will be no marketable surplus produced at prices below the level P_o. The government has, therefore, got to import from abroad. At a point like S_* on the supply curve in Figure 1, production is not possible. This could be a case of drought and, hence, government importation becomes inevitable.

Basic Assumptions of the Model

1. The model is static. The focus is on the supply side.
2. At least agricultural producers in rural areas are able to produce and meet their subsistence family food requirements.
3. A backward bending supply curve for producers' food production is not possible. As producers income increases, work will not be substituted for leisure because of the high income elasticity of demand for the products, and effective cash demand for non-farm products.
4. The government is willing and able to import whatever amount of food is needed for the urban

sector, once there is a shortage of marketable surplus.

Description of Scenarios

There are a number of policy strategies that could be presented to show how the agricultural sector will perform in terms of food production in relation to the urban sector food needs.

Free Market With No Food Imports

Figure 1 represents a model depicting a free market in a country without any imports. If the policy would be to let the domestic food market settle its own equilibrium with no imports, producer food prices would be OP_f. This is the price that equates the marketable surplus P_oL with the urban sector's demand for food. At price P_f, the total output of the agricultural sector would be OQ_t. Agricultural producers would consume OQ_s units of food and market $Q_tQ_s = MQ_o$ units to the urban sector. The consumer's price would be MP_c. Producers gross revenue at P_f will amount to abQ_tQ_s.

Free Market Policy With Imports

Scenario I: World prices are greater than price intercept of the marketable surplus curve (i.e., $P_w > P_o$).

An alternative policy would be to meet urban food demand with a free market policy with food imports. In this

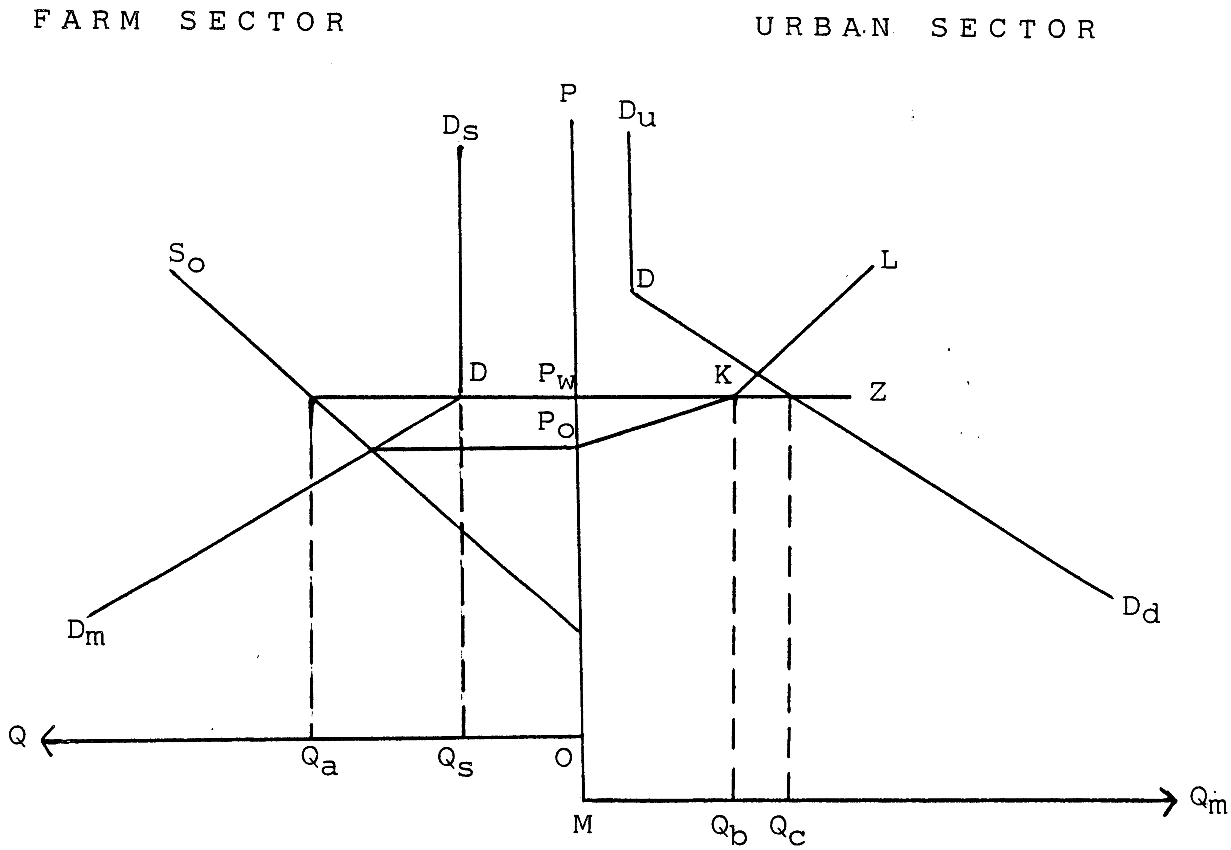


Figure 2. Free Market With Food Imports.

situation domestic food prices are equated to world food prices (P_w) which represents free market prices. The suppl of food from imports is assumed to be perfectly elastic at P_w. The impact of free market policy with imports depends on whether $P_w \gtrless P_o$. If P_w is greater than P_o, as illustrated in Figure 2, the total supply of food to the urban sector is P_oKZ. Agricultural production would be OQ_a of which OQ_s units would be consumed by the agricultural sector and $Q_a - Q_s$ would become marketable surplus to the urban sector. Producers' food prices would be OP_w and consumers will pay MP_w. The urban sector would consumer MQ_c units of food. MQ_b units of food would be produced locally and $Q_c - Q_b$ would be imported, which represents a cost to the government in terms of foreign exchange.

Scenario II: World prices are less than price intercept of the marketable surplus curve (i.e., $P_w < P_o$).

If world food prices are below P_o (i.e., $P_w < P_o$), as shown in Figure 3, agricultural food production would be OQ_s. This will be just enough to cover producers' subsistence requirements OQ_s.

The government has to import an amount MQ_m'' units of food, to cover the urban sector's food demand. The agricultural sector will be able to consume OQ_s units in order to subsist, and the urban sector will consume MQ_m'' units of food. This alternative will not favor producers.

The price they will receive, OP_w, will be too low to act as an incentive to expanded production. Clearly, urban

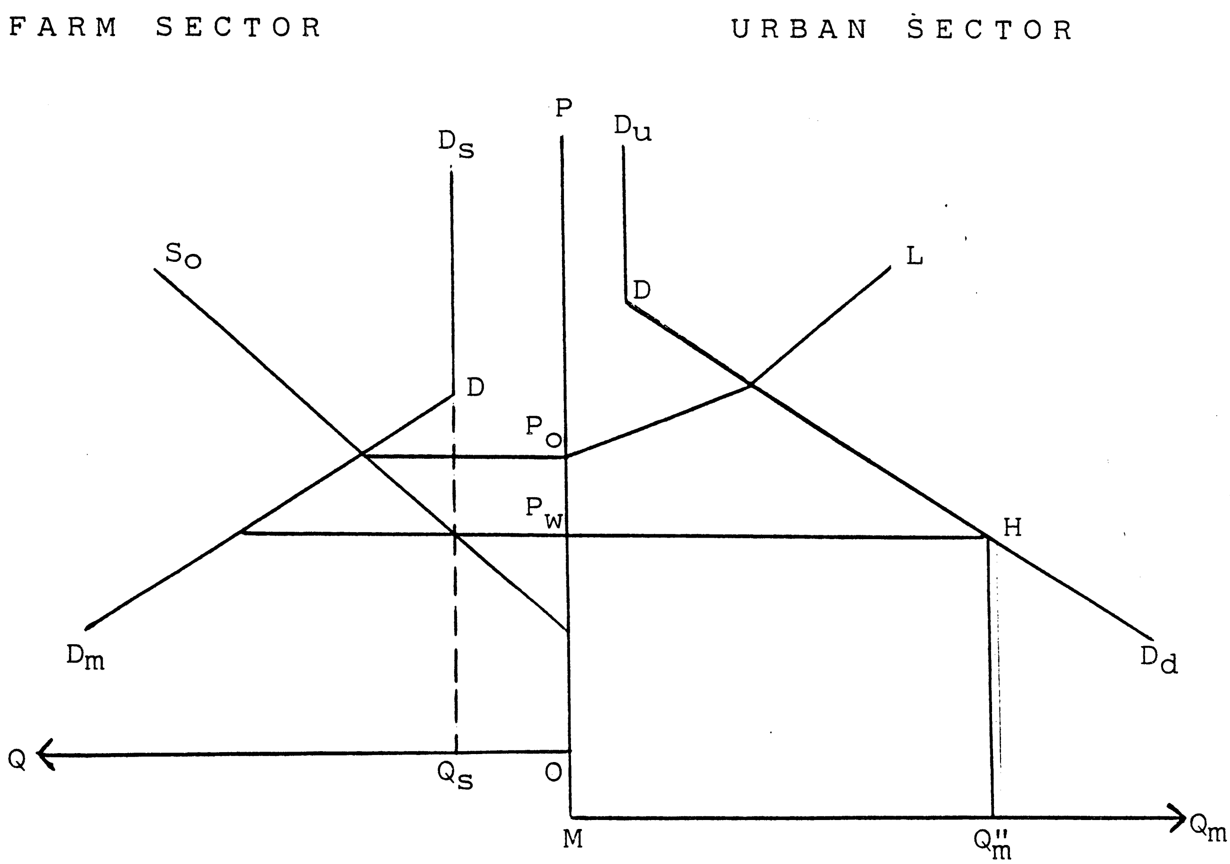


Figure 3. A Case of Lower World Food Prices.

consumers will be better off as they will be paying low food prices, MP_w. The government cost in terms of foreign exchange would be presented by an area $MP_wHQ''_m$.

Subsidization Through Price of the Product

A common policy in many developing countries involves fixing the price of food. The major reasons for fixing agricultural food prices in most of the developing countries have been to stabilize production, foster self-sufficiency and control the cost of living of the urban consumers. There are a number of approaches which can be suggested to determine the impact of fixing food prices to both producers and consumers.

> Scenario I: Producer prices (P_f) are equated to consumer prices (P_c) but greater than world market prices (i.e., $P_f = P_c > P_w$). (The situation is illustrated in Figure 4.)

Domestic agricultural production would be OQ_a of which OQ_s will be consumed by producers. $OQ_a - OQ_s = Q_aQ_s = MQ_A$ units of food which would be marketed in the urban area. The government has to import an amount $Q_AQ'_A$. Producers will receive OP_f which is a higher price level than OP_o or OP_w. Their gross revenue will amount to DaQ_aQ_s. Clearly, urban consumers would be worse off by paying higher price MP_c than MP_o or MP_w for their food needs. In contrast, a free market alternative at P_w agricultural producers will produce OQ_b units of food of which they will consume OQ_c. $Q_b - Q_c = MQ_B$ would be marketed to the urban sector. However, MQ_B is less than MQ_A units of food which can be marketed if

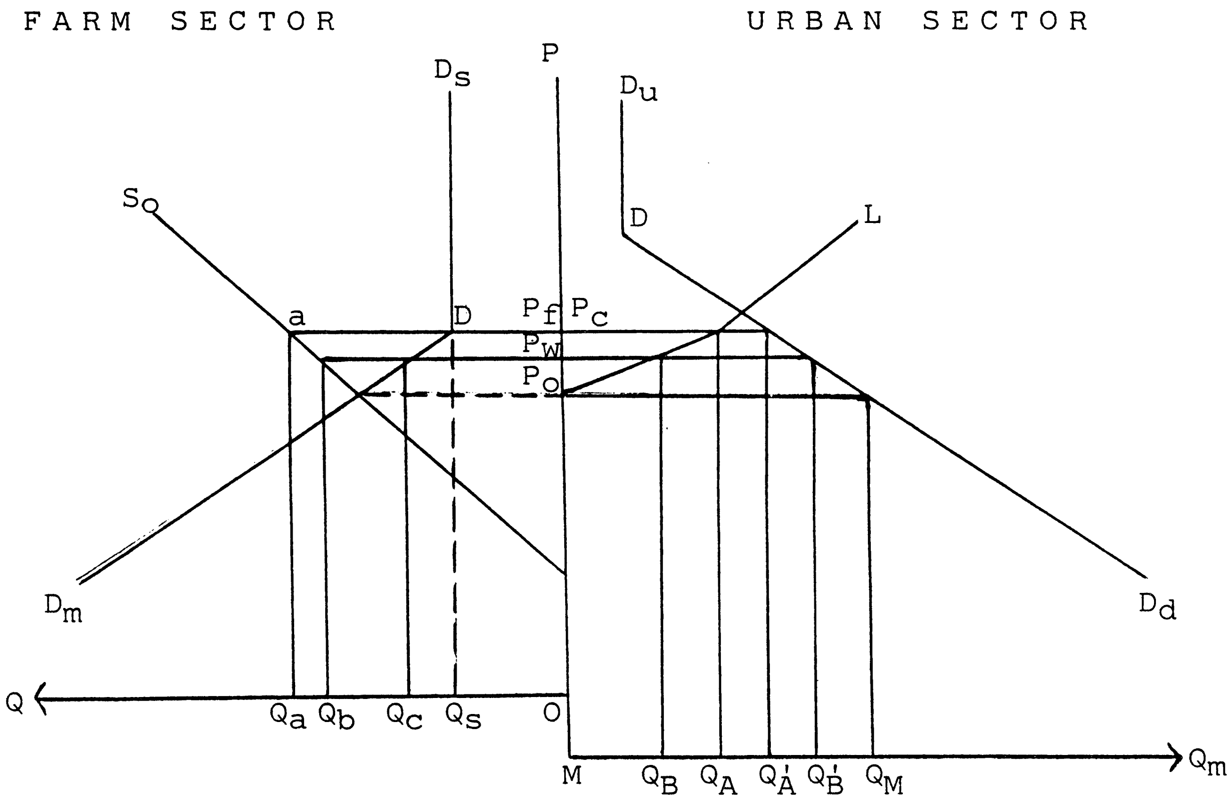


Figure 4. World market prices are less than producer prices which are fixed at the same level as consumer prices, i.e., $P_f = P_c > P_w$.

producer prices were OP_f. At the world price level OP_w, the government has to import Q_BQ_B' which is a greater amount than Q_AQ_A'. At price level OP_o the government has to import MQ_M units of food.

Scenario II: World market prices (P_w) are greater than producer prices (P_f) which are fixed at the same level as consumer prices (P_c) (i.e., $P_w > P_f = P_c$).

As illustrated in Figure 5, agricultural production would be $OQ_e - OQ_g = Q_eQ_g = MQ_E$ will be supplied to the urban sector. The government has to import Q_EQ_E' to satisfy urban food needs. Producer prices will be OP_f with a gross revenue of LmQ_eQ_g. The alternative would have been the free market at world price level P_w. By fixing $P_f = P_c < P_w$ and using the free market, consumers are subsidized. Instead of paying MP_w, they will pay MP_c. However, the government is also taking away price incentives for expanded domestic food production. Instead of receiving OP_w, producers will be paid OP_f. A consumer subsidy will amount to the shaded area pqrs. The net loss to producers in terms of income reduction due to food prices below world market prices (P_w) will amount to lmbD. However, DP_wP_{fm} will be a non-subsidy benefit to producers as consumers.

Scenario III: Producer prices are equated to world market prices but greater than consumer prices (i.e., $P_f = P_w > P_c$).

Figure 6 illustrates a situation where producer prices (P_f) are set too low to generate a marketable surplus and urban consumers are made to pay the same lower prices for

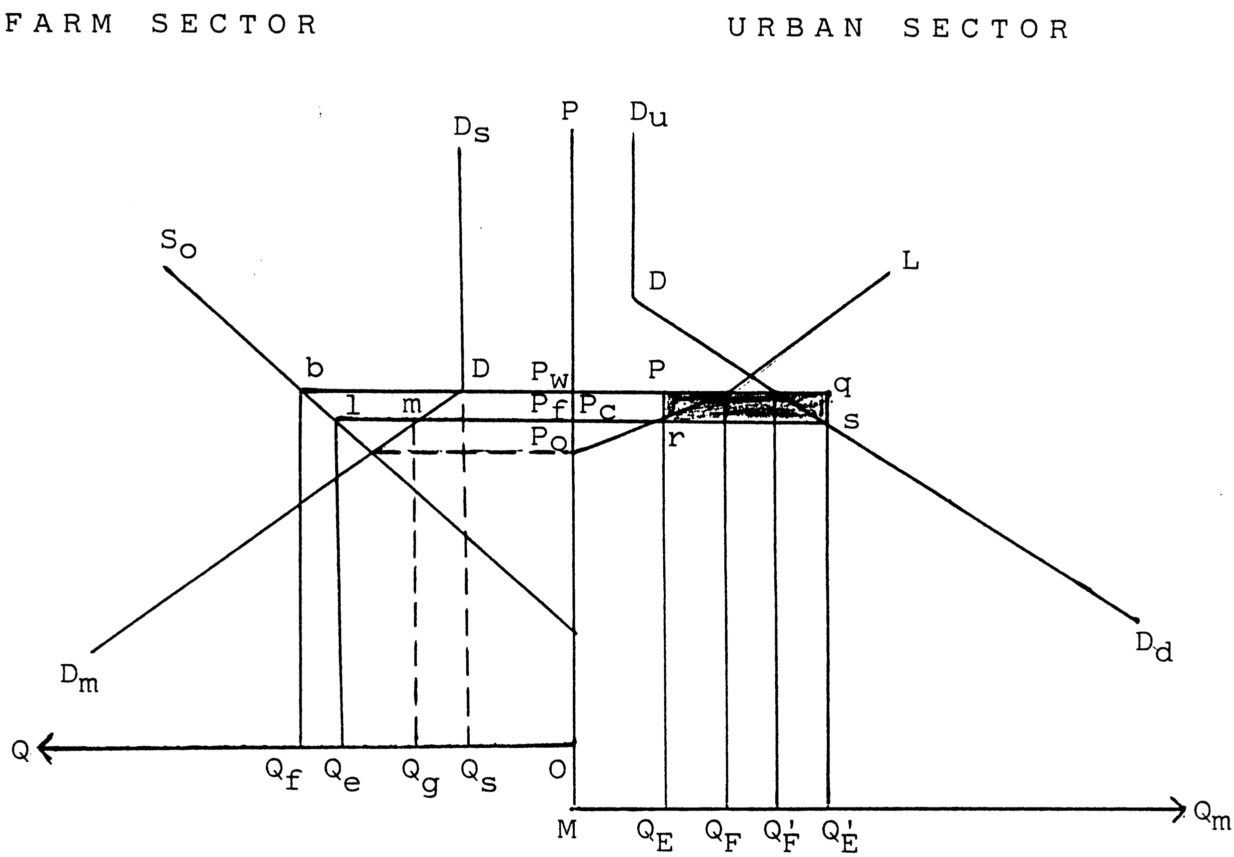


Figure 5. A case where world prices (P_w) are greater than producer prices which are fixed at the same level as consumer prices (P_c), i.e., $P_w > P_f = P_c$.

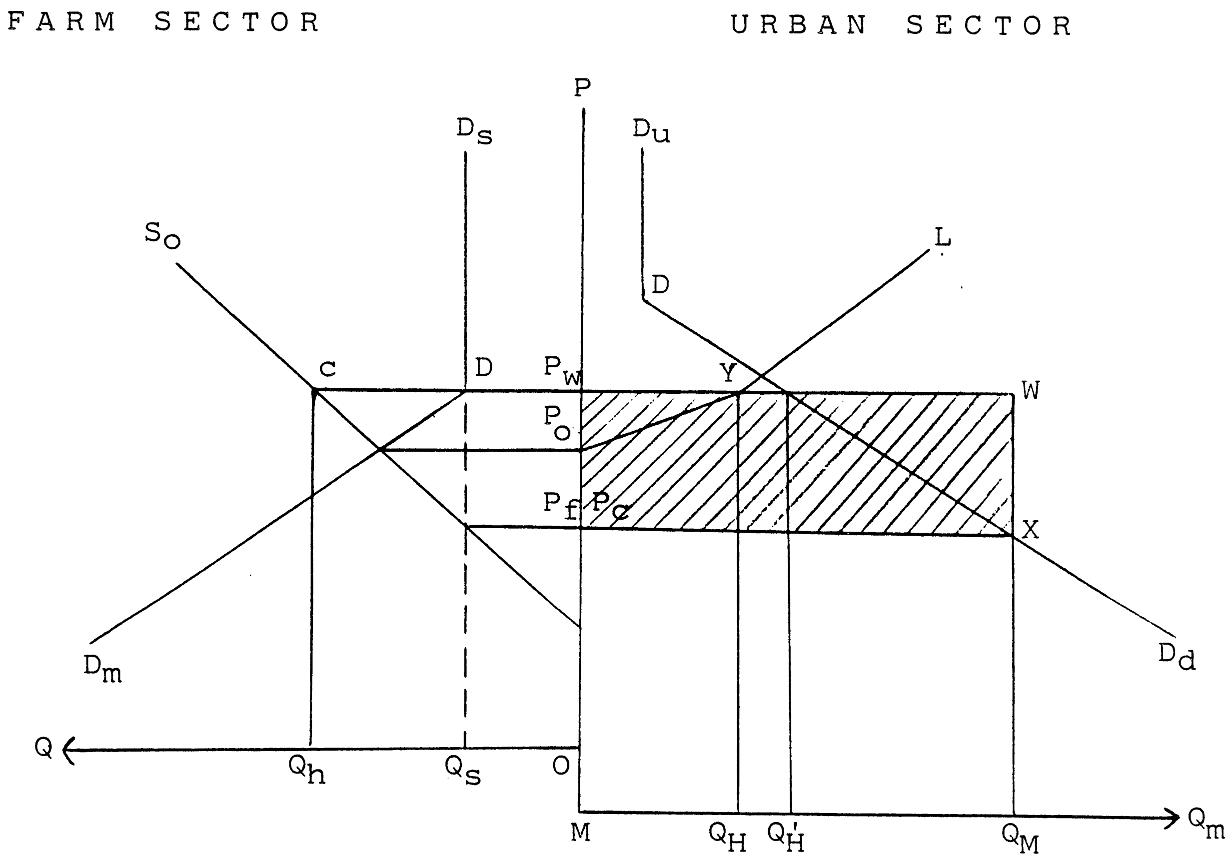


Figure 6. A case where $P_c = P_f < P_w$ compared to a case where $P_f = P_w > P_c$.

their food needs. These prices are below world market prices, P_w, (i.e., $P_c = P_f < P_w$).

Agricultural production would be OQ_s, all of which will be consumed in the agricultural sector. There will be no marketable surplus to the urban areas and, consequently, the government has to import MQ_M amount of food to satisfy food needs of the urban sector. Clearly, producers will be worse off because of low prices OP_f and, hence, will not have an incentive to stimulate more production. Consumers will be better off since they will pay low prices, MP_c, for food. However, a different scenario can be shown with the aid of Figure 6. If food producers are paid the prevailing world market price, P_w, (i.e., $P_f = P_w > P_c$) agricultural production would be OQ_h of which OQ_s will be consumed in the agricultural sector. $OQ_h - OQ_s = Q_hQ_s = MQ_H$ will be marketed and consumed in the urban sector. Producers will be paid OP_w and generate a gross revenue of cDQ_hQ_s. If consumers are made to pay MP_c for their food needs, clearly they will be better off. This will be a consumer subsidy amounting to the shaded area. They will be worse off if they are to pay MP_w. Producers are going to be well off. P_oP_wY is a payment to producers by the government on behalf of the urban sector. P_cP_oYWX is a payment in terms of foreign exchange to imports by the government on behalf of consumers. At world market prices the government would have to import $Q_HQ'_H$ to satisfy the urban sector's food needs. This amount is much less than the previous case when producer prices are set too low to generate marketable surplus.

Scenario IV: Producer prices are greater than consumer prices equated to world market prices.

Figure 7 illustrates a case where producers are paid higher producer prices (P_f) than the prevailing world market prices (P_w) and consumers are made to pay world food price levels for their food needs (i.e., $P_f > P_w = P_c$).

Agricultural production would be OQ_p out of which OQ_s will be consumed by agricultural producers. $OQ_p - OQ_s = Q_pQ_s = MQ_p$ would be the marketable surplus to be directed to the urban consumers. Producers would receive OP_f while urban consumers would pay MP_c for food needs. MP_cKQP would be foreign exchange savings. Government would have to pay Q_pQ_RKZ for food imports to satisfy food requirements for non-producers. P_fWKP_c is a cash subsidy to producers. If a free market solution is taken, i.e., $P_f = P_c = P_w$, no marketable surplus would be produced and the government will have to pay MQ_RP_cZ for food to satisfy food needs of the urban sector through importation.

Scenario V: Producer prices are greater than world market prices and greater than consumer prices.

Figure 8 illustrates an alternative which has rarely been considered in developing countries because it is very expensive. This is subsidizing both producers prices and urban food prices (i.e., $P_f > P_w > P_c$).

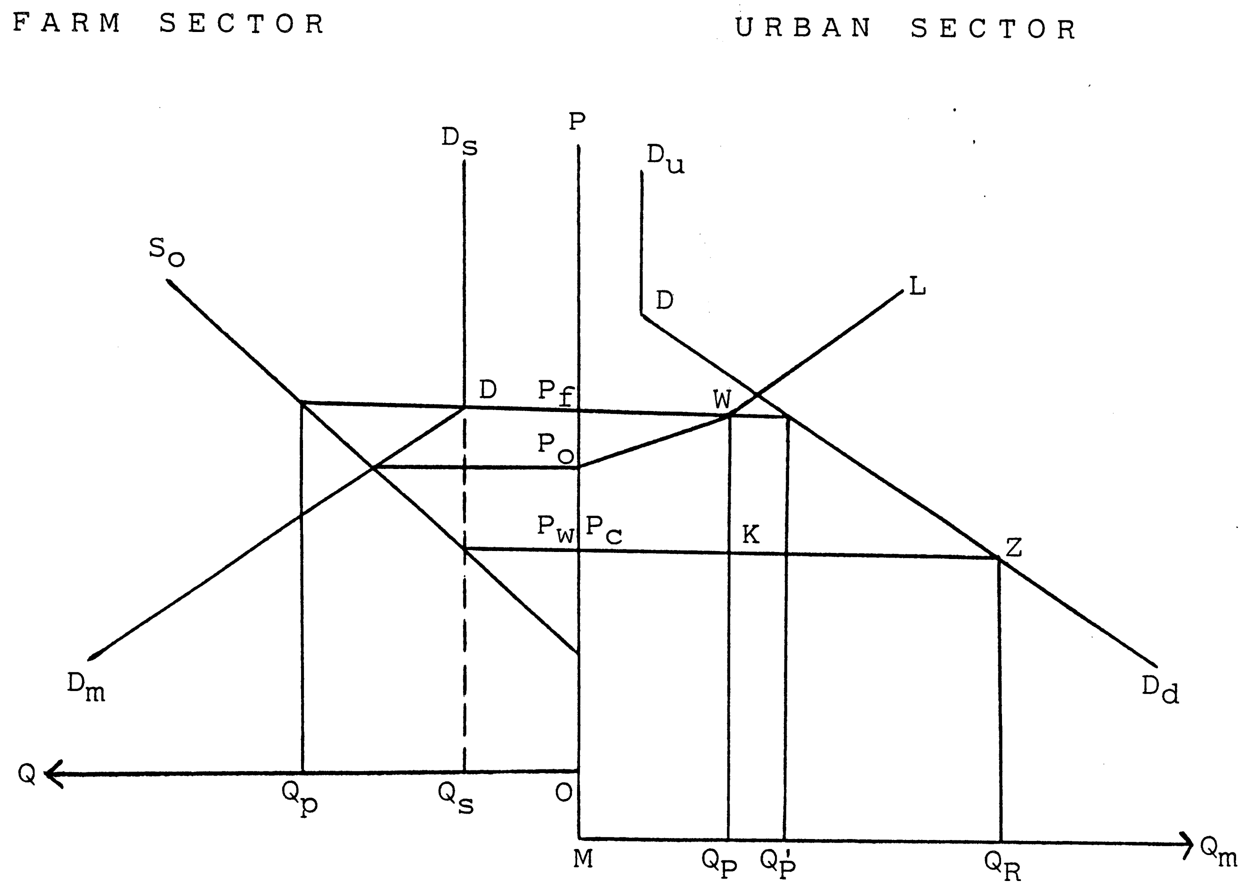
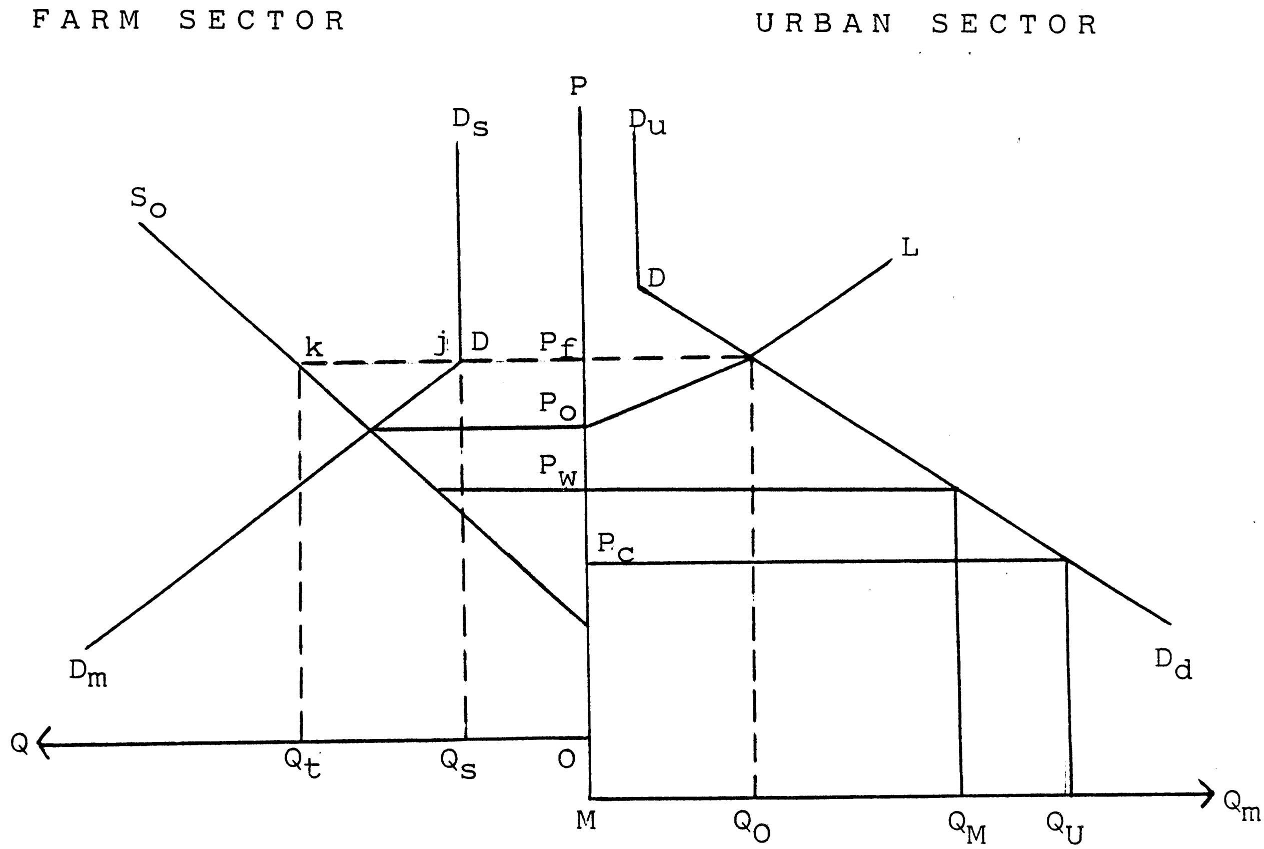


Figure 7. A case when $P_f > P_w = P_c$.



<u>Figure 8</u>. A case where $P_f > P_w > P_c$.

In this case, both the consumer and the producer will be gaining at the expense of the government. The government could give producers higher prices such as P_f instead of world market prices (P_w). Agricultural production will be OQ_t units of food of which OQ_s will be consumed in that sector. $Q_tQ_s = MQ_o$ will be marketed to the urban sector. At price level P_f producers' gross revenue is shown to be jkQ_tQ_s. However, instead of urban workers paying MP_f for food, the government subsidies will make them pay MP_c for food. As a result, the government will have to import Q_oQ_u to satisfy urban food needs. At world market price level OP_w, the government would have to import MQ_M. The alternative will be very expensive in terms of foreign exchange and domestic currency for the government.

Whereas, the preceeding section analyzes increases in food production caused by subsidization through price of product, there are other ways which can be suggested to increase food production to allow more marketable surplus and reduce food prices for urban consumers. These include technological changes and subsidization through the price of inputs.

The Impact of Technological Changes

Fostering technological development, i.e., improving the level of technologies, will influence the level of output and production costs. Basically technological shifts have identical effects as cost subsidies.

Technological changes enable the producer to produce the same quantity of a given product with less effort or to produce a greater quantity of a given product with the same effort. These effects may occur for one or both of two reasons. First, new types of inputs may be added to the input array used in the production process and old types may be discarded, e.g., a shift from handhoe to animal power. The second technological change is improvement in the quality of inputs used. Technological changes result in shifts of both the production function and the supply curve.

Cost Reducing Technology

Figure 9 illustrates the impact of technological change on increasing the level of marketable surplus. If D_sDD_m is taken to be the total agricultural sector's demand for food and S_o as the supply curve, a marketable surplus MS_o of food for urban workers is brought into the market. At the price level P_1, deQ_1Q_s amounts to the producers' gross revenue. Food prices for urban consumers will be at a level like MP_1.

A change in technology, such as increased use of fertilizer, will shift the supply curve downwards from S_o to S_1. At S_1 the producers will be able to achieve a larger quantity of marketable surplus MS_1, with quantity q_2 greater than q_1. At price level P_2, cfQ_2Q_s represents producers' gross revenue. The direct effect is the reduction of consumers' food prices from MP_1 to MP_2. No marketable

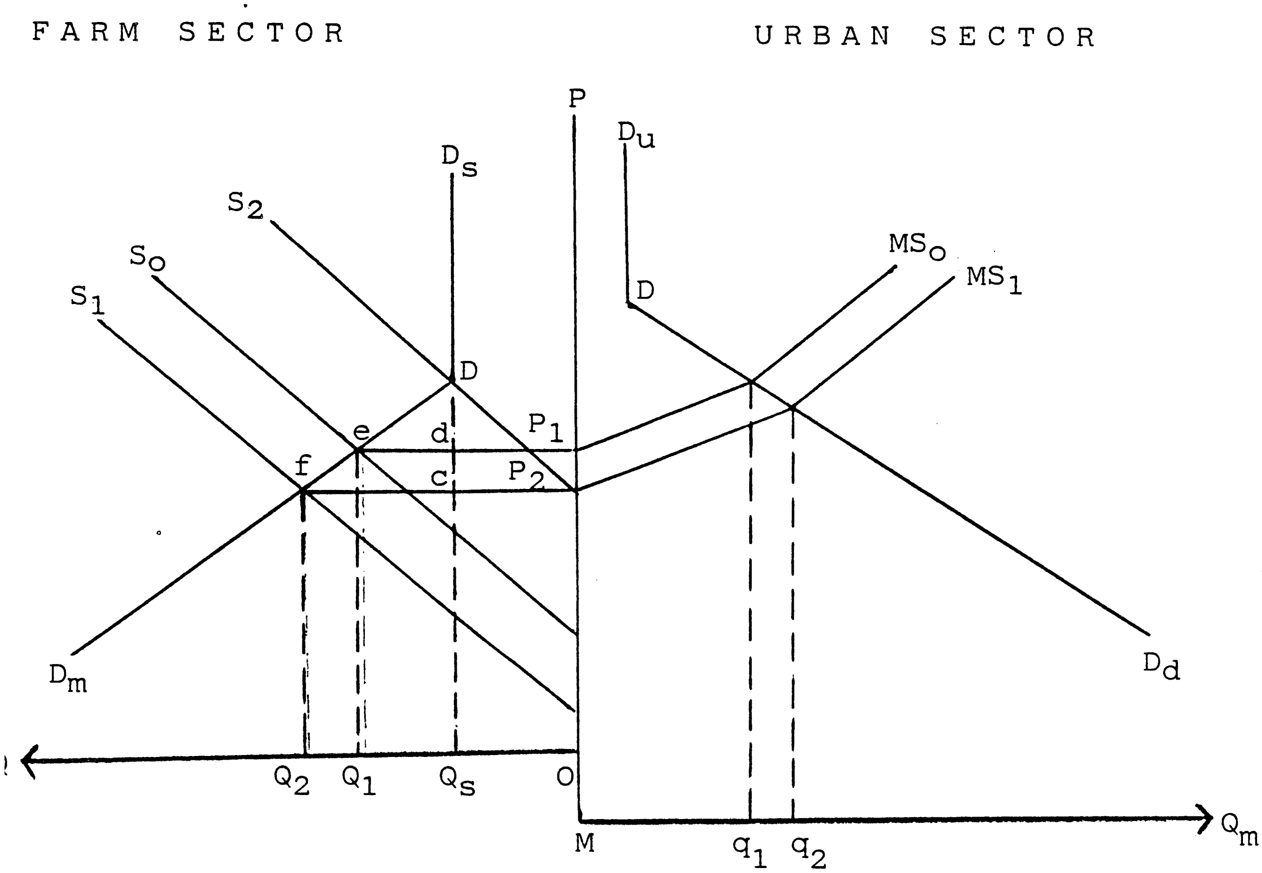


Figure 9. The Case of Cost Reducing Technology.

surplus is produced at point D, on S_2. At S_2, the supply curve intersects the demand curve D_sDD_m at a point where production costs are just enough to cover the subsistence requirements of producers.

Subsidization Through Input Prices

Reductions in input prices basically involve subsidization of production costs. This represents a government cost. Producer input subsidies have the same effect on marketable surplus as do producer product price subsidies.

Changes in input prices have a substantial impact on the supply curve. Conceptually, a change in the price of an input is taken as a supply shifter. An increase in an input price shifts the cost curves of a producer and, hence, the supply curve to the right on the left half of Figure 10. A decrease in the price of an input results in the opposite effect. Changes in input prices, e.g., a reduction in prices, basically involves the subsidization of producers' production costs by the government. Subsidies on inputs such as fertilizer, better seed, etc., help to compensate the poor risk-bearing ability of producers and, hence, promote greater use of innovative inputs and new technology. This will lower producers' production costs, and consequently, the supply will shift to the left and expand food production.

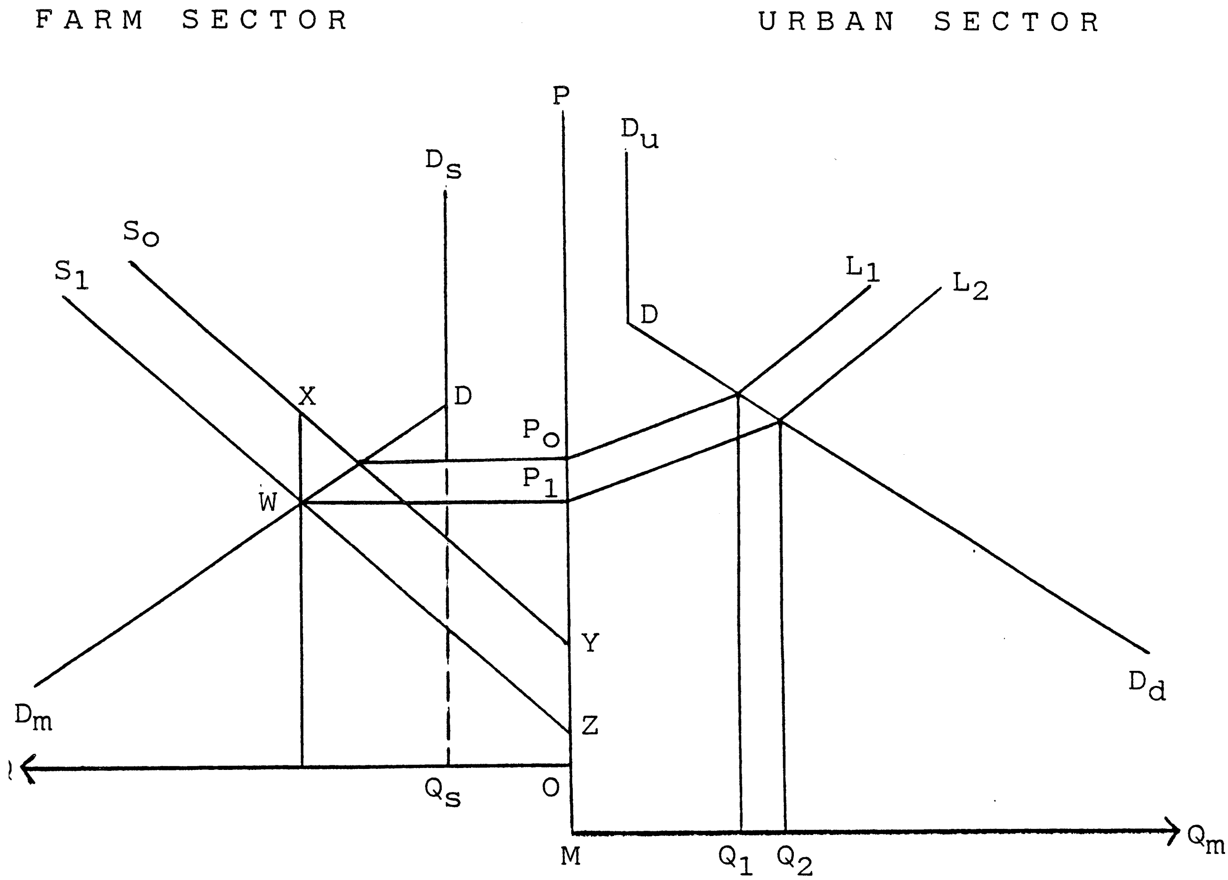


Figure 10. Price Subsidization Through Input.

Reductions of Input Prices

In Figure 10, starting from a supply curve S_o, P_oL_1 illustrates the marketable surplus amounting to MQ_1. However, a reduction of input prices, e.g., a subsidy on fertilizer, will shift the cost curves and so the supply curve of the producer down and to the left in the left section of Figure 10, from S_o to S_1. Producers will profitably supply a greater quantity of crops at any given price level. More production will increase the marketable surplus to a level like MQ_2. The urban food prices will be reduced from MP_o to MP_1. Government costs in terms of input subsidies are WXYZ.

Conclusively, a set of literature pertaining to the kind of alternatives analyzed above is referred to as producer or farm supply response. Supply response specifies the output response to a price change. Supply response involves both movement along a supply curve and shifts in the curve.[2]

FOOTNOTES

[1] E. O. Heady and J. Dillon, Agricultural Production Functions. Iowa State University Press, Ames, Iowa, 1972, pp. 235-239.

[2] For a detailed analysis the reader is referred to Tomek, W. G. and Kenneth L. Robinson, Agricultural Product Prices, 2nd Edition, Cornell University Press, Ithaca and London, pp. 72-92.

CHAPTER III

MBEYA REGION AS A CASE STUDY

The availability of data and its agricultural potential has led the Mbeya region to be chosen for the case study. The aim is to focus on the effectiveness of changes in (a) input costs; (b) output prices; and (c) technology in general on increased food production. The question is if Mbeya producers can increase food production just because their prices have been increased. That is, do producers have resources, inputs, and technology to enable them to increase food production. Price increases, not accompanied by the right set of technology, will not necessarily result in increased production. Increased production may not be possible until technological constraints are corrected. On the other hand, it is possible to hold output prices constant and improve technology or subsidize inputs.

The Geography and Location

The Mbeya region is located in the southern part of Tanzania. It is divided into six districts with an area of 60,387 km. According to the population projections (1980-2000) by region in Tanzania mainland, the region is expected to have a population of 1,336,000 in 1985 of which 1,162,000 will be rural and 174,000 people will be in urban areas.[1]

The Mbeya region is representative of an area which, under proper agricultural husbandry and incentives, could form the grain basket of Tanzania. It has an average rainfall of 1,666 mm. Endowed with fertile soils, Mbeya shares a very big agricultural potential with regions such as Rukwa, Iringa, and Ruvuma.

The Food Crop Sub-Sector

The region is divided into 15 agro-economic zones.[2] As such, agriculturally it is an area with great diversity in terms of resources. Maize and rice form the basic preferred staples for the region. However, a wide range of food crops is grown in the region as indicated in Table 3. The level of technology is still traditional. The 1980 statistics on source of farm energy indicates that 253,000 ha. of land area were cultivated by 156,800 households, using hand labor. About 67,000 ha. were cultivated by 18,700 households using tractors as a source of farm energy.[3] Therefore, over 70 percent of the households still use hand tools in agricultural production.

Toward Understanding Supply Response for Mbeya Region Producers

Agricultural economists and policymakers have frequently been faced with decisions about increasing food production. Usually, the decisions and recommendations have been based on output/input prices and technological improvements. If low output prices are viewed as the problem, the solution

Table 3.1

SUMMARY OF MBEYA REGION FOOD CROPS - INPUTS AND OUTPUTS: 1982

	MAIZE		PADDY		SORGHUM		FINGER MILLET		BANANA		IRISH POTATOES		CASSAVA		WHEAT	
Range	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Average Plot Sizes (ha)	0.13	2.4	0.25	2.9	0.4	1.3	0.05	1.5	0.1	0.9	0.35	0.68	0.05	0.25	0.05	0.05
Average Yield/kg. (ha)	492	2,628	1,399	3,125	287	1,195	300	1,750	3,769	19,760	4,643	4,997	1,616	5,000	580	890
Value of Sales Shs./holding	147	1,912	399	4,654	30	780	45	2,540	34	3,048	1,824	2,791	234	234	4	115
Value of Production Shs./holding	214	6,499	2,845	14,138	828	2,951	75	4,042	768	6,363	2,718	5,184	250	727	104	500
Value of Imports Shs./holding	24	674	26	1,543	15	197	4	128	1	548	162	220	0	6	20	28
Hired Labour Inputs (mandays)	0	358	0	402	0	98	0	96	0	25	0	68	0	0	0	8
Labour Peaks (Months)	July	Feb	Nov	June	Feb	March	Sept	July	Mar	Mar		Sept		Jan		
(Mandays)	11	40	25	64	21	30	8	17	14	23		32		13		
Technology	Dm,Im	H	R	H,Di	Dm	H		H		H		H		H		H
Net Earnings Shs./holding	187	6,198	2,606	12,573	813	2,815	49	3,967	739	6,342	2,487	5,008	241	720	65	65
Total Family Labour Input	12	93	38	156	12	75	4	63	14	112	14	85	5	27	5	8
Net Earnings/Family (Mandays)	13	71	29	88	18	68	8	217	31	89	29	358	27	48	8	93

SOURCE: H. A. Mwaipyana, Indicative Farm Models for the Major Farming Systems in Mbeya Region, Volume I: Main Report, Marketing Development Bureau, Dar-es-Salaam, February 1982.

NOTES: Dm = Little use of draught animals
Im = Little use of purchased inputs
R = Traditional irrigation
H = Hand operations predominates
Di = Use of draught animals is important

has been to increase the level of producer prices. If the problem is associated with the state of technology, the solution is taken to be the introduction of technological packages which sometimes results in inefficient and unprofitable utilization of resources. For example, a lack of spare parts, incomplete technological packages and shortage of foreign exchange have presented major constraints to utilizing these packages.

Such solutions to problems affecting the level of increased production have been inadequate and partial. They are partial because of the number of constraints encountered by a traditional producer in developing countries. For instance, a producer in the Mbeya region is weak in physical equipment, financial resources, and is bound by a number of constraints such as low levels of technology and the lack of physical investment. Before any external help is extended to this producer, consideration of all these constraints should be taken into account in order to allow him to stretch out his capacities to viable opportunities. For example, adoption of better methods of production can be made possible through the reduction of risk and uncertainties. When risks in income variability are reduced, producers can: (a) utilize good agricultural husbandry, and (b) change to better implements in order to overcome, with less effort, the physical constraints encountered in production.

The effectiveness of technology on increasing food crop production is through lowering the costs of production. The importance of a sufficient input delivery system cannot be overestimated. Reference is made to the provision of inputs such as seeds, fertilizers, herbicides, and better farm implements in the production process. Mbeya producers can be expected to have the motivation of producing more food if their costs of production are lowered. However, the lack of adequate storage facilities, poor means of information, transport and communications, and weak delivery systems greatly affect the smooth acquisition of agricultural inputs by producers. If this is accompanied by low product prices, which cannot cover the average total costs, then producers will be unlikely to increase the level of food production in the region and, hence, the country at large. They will not be able to produce a marketable surplus. Increasing output prices, alone, as a means of capturing a positive supply response among producers, might not be sufficient. Other constraints have to be examined so as to ensure effective policies directed to increased food crop production.

Traditional producers have been victims of a misconception that their cash needs are "relatively fixed" and, hence, they produce less. The great implication is the availability of consumer goods in the market. With the availability and enough production of mass consumption of goods, agricultural producers are induced to produce more. Without enough consumer goods, producers will question the desirability of producing more and get cash which cannot be spent. Producers' money is wanted not for its own sake but for the things it will buy. Therefore, even if producers receive higher product prices, modern farm implements, and effective input delivery systems, they will produce less if they are not able to attract and purchase the desired commodities.

To illustrate: transport bottlenecks must be broken so that the marketable surplus can be transported from surplus to deficit regions. Consumer goods must be available in the rural villages so that producers can spend their higher incomes on something they want. Agricultural inputs must be available on a timely basis, at reasonable costs and the marketing authorities must pay promptly for the crops bought, etc. Further, there must be institutional arrangements that ensure that the benefits of the higher prices accrue to the producers and not to potentially inefficient public marketing authorities. In addition, new technology must be available so that the incentives of higher prices can speed up growth of production significantly.[4]

Conclusion

The conceptual economic framework for producers based on supply response is important in order to understand how they can attain increased production. If the level of incentives, e.g., product prices change, these are likely to be correlated with changes in supply shifters, given two time periods. When prices increase, new techniques of production are introduced by producers. This presupposes a backlog of new technologies. In addition, increased output, due to the use of more inputs, can be expected as produce prices increase. For producers, the rate of change of farm output will greatly depend on favorable agricultural prices. They must have an incentive to use new techniques and access to sufficient working capital to make the necessary investments.

The host of constraints encountered by traditional producers explains the imperative of a cautious approach in helping transform traditional food crop production. Although changing relative prices affect resource allocation, the impact of price policy on aggregate output might be small. If there are few new technologies, increases in aggregate output will depend on increased use of fertilizers, seed, and other inputs. A variety of non-price factors may mute the incentive effect of prices, including lack of rural consumer goods and poor infrastructure. Higher food prices will not lead to greater fertilizer use where demand is already constrained by inadequate supplies or ineffective distribution systems. Higher prices, even above world market levels and limited storage capacity, will make even temporary surpluses very costly.[5] In other words, many other things are necessary to accompany higher prices for agricultural producers to produce extra supply for the market. Among these is the removal of physical, social, and administrative barriers to increased supply.

FOOTNOTES

[1]The United Republic of Tanzania. Tanzania National Food Strategy. Main Report. Ministry of Agriculture, N.F.S. Report, Dar-es-Salaam, June 1982.

[2]Indicative Farm Models for the Major Farming Systems in Mbeya Region by H. A. Mwaipyana, Vol. 1: Main Report. Marketing Development Bureau, Dar-es-Salaam, February 1982.

[3]Tanzania National Food Strategy. Main Report. Ibid.

[4]Paul Streeten, "Food Prices as a Reflection of Political Power," in Ceres No. 92. FAO Review on Agriculture and Development, Vol. 16, No. 2, March-April, 1983, p. 19.

[5]C. Christen and L. Witucki, "Food Problems and Emerging Policy Response in Sub-Saharan Africa." AJAE, Vol. 64, No. 5, December 1982, Proceedings Issue.

CHAPTER IV

METHODOLOGY AND DATA

A macro level approach using aggregated data for Mbeya region will be used. The intention is to determine the potential impact of output prices, input subsidies and technological changes on increasing food crop production to allow a marketable surplus for urban consumers.

Linear Programming (LP) will be applied to test the hypotheses and indicate the normative supply function for the Mbeya region. The function is normative in the sense that it will explain what ought to hold true if farmers were to allocate their resources with the objective of maximizing net revenue. It will not explain why producers in fact provide a somewhat different pattern of production and resource use.[1] Hence, the resulting supply function cannot claim to predict Mbeya producers' actual response to price changes with certainty.

Farm budget data for the Mbeya region will be used to determine cost coefficients for the existing production in the region.[2] These will be compared with farm budget data based on production cost estimates classified for Mbeya region.[3] Based on research data, additional coefficients will represent improved production conditions in the region.

Analytical Procedure

A regional programming model for food crop production will be formulated for the Mbeya region. The objective function maximizes total farm income less variable costs, assuming the availability of inputs and a set of output prices. Total variable costs consists of expenditures on chemicals (fertilizer, insecticides) and seeds.

Production Activities

Production activities are based on potential land use in the region.

Table 4.1

Land Use Potential for Mbeya Region 1982

Crop	Districts	Land Class
Maize	Rungwe, Mbeya, Chunya, Mbozi and Ileje	LAA, LAB, LAC
Rice	Kyela, Mbeya	LAD, LAB
Groundnuts	Mbozi, Chunya	LAC, LAB
Beans	Chunya, Mbeya, Mbozi	

Notes: LAA = Soils of low fertility in areas of high rainfall.
LAB = Soils of low to medium fertility with moderate potential.
LAC = Various alluvial or colluvial soils of considerable potential but often requiring flood control drainage or special management.
LAD = Soils of medium to high fertility with high potential.

SOURCE: Land Use Potential Map, 1967, Atlas of Tanzania.

Selling Activities

Selling activities are limited to the domestic market, initially assuming the official government producer price for each crop. The inclusion of the selling activities in the model is a realistic description of aggregate food market conditions given output prices. The activities will indicate the amount of marketable surplus from each of the production activities. The level of marketable surplus will be compared to the urban food requirements in the Mbeya region. The intention is to see if the urban demand for food can be met with production from the region, and, if so, at what prices. Surplus food above Mbeya's urban needs is assumed to be marketed outside the region.

Consumption Activities

The consumption activities focus on an annual subsistence food requirement based on calculations of calories from each crop. An average farm family of eight members is assumed. The data for an average family's food needs and the size of the farm population are used to calculate the entire annual food needs for Mbeya farm families.

Calorie and protein needs can be met by any combination of food. However, the study has specified a number of crops as a mix that was assumed. For Mbeya region rural families this is justified on the basis that food tastes do not change in the short run. Maize and rice are the dominant preferred food in the region. The procedure for presenting average family food requirements is illustrated by the following tables.

Table 4.2

Nutritional Analysis of Food Demand in Tanzania
Average Per Capita 1980

Item	Grams/ day	No. of Calories/ day	Protein Grams/ Day
Rice	33	115	2.3
Maize	237	766	17.8
Groundnuts	3	5	0.4
Beans	51	174	11.3

SOURCE: Tanzania National Food Strategy. Main Report, Dar-es-Salaam, June 1982 (Table 5.4).

An average family in Mbeya region is assumed to consist of eight people. Nutritional requirements data on an average Tanzanian is taken from a study namely An Analysis of the Food Crop Subsector.[4] Based on the data, calculations of the nutritional requirements for an average Mbeya region family are made to determine the kilocalories and protein gram requirements. Age distribution, characteristics and nutritional requirements assumed for the family members in a household are shown in Table 4.3.

The consumption activities in the model will also show if the different types of production activities are able to meet regional family subsistence requirements. Conversion

Table 4.3

KILOCALORIE REQUIREMENTS PER TANZANIAN FAMILY PER TIME PERIOD SPECIFIED

Age Years	Percentage Requirements of Kilocalories[a]	Maize	Rice	Ground-nuts	Beans
0 - 1[b]	20	153.2	23.0	1.0	34.8
1 - 5	42	321.7	48.3	2.1	73.1
5 - 10	55	421.3	63.3	2.75	95.7
10 - 15	78	597.5	89.7	3.9	135.7
15 - 20	93	712.4	108.8	4.65	161.8
20+ Male	83	635.8	95.5	4.15	144.4
20+ Female[c]	83	635.8	95.5	4.15	144.4
20+ Female[d]	100	766.0	115.0	5.0	174
Total per family per day		4244.0	639.0	28.0	964.0
Total per family per month		127320	19170	831	28920
Total per family per year		1527840	230040	9972	347040

[a]Calculated from recommended daily intake of nutrients for East Africa. See An Analysis of The Tanzanian Food Crop Subsector by University of Missouri-Columbia, p. 121.

[b]Requirements in addition to that provided by mothers' milk.

[c]Very active, not pregnant or lactating.

[d]Very active, is pregnant and/or lactating.

Table 4.4

PROTEIN REQUIREMENTS PER TANZANIAN FAMILY
PER TIME PERIOD SPECIFIED

Age/Years	Percentage Requirements of Protein[a]	Maize	Rice	Ground-nuts	Beans
0 - 1[b]	28	4.98	0.64	0.11	3.2
1 - 5	50	8.9	1.15	0.2	5.7
5 - 10	61	10.85	1.40	0.24	6.9
10 - 15	67	11.9	1.54	0.27	7.6
15 - 20	72	12.8	1.65	0.29	8.1
20+ Male	72	12.8	1.65	0.29	8.1
20+ Female[c]	67	11.9	1.54	0.27	7.6
20+ Female[d]	100	17.8	2.3	0.4	11.3
Total per family per Day		92	12	2.0	59
Total per family per Month		2760	360	60	1770
Total per family per Year		33120	4320	720	21280

[a]Calculated from recommended daily intake of nutrients for East Africa. See An Analysis of the Tanzanian Food Crop Subsector by University of Missouri-Columbia, p. 121.

[b]Requirement in addition to that provided by mothers' milk.

[c]Very active, not pregnant or lactating.

[d]Very active, is pregnant and/or lactating.

of kilocalories into kilograms provides a figure for each crop necessary to satisfy the amount of food needed by an average family on an annual basis. Calculations are based on the information provided in Table 4.5. Also, Appendix A.

Table 4.5

ANNUAL AVERAGE KILOCALORIES AND PROTEIN REQUIREMENTS OF A TANZANIAN FAMILY

Crop	Annual Avg. Family Kilo-calorie Requirements	Annual Avg. Family Protein Requirements	Kilograms Per Year
Maize	1,527,840	34,475	473.0
Rice	230,040	33,110	65.0
Groundnuts	9,972	798	6.0
Pulse (Beans)	347,040	22,200	100.0

NOTE: Calculations are derived from Table 4.3.

Capital Borrowing Activity

A capital borrowing activity is introduced in the model. It is intended to indicate the potential impact of credit on producers' operations. Capital borrowing will be based on the on-going interest rate of 8.5 percent. The capital borrowing activity will be related to the possibility of regional producers using animal-drawn implements instead of hand tools, especially for maize production.

Traditional Factors of Production

Conventional inputs play the dominant role in the food crop sub-sector in Mbeya region. These consist of land and labor.

Land

Land as a constraint is divided according to land quality and potential use. Four land quality classes will be considered in the study.

1. Soils of low fertility in areas of high rainfall. These cover an area of approximately 667,700 hectares.

2. Soils of low to medium fertility with moderate potential. These cover an area of approximately 3,929,520 hectares.

3. Various alluvial or colluvial soils of considerable potential, but often requiring flood control drainage or special management. These cover approximately 1,677,850 hectares; and

4. Soils of medium to high fertility with high potential. These cover approximately 1,310,374 hectares.

Labor

The total rural population is taken as the base for determining this resource. Calculations are based on 1985 expected regional population data. Since 13 percent[5] of the regional population is assumed to be urban, this amount is deducted from the total population. The remaining figure represents rural population. About 46 percent[6] of

Table 4.6

LAND AREAS OF MBEYA REGION CLASSIFIED ACCORDING TO POTENTIAL LAND USE

Type of Land Area	Percentage Distribution	Square Miles	Square Kilomiles	Number of Hectares
A	8.0	2,568	6,677	667,700
B	36.3	11,652	30,395.2	3,929,520
C	22.5	7,222.5	18,778.5	1,677,850
D	15.7	5,039.9	13,103.7	1,310,374
E	13.8	4,429.8	11,517.5	1,151,748
F	3.6	1,155.6	3,004.6	300,460

A = Soils of low fertility in areas of high rainfall.

B = Soils of low to medium fertility with moderate potential.

C = Various alluvial or colluvial soils of considerable potential but often requiring flood control, drainage or special management.

D = Soils of medium to high fertility with high potential.

E = Soils of very low fertility with moderate potential.

F = Soils unsuitable for cropping.

SOURCE: Derived from Land Use Potential Map, 1967, Atlas of Tanzania.

the population is less than fifteen years old. The figure for this measure is subtracted from the total rural population to arrive at an estimate of the size of the adult population in rural areas.

Labor as a constraint is expressed in terms of man days per hectare given different cropping activities. In order to obtain the total labor utilized, assumptions are needed about the equivalence of work units by age and sex. A great deal of controversy exists as to the equivalencies.[7] Delgado writes, "there is very little or no basis for estimating that a female worker is worth less than a male worker in the same age group."[8]

The study uses equivalencies based on age for both sexes. The study assumes a weight of 0.262 for the population aged up to ten years and a weight of 0.76 for the population aged from ten years to fifteen years. A weight of 1.0 is attached to the population from fifteen years and above. Based on the population composition figures for Tanzania, a total rural labor force of approximately 842,070 man-days was calculated for the Myeba region. Population up to ten years comprise 33 percent of the total Mbeya region's rural population. Given a weight of 0.262, this age cohort contributes approximately 100,561 man-days. The population cohort aged between ten to fifteen years which makes approximately 13 percent of the total region's rural population contribute approximately 113,402 man-days. Therefore, the total population aged up to fifteen years contributes a total of approximately 214,000 man-days. Adding the amount to the total region's rural adult population of 628,069 the region has a capacity of approximately 842,070 man-days as a source of farm energy. The following table shows the population composition of Mbeya region. See Appendix B for Mbeya region's total population data by districts and selected characteristics.

Table 4.7

POPULATION COMPOSITION OF THE MBEYA REGION
(as expected in 1985)[a]

Age	Percentage Distribution[b]	Total Rural Population
0 - 1	5%	58,155
1 - 6	15	174,464
6 - 10	13	151,202
10 - 15	13	151,202
15 & Above	54	628,069
	100%	1,163,092

[a]Calculations are based on 1985 population projections data given in United Republic of Tanzania, National Food Strategy, Main Report, Ministry of Agriculture, Dar-es-Salaam, June 1982.

[b]See "An Analysis of the Tanzanian Food Crop Sub-sector." Final Report Contract No. AID/CM/Afr-C-73-11 by University of Missouri-Columbia (p. 120).

Working Capital

Working capital is incorporated in the program model and the amount is expressed in terms of Tanzanian shillings.

Table 4.8

CAPITAL REQUIREMENTS OF DIFFERENT TYPES OF FARMING TECHNIQUES

Level of Technology	Investment Goals	Recurrent An. Costs or Hire Chg.	No. of hectares	Cost Per Hectare (Tz. Shs.)
Hand Tools Only[1] (a)	175.00	60.00	1.0[a]	60.00
(b)		9.00	2.0[b]	45.00
Hand Tools	175.00	144.00	3.6[b]	40.00
& Ox Plow	5,300.00	1,524.00[c]	6.0[b]	254.00
Hand Tools &	175.00	144.00	3.6	60.00
Tractor Plow		2,160.00	3.6	600.00[d]

[a]Farms using hand tools only average 2.2 ha. However, a large number of small holder farms are only 1 ha. or less in size. Coding has, therefore, been shown for two different farm sizes.

[b]Farmer increases the size of his farm to 3.6 ha. and hires out oxen for 2.4 ha.

[c]25 percent on animals, 20 percent on equipment, no depreciation on animals due to eventual sale for meat.

[d]Estimated current commercial charge of Tz. Shs. 600 per ha.

SOURCE: Tanzania National Food Strategy. Main Report. Ministry of Agriculture, Dar-es-Salaam, June 1982, p. 222.

NOTE: Hand tools set comprises: 2 hoes, 2 pangas, 1 axe, and 1 sickle

Animal draught equipment includes: 1 pair oxen, 1 yoke, 2 trek chains, and 1 plow

Fertilizer is expressed in terms of kilograms per hectare. The total amount of small holder fertilizer use for 1985 in Mbeya region is taken as the base level for the resource.

Consumption Level As A Constraint

The total amount of food requirements for the region's farm population for each food crop is put in the model as a constraint. Any amount of food production over and above this constraint is taken as the marketable surplus. The annual food requirement per household is expressed in terms of kilograms. The method used in arriving at the entire regional food requirements is that of multiplying the annual requirement per household by the total number of regional households. With an expected rural population of 1,163,091 in 1985, Mbeya region will have approximately 145,386 households, assuming each to have eight members.

Table 4.9

ANNUAL AMOUNT OF FOOD REQUIREMENTS FOR EACH CROP UNDER STUDY[1] FOR THE MBEYA REGION'S RURAL FAMILIES BY 1985

Crop	Total Required	Kilograms	Metric Tons
Maize	473[2] x 145,386	68,767,578	68,768
Rice	65[2] x 145,386	9,450,090	9,450
Groundnuts	6[2] x 145,386	872,316	872
Beans	100[2] x 145,386	14,538,600	14,539

[1]Nutritional requirements can be met by many combinations of many crops. The mix is restricted as shown because this is the mix now commonly consumed. It is justifiable to state that food tastes do not change in the short run.

[2]Annual required amount per household.

Output Prices

The official government output prices will be used initially in the model. Output prices for the Mbeya region are those for the 1984-85 cropping season.

Table 4.10

GOVERNMENT ANNOUNCED PRODUCER PRICES BY 1984-85*

Crops	Price Level in Tz. Shs.
Millet/Sorghum	1.60
Cassava	2.00[a]
Groundnuts	8.00
Beans	8.00[b]
Rice	6.00[c]
Maize	4.00[d]

[a]The crop is assumed to be First Grade cassava.

[b]The crop is assumed to be First Grade beans.

[c & d]Price for recommended regions for which Mbeya region is taken to be among those recommended.

SOURCE: "Producer Prices Up" in Mwenge: Newsletter of the Embassy of Tanzania, December 30, 1983, p. 4.

*The President of Tanzania, Mwalimu J. K. Nyerere announced these new producer prices for the 1984-85 farming season in Tabora on October 19, 1983.

Input Prices

Input prices used in the model are those for fertilizers, insecticides, and seeds in the country. The domestic prices and subsidy element for various fertilizers shown below indicate that the subsidies represent 30 to 50 percent of the ex-factory price.

Table 4.11

PRICES AND SUBSIDY OF FERTILIZERS IN TANZANIA 1982

Fertilizer Product	Ex-factory Price Tanga Shs/mT	Selling Price Shs/mT	Subsidy Shs/mT	Subsidy as % of Ex-factory Price
Sulphate of Ammonia	3,327	1,881	1,446	43
T.S.P.	4,390	2,116	2,274	51
S.O.P.	2,535	1,783	752	30
NPK 25-5-5	4,289	2,171	2,118	49
NPK 20-10-10	4,351	2,468	1,883	43
NPK 6-25-18	5,034	2,420	2,614	52
Urea	Imported	3,115	Nil	-
CAN	Imported	2,214	Nil	-

TSP = Triple-Super Phosphate
NPK - Nitrogen, Phosphorous, Potassium
CAN = Calcium Ammonium Nitrate

SOURCE: Tanzania National Food Strategy. Main Report, Ministry of Agriculture Dar-es-Salaam, June 1982, p. 132.

The input costs and prices used in the model are those indicated in the production cost estimates published by the Maize Development Bureau, Tanzania.

Table 4.12

TANZANIAN SMALL HOLDER EXPENDITURES ON INPUTS 1982-83

	Cost
A. SEED	
1. Maize:	
Composite Seed	8.00 Tz Shs/kg
Hybrid Maize	12.00 Tz Shs/kg
2. Rice:	
Upland-traditional	2.30 Tz Shs/kg
Irrigated-traditional	2.30 Tz Shs/kg
Irrigated-improved	7.00 Tz Shs/kg
3. Groundnuts	4.80 Tz Shs/kg
B. FERTILIZER	
TSP	2.12 Tz Shs/kg
SA	1.88 Tz Shs/kg
C. INSECTICIDES	
Thiodan	9.66 Tz Shs/kg

SOURCE: J. M. Stainburn, "Production Costs of Major Agricultural Commodities in Tanzania." Marketing Development Bureau, Dar-es-Salaam, October 1982.

The Production Technology Set

The levels of all of the technical co-efficients in the program model, except the resource level constraints are per hectare. Each cropping activity consists of yield per hectare, together with fixed proportions of inputs, namely land, labor, chemicals, seed, and working capital.

A study of the Mbeya region's farming systems was the basis for the relationships between yields and inputs for each crop under study.[9] The relationships reflect the conditions as they currently exist in the Mbeya region. The Marketing Developing Bureau has estimated the relationships for improved technology for each crop in the study.[10] The estimates for both conditions, however, are not necessarily the biological or profit maximizing optima. Nevertheless, the data are used under the assumption that they provide a reliable basis for estimating the costs and benefits of the different programs to be investigated in the study.

Existing Production Conditions (Technology Set I) versus Improved Production Conditions (Technology Set II)

The production activities are going to be analyzed based on two sets of technology, i.e., existing and improved. The existing production conditions represent the set of typical technology levels. This technology is currently in use. It is taken in contrast to the improved one (Technology Set II). The improved technology is assumed to be profitable and technically feasible for the Mbeya region's food producers. However, as yet, it has not been generally adopted by the average region's producers. Farm budget data for both technology sets are shown in Tables 4.13 through 16.

Table 4.13

FARM BUDGET DATA FOR EXISTING PRODUCTION CONDITIONS IN MBEYA REGION (Technology Set I)

Labor Days per Hectare	Activities, Costs & Yields			
	Maize	Rice	Groundnuts	Beans
Land Preparation	13	13	45	28
Planting	7	14	27	15
Irrigation	-	1	-	-
Apply Fertilizer	2	-	-	-
Weeding	22	31	30	28
Crop Production, Harvesting, Processing-Storage	14	23	100	15
Marketing	1	1	15	2
TOTAL	59	103	217	88
Input Cost/Hectare	289	440	502	168
Yields kgs./ha.	1,363	1,841	1,428	2,400

SOURCE: Indicative Farm Models for the Major Farming Systems in Mbeya Region. Volume II, H. A. Mwaipyana, Agricultural Production Economist, Marketing Development Bureau, February 1982.

Table 4.14

MAIZE: SMALLHOLDER PRODUCTION COSTS AND RETURNS UNDER IMPROVED CONDITIONS, SH PER HA PRODUCTION YEAR 1981-82, MARKETING YEAR 1982-83

	PACKAGE 1	PACKAGE 2	PACKAGE 3
YIELD: Kg Per Ha	1,500	2,200	2,700
PRODUCER PRICE: Sh Per Kg	1.75	1.75	1.75
REALIZATION: Sh	2,625	3,850	4,725

PRODUCTION COSTS	LABOUR DAYS	INPUT COST SH	LABOUR DAYS	INPUT COST SH	LABOUR DAYS	INPUT COST SH
Land Preparation, Flat or Ridge	40		40		40	
Planting: Kg/Ha 25						
Composite Seed @Sh/Kg 8.00(Packages 1,2)	10	200	10	200		
Hybrid Seed @Sh/Kg 12.00(Package 3)					10	300
Fertilizer						
TSP (Packages 2,3)						
Kg/Ha 50 @Sh/Kg 2.12			1	106	1	106
SA (Package 2)						
Kg/Ha 100 @Sh/Kg 1.88			2	188		
(Package 3)						
Kg/Ha 150 @Sh/Kg 1.88					3	282
Weeding	25		25		25	
Pest Control						
Thiodan 4 Kg/Ha 10 @Sh/Kg 9.66	1	97	1	97	1	97
Harvesting, Shelling, Transport	50		55		65	
Marketing, Transport	5		5		5	
Total Labour/Cost: Day/Sh	131	297	139	591	150	785
Gross Margin: Sh		2,328		3,259		3,940
Return Per Labour Day: Sh		18		23		26

SOURCE: MDB, After the National Maize Project Classification.

Table 4.15

PADDY: SMALLHOLDER PRODUCTION COSTS AND RETURNS, SH PER HA
PRODUCTION YEAR 1981-82, MARKETING YEAR 1982-83

	TRADITIONAL				IMPROVED CONDITIONS IRRIGATED			
	UPLAND		IRRIGATED		NO FERTILIZER		WITH FERTILIZER	
YIELD: Kg Per Ha	400		2,500		3,000		3,600	
PRODUCER PRICE: Sh	3.00		3.00		3.00		3.00	
REALIZATION: Sh	1,200		7,500		9,000		10,800	
	LABOUR DAYS	INPUT COST SH	LABOUR DAYS	INPUT COST SH	LABOUR DAYS	INPUT COST SH	LABOUR DAYS	INPUT COST SH
Land Preparation	55		46		46		46	
Nursery Establishment			5		5		5	
Broadcasting Seed	1							
Seed								
Traditional Smallholder								
Upland:Kg/Ha 30 @Sh/Kg 2.30		69						
Irrigated:Kg/Ha 40 @Sh/Kg 2.30				92				
Improved Smallholder								
Irrigated:Kg/Ha 100 @Sh/Kg 7.00						700		700
Transplanting			118		118		118	
Fertilizer								
SA Kg/Ha 175 @Sh/Kg 1.88							3	329
Weeding	40		41		41		41	
Irrigation			4		4		4	
Bird Scaring			60		60		60	
Harvesting	18		54		54		54	
Threshing, Winnowing	6		44		54		64	
Transport, Marketing			2		2		2	
Total Labour/Cost: Day/Sh	120	69	374	92	384	700	397	1,029
Gross Margin: Sh		1,131		7,408		8,300		9,771
Return Per Labour Day: Sh		9		20		22		25

SOURCE: MDB

Table 4.16

GROUNDNUTS: PRODUCTION COSTS AND RETURNS, SH PER HA PRODUCTION YEAR 1981-82, MARKETING YEAR 1982-83

			TYPICAL SMALLHOLDER		IMPROVED SMALLHOLDER	
YIELD: Kg Per Ha			300		700	
PRODUCER PRICE: Sh Per Kg			5.80		5.80	
REALIZATON: Sh			1,740		4,060	
PRODUCTION COSTS			LABOUR DAYS	INPUT COST SH	LABOUR DAYS	INPUT COST SH
Land Preparation			35		45	
Sowing Own Seed Kg/Ha	60 @Sh/Kg	4.80	20	288	25	288
Seed Dressing BHC 5 Percent Gm Per Kg Seed	3.33 @Sh/Kg	10.66			2	2
Fertilizer TSP Kg/Ha	100 @Sh/Kg	2.12			2	212
Weeding			30		30	
Lifting			30		50	
Picking			15		20	
Shelling, Sorting			20		30	
Transport, Marketing			10		15	
Total Labour/Cost: Day/Sh			160	288	219	502
Gross Margin: Sh				1,452		3,558
Return Per Labour Day: Sh				9		16

SOURCE: MDB

Application of the Model

Linear programming will be run on a comparative basis between existing production conditions (Technology Set I) and improved production conditions (Technology Set II). The analysis will determine: (a) how efficiently the region uses resources given the existing conditions; (b) whether existing conditions can bring more output only through the acquisition of improved technology, or (c) if technology or product prices are the major handicaps to increased food production. The result of the analysis will form the basis of rejecting or accepting the specific hypotheses of the study.

Range Analysis

The range analysis will be used to extend the information provided in the optimal solution. It will help in making more useful interpretation of the shadow prices by providing an estimate of the range over which a shadow price for each resource is relevant.[11]

Parametric Routines

A post optimal analysis, parametric programming, will be used to evaluate the effect of changes in input and output prices, resources, and technology levels in the program. With the appropriate modifications in the objective function, the technical coefficients and resource levels, the model will simulate how a regional food production sector behaves given: (a) increased output prices; (b) reduced input costs; (c) increased levels of technology; (d) free market conditions; and (e) controlled ones.

A series of alternative producer prices and reduced input price scenarios will be analyzed empirically for Mbeya producers. The range of output prices will be the difference between officially fixed producer prices for food and the black market prices. The black market prices are taken to represent the free market situation. Input prices will be applied in the model given different percentages of subsidies. The process will show how increasing output prices or decreasing input costs in the Mbeya region, based on the level of these other prices, would affect the optimum mix of activities and the level of food production. The Mbeya region producers' response to price stimuli will, thus, be identified.

The entire analysis via the linear programming technique opens up the possibility to examine systematically the impacts of public interventions in the food crop production sector or the region. The results will be analyzed with reference to the government's official fixed prices and subsidy alternatives to producers in order to test for alternative adjustments and their consequences. If a wide gap exists between actual and optimal responses, the idea would be for policymakers to provide economic incentives to bridge the gap so as to improve the level of production.

The development of the linear programming model will assist in determining the volume of inputs needed for production under improved technology relative to the capacity of the input supply system in the Mbeya region. The use of secondary data on regional storage facilities and the amounts of inputs channelled to the region will help the study to determine if there are going to be handling bottlenecks if producers' supply response turn out to be highly positive. The central issue will be to determine if the Mbeya region has an input system with enough capacity to handle the needed volume of purchased inputs if economically optimum quantities are used.

FOOTNOTES

[1]Earl O. Heady and W. Candler. Linear Programming Methods. The Iowa State University Press, 1963, p. 708.

[2]Henry A. Mwaipyana. Indicative Farm Models for the Major Farming Systems in Mbeya Region: Vol. I, Main Report. Marketing Development Bureau, Dar-es-Salaam, February 1982.

[3]J. M. Stainburn. Production Costs of Major Agricultural Commodities in Tanzania. Marketing Development Bureau, Dar-es-Salaam, October 1982.

[4]"An Analysis of the Tanzania Food Crop Subsector." Final Report, Contract No. AID/CM/Afr-C-73-11, by the University of Missouri-Columbia (Dr. Melvin Blase, Team Leader).

[5]1982 World Population Data Sheet.

[6]1982 World Population Data Sheet.

[7]Jean M. Due and P. Anadajayase Keram. Two Contrasting Farming Systems in Morogoro Region, Tanzania. Department of Agricultural Economics, University of Illinois at Urbana-Champaign, July 1982, p. 27.

[8]Delgado, Christopher L. Livestock vs. Foodgrain Production in Southeast Upper Volta: A Resource Allocation Analysis. Center for Research on Economic Development, University of Michigan, Ann Arbor, 1979, p. 98.

[9]Henry A. Mwaipyana, Ibid.

[10]J. M. Stainburn, Ibid.

[11]Raymond R. Beneke and R. Winterboer. Linear Programming Applications to Agriculture. The Iowa State University Press, Ames, 1973, p. 121.

CHAPTER V

ANALYTICAL RESULTS

A comparative run between existing production conditions (Technology Set I) and improved production conditions (Technology Set II) represented the initial run. The aims were to determine the impact of (1) product prices; (2) input costs; and (3) technology on increasing food production to allow marketable surplus.

Four crops — maize, rice, beans, and groundnuts — were analyzed. Production activities for the crops were based on the information given in Tables 21 through 24. Due to the small size of the Mbeya region and the relatively good means of transportation compared to most regions in Tanzania, labor was assumed to be mobile throughout the region. The total rural labor supply formed the resource level as the source of farm energy. The amount of working capital assumed to be available was taken to be low.[1] The assumption was relaxed in the course of the study. The entire analysis assumed that all land in the region was available for food crop production.

Results of Run I (The Basis Solution)

Run I optimized net income, with an income of approximately 588 million Tz. Shs. The run used approximately

333,156 hectares out of 6,885,444 hectares in the region. This is about 4.8 percent of the total land area. Owned or subsistence food requirements for the rural producers were met for each food crop. The traditional production technology for maize produced about 50.5 percent of the total subsistence requirements. Maize production based on Technology Set II, i.e., using composite seed and fertilizer (Package 3), produced the remaining 49.5 percent of the total subsistence requirement. Traditional technology was used for rice, beans, and groundnuts to produce subsistence requirements. A reduction of one kilogram in the levels of subsistence requirements for maize, rice, groundnuts, and beans cost the regional food producers 4.00 Tz. Shs., 6.00 Tz. Shs., 21.77 Tz. Shs., and 8.00 Tz. Shs., respectively.

The Limiting Factors of Production in Run I

The following turned out to be the major constraint, i.e., the major limiting factor in food production: (a) labor for land preparation and weeding maize; (b) labor for weeding rice; and (c) land preparation labor for beans and groundnuts. A reduction of one manday for preparing land or weeding maize, reduced the value of the regional program by 179.70 Tz. Shs. and 128.49 Tz. Shs., respectively.

A reduction of one manday for weeding rice reduced the program's value by 264.72 Tz. Shs., while for preparing land for beans and groundnuts it reduced the program's value by 679.71 Tz. Shs. In comparison, the prevailing daily wage for this type of labor in the area is approximately 18 Tz. Shs.

Production of Marketable Surplus in Run I

Run I generated a considerable amount of marketable surplus. However, Technology Set II, generated a marketable surplus only in the case of maize. The marketable surplus for maize was approximately 115 metric tons, given the prevailing output price of 4.00 Tz. Shs./kg. The rice production activity under traditional technology had a marketable surplus equivalent to 4,804 metric tons given the prevailing price of 6.00 Tz. Shs./kg. The bean production activity generated a marketable surplus of 6,910 metric tons at the output price of 8.00 Tz. Shs./kg.

Range Analysis on Run I

Maize Production

The range analysis showed the marginal value product or shadow price of labor for maize to be 179.70 Tz. Shs. and 128.49 Tz. Shs. for land preparation and weeding, respectively. Each manday reduction in labor for land preparation from 842,070 to 832,764 mandays reduced the value of the program by 179.70 Tz. Shs. Conversely, each manday beyond 842,070 to 859,294 would add 179.70 Tz. Shs. to the value of the program. On the other hand, each manday reduction in weeding labor from 843,070 to 827,976 mandays reduced the value of the program by 128.49 Tz. Shs.

Each manday added beyond 842,070 to 894,336 mandays would add 128.49 Tz. Shs. Maize production using hybrid seed and fertilizer (Technology Set II, Package 2) did not enter the plan. Forcing maize production under Package 1 into the plan would result in an income penalty of 4,311.99 Tz. Shs. If the activity is forced above 384 hectares, the penalty would increase. Forcing maize production under Package 2 into the plan would result in an income penalty of 1,805.99 Tz. Shs. If the activity is forced above 170 hectares the penalty would increase.

Rice Production

The marginal value product or shadow price for weeding rice was 264.72 Tz. Shs. Each manday reduction in weeding labor from 842,070 to 207,902 mandays reduced the value of the program by 264.72 Tz. Shs. Each manday added beyond 842,070 to 1,395,806 mandays would add 264.72 Tz. Shs. to the value of the region's agricultural food output.

Irrigated rice production without the use of fertilizer did not enter the plan. Forcing the activity into the plan would create an income penalty of 10,496.36 Tz. Shs. If the activity is forced above 3,150 hectares, the penalty would increase. Irrigated rice production with fertilizer use, would result in an income penalty of 7,146.36 Tz. Shs. if forced into the plan. If the activity is forced beyond 2,625 hectares the penalty would increase. Both of these rice production activities are categorized in Technology Set II.

Bean and Groundnut Production

The shadow prices for preparing land for beans and groundnuts was 679.71 Tz. Shs. Each manday reduction in land preparation labor from 842,070 to 197,106 reduced the value of the program by 679.71 Tz. Shs. Each manday added beyond 842,070 to 851,232 mandays would add 679.71 Tz. Shs.

Slack Activities

There were slack activities for land and labor for most activities, except for those indicated to be the limiting factors. Working capital had an unused amount, despite the initial pessimistic figure of 13 million Tz. Shs.

Implications Concerning Run I

The linear programming analysis based on Run I, indicated that existing production conditions (Technology Set I) are responsible for the production of regional rural families' own food needs. On an annual basis, the region's producers are able to produce for their own food requirements from each crop. They are also able to channel a relatively small amount of marketable surplus to the urban sectors.

Except for one production activity for maize, i.e., maize production using composite seed and fertilizer, all activities under the improved production conditions (Technology Set II) did not enter the plan. Forcing of the production activities under Technology Set II into the plan proves to be very expensive for traditional producers, as indicated in the range analysis. The major limiting resource or the major constraint has been labor for land preparation and weeding for all four crops, given the respective production activities.

Clearly, there is a need to overcome the major bottlenecks in terms of limiting resources (labor) in order to attain a larger amount of marketable surplus. Although the amount of working capital was taken at a pessimistically low level, the resource did not pose a constraint. Contrary to expectations, traditional technology (Technology Set I) produced better results than the improved production conditions (Technology Set II) in the case of Mbeya region. The analysis suggests that Technology Set II might be unprofitable for the traditional food producers who depend on production methods dominated by handtools.

Hand labor makes approximately 85 percent of the Mbeya region's source of farm energy. For instance, in the case of maize and rice, calculation of the percentage increase in returns between the two technologies shows the following: Traditional maize producers would have to incur an increased cost of 204 percent and 272 percent for Package 2 and Package 3 in order to produce the same amount of own subsistence needs. Traditional rice producers would have to experience a percentage increase of 62 percent and 216 percent in terms of cost even before meeting annual subsistence requirements for using Technology Set II, i.e., irrigated rice without fertilizer use and with fertilizer use, respectively.

Therefore, the packages for improved technology are expensive considering the low income levels of traditional food producers. The packages for improved technology might be partial and incomplete. The level of estimated costs indicated in the farm budget consists of only fertilizer, seed, and herbicides. Other costs might not have been incorporated or closely estimated, hence, not taking account of the ideal package costs. This suggests the improved technology might be even more expensive for producers to afford.

The results reflect relatively closely what actually happens in the traditional agricultural setting. Low levels of income, mostly subsistence production, some unused land and a labor "bottleneck" are characteristic features of traditional agriculture.

Run II: Improvisation of Animal Traction As a Source of Farm Energy to Overcome Land Preparation and Weeding Bottlenecks

The analysis assumed a change in the original technical coefficients to allow animal traction technical coefficients to "break out" of traditional agriculture. (See Tableau in Appendix D.) The aim was to reduce labor requirements for the activities which constituted labor bottlenecks. The level of working capital was not increased given the unused amount in Run I. However, Run II anticipated increased capital needs. No improvisation was done for the technical coefficients for harvesting using animal power as the

Table 5.1

OPTIMAL RESULTS BASED ON RUN I
(Basis Solution)

1. Net Value of Regional Food Output (in Tz. Shs.)	588	million
2. Total Land Use (in Has.)	333,156	
3. Total Fertilizer Used (in Metric Tons)	3,863	
4. Level of Subsistence Food Required and Produced for Rural Population (in M/Tons):		
Maize	68,768	
Rice	9,450	
Beans	14,539	
Groundnuts	872	
5. Level of Marketable Surplus (in M/T):		
Maize	115	
Rice	4,804	
Beans	6,910	
6. Limiting Factors & Shadow Price (in Tz. Shs.):		
Maize: Land Preparation	179.70	
Weeding	128.49	
Rice: Weeding	264.71	
Groundnuts & Beans:		
Land Preparation	679.71	

practice is not widely used for the crops involved in either developing or developed countries.

Results of Run II

The income level increased from 588 million Tz. Shs. in Run I, to 1,130 million Tz. Shs. The run used approximately 599,678 hectares for food crops compared to 333,156 hectares used in Run I. Rural families' subsistence food requirements were more than met. Maize production under traditional technology was responsible for the production of most food needs. However, maize production under Technology Set II (Package 2, using composite seed and fertilizer) produced a marketable surplus equivalent to 1,563 metric tons, given the output price of 400 Tz. Shs./kg. With animal traction rice is produced with both the traditional technology and improved conditions for irrigated rice using fertilizer. The former production conditions produced 10,269 metric tons of marketable surplus, adding to a total of 10,464 metric tons, given the output price for rice of 6.00 Tz. Shs/kg. There was a marketable surplus for beans using traditional technology amounting to 11,965 metric tons. The output price for beans is 8.00 Tz. Shs. per kg. Groundnut production met subsistence requirements only.

Limiting Factors of Production in Run II

Harvesting labor and credit for each crop turned out to be the limiting factors. The shadow prices for labor for maize, rice, groundnuts, and beans are 170.30 Tz. Shs., 68.43 Tz. Shs., and 937.18 Tz. Shs., respectively. The shadow price for working capital was 51.66 Tz. Shs. per hectare.

Range Analysis on Run II

The improved production conditions for maize (Package 1 and Package 3) did not enter the plan. Forcing Package 1 initially into the plan would result in an income penalty of 1,113.62 Tz. Shs. If the activity is forced above 10,041 hectares, the penalty would increase. In the case of rice production, initially forcing the improved conditions for irrigated rice with no fertilizer would result in an income penalty of 3,349.99 Tz. Shs. If the activity is forced above 1,951 hectares, the penalty would increase.

Implications Concerning Run II

The approach of making available animal energy increased quantities of marketable surplus produced for most of the food crops. Traditional technology continued to indicate better results than the improved production conditions. Throughout the analysis harvesting labor was the major limiting resource or constraint. Unless the bottleneck is corrected generation of more marketable surplus in the region may be impossible.

Table 5.2

OPTIMAL RESULTS BASED ON RUN II

1. Net Value of Regional Output (in Tz. Shs.)	1,130	million
2. Total Land Used (in Has.)	509,768	
3. Total Fertilizer Used (in Metric Tons)	3,504	
4. Level of Subsistence Food Required and Produced for Rural Population (in M/Tons):		
Maize	68,768	
Rice	9,450	
Beans	14,539	
Groundnuts	872	
5. Level of Marketable Surplus (in M/T):		
Maize	1,563	
Rice	10,464	
Beans	11,965	
6. Limiting Factors and Shadow price (in Tz. Shs.)		
Maize: harvesting	170.30	
Rice: harvesting	68.43	
Groundnut & Beans: harvesting	937.18	
Working Capital	51.66	

Run III: Overcoming the Harvesting Bottleneck

Most of the preceeding runs indicated harvesting labor to be the major constraining factor. The impossibility of improvising animal traction for harvesting was self-evident. No harvesting is done by animal traction in Mbeya region. Nevertheless, the need of Run III was to reduce the required mandays for harvesting. The method was assumed to use machine power to overcome the bottleneck. This necessitated an increase in the level of working capital by approximately 57 percent.

Results of Run III

The net value of regional output was 1,641 million Tz. Shs. Approximately 669,980 hectares of food crop production were used. All subsistence food requirements by regional rural families were met. Maize production under traditional technology contributed 8 percent of the total subsistence food, while maize production using hybrid seed produced the remaining portion. About 16,766 metric tons of marketable surplus was produced under maize production using traditional technology. The prevailing output price was 4.00 Tz. Shs./kg. Rice production under traditional technology generated a marketable surplus equivalent to 8,565 metric tons given an output price of 8.00 Tz. Shs./kg. Rice production under Technology Set II did not enter the plan. Bean production generated a marketable surplus of

15,926 metric tons, given an output price of 8.00 Tz. Shs./ kg. Groundnut production was able to meet subsistence needs only.

Limiting Factors in Run III

The analysis was aimed at overcoming the harvesting bottleneck. Despite the fact that the constraint was taken care of, another set of constraints developed. Labor for land preparation and weeding maize resulted as limitations with shadow prices of 373.23 Tz. Shs. and 231.85 Tz. Shs., respectively. Labor for weeding rice had a shadow price of 539.25 Tz. Shs. Labor for land preparation for both groundnuts and beans had a shadow price of 1,359.42 Tz. Shs. The groundnut production activity was not able to generate a marketable surplus although it met the annual food intake requirement. The shadow price for working capital was zero, indicating that it was not a limiting resource.

Range Analysis in Run III

The analysis indicated that forcing maize production using composite seed and fertilizer into the plan, would lead to an income penalty of 1,805.99 Tz. Shs. The penalty would increase if the activity were forced beyond 23,554 hectares. Forcing irrigated rice production without and with the use of fertilizer would result in income penalties of 11,280.74 Tz. Shs. and 7,930.74 Tz. Shs., respectively. If the activities were forced beyond 2,150 hectares and

Table 5.3

OPTIMAL RESULTS BASED ON RUN III

1. Net Value of Regional Output (in Tz. Shs.)	1,641	million
2. Total Land Used (in has.)	669,980	
3. Total Fertilizer Used (in Metric Tons)	7,369	
4. Level of Subsistence Food Required and Produced for Rural Population (in M/Tons):		
Maize	68,768	
Rice	9,450	
Beans	14,539	
Groundnuts	872	
5. Level of Marketable Surplus (in M/Tons)		
Maize	16,766	
Rice	8,565	
Beans	15,926	
6. Limiting Factors and Shadow Price (in Tz. Shs.)		
Maize: Land Preparation	373.23	
Weeding	231.85	
Rice: Weeding	539.25	
Groundnuts & Beans: Land Preparation	1,359.42	

2,625 hectares, respectively, the income penalties would increase.

Comparison of the Runs

The results of the different runs are compared in this section to see what happens as assumptions are relaxed and obstacles overcome. The bottlenecks encountered in Run I were basically in the form of labor. Run II was improvised to overcome the bottlenecks through the assumption of animal traction coefficients. The results led to an increased net value of regional food output and the level of marketable surplus, for the region. The harvesting bottleneck was overcome by introducing the assumption of improvised "machine power" technical coefficients. The level of working capital was increased assuming an increased need of capital given a different type of farm energy. The results indicated an even greater increase in the level of net value of regional food output. This was estimated to be a 279 percentage increase compared to Run I. The amount of land and fertilizer used increased by more than 50 percent.

As bottlenecks were overcome, it became more profitable for regional producers to increase the level of their incomes and production. Both runs had a considerable amount of slack variables. The improved production conditions (Technology Set II) did not indicate better results compared to the traditional technology (current production conditions). The farm budget data for Technology Set II

Table 5.4

COMPARISON OF THE RUNS
BASED ON OPTIMAL RESULTS

	Run I	Run II	Run III
1. Net Value of Regional Food Output (in Mil. Tz. Shs.)	588	1,130	1,641
2. Total Land Used (in Has.)	333,156	509,768	669,980
3. Total Fertilizer Used (in M/Tons)	3,863	3,504	7,369
4. Level of Marketable Surplus (in M/Tons):			
Maize	115	1,563	16,766
Rice	4,804	10,464	8,565
Beans	6,910	11,965	15,926
5. Limiting Factors and Shadow Prices (in Tz. Shs.):			
Maize: Land Preparation	179.70	-	373.23
Weeding	128.49	-	231.85
Harvesting	-	170.30	-
Rice: Weeding	264.72	-	539.25
Harvesting	-	68.43	-
Groundnuts & Beans:			
Land Preparation	679.71	-	1,359.42
Harvesting	-	937.18	-
Working Capital	-	51.66	-

Table 5.5

COMPARISON OF THE RUNS BASED ON SLACK VARIABLES

Variable	Run I	Run II	Run III
1. Land (in Hectares)	6,554,288	6,375,676	6,215,464
2. Labor (in Mandays):			
Maize: Land Preparation	-	432,049	-
Planting	535,863	626,045	512,308
Weeding	-	255,819	-
Harvesting	12,759	-	117,772
Rice: Land Preparation	643,035	601,700	623,756
Planting	627,725	483,691	623,756
Weeding	-	20,291	-
Harvesting	520,552	-	499,004
Groundnuts & Beans:			
Land Preparation	-	184,857	-
Planting	390,416	466,607	360,974
Weeding	9,162	189,744	4,887
Harvesting	286,416	-	285,337
3. Working Capital (in Tz. Shs.)	2,557,255	-	9,330,331
4. Fertilizer (in Metric Tons)	16,391	16,750	12,885

presented potential levels of yields and income. The attainment of these levels depend on a number of aspects, namely: (1) Profitability of the package; (2) The availability of inputs; and (3) The income levels of the traditional producers which dictate their savings and investment decisions and, hence, the level of purchasing power.

Sensitivity Analysis on the Model

Run III was subjected to a sensitivity analysis, as a post-optimal analysis. The aim was to estimate the effect of changing the levels of output prices and input costs on the model's results. However, it was necessary to correct the bottlenecks in Run III first, in order to get the impact of increased prices. Labour hiring activities were introduced to labour requirements for the limiting factors in Run III. These were: (1) labour for land preparation and weeding maize; (2) labour for weeding rice; and (3) labour for land preparation for both groundnuts and beans. Labour is hired at a rural wage rate of approximately 20.00 Tz. Shs. per day.

Parametric Programming Routines

Subsidization Through Price of the Product

Producer prices for the four food crops were increased from the official level of government prices by approximately 200 percent. This was done to at least equate the level of prices to the free market solution. (The black market or parallel market in the case of Mbeya region.) Maize prices were increased from 4.00 Tz. Shs. at intervals of 4.00 Tz. Shs. up to 12.00 Tz. Shs./kg. Output prices for beans and groundnuts were increased from 8.00 Tz. Shs. to 24.00 Tz. Shs./kg.

The results indicated changes in the model. Approximately 1,027,808 hectares were used in the model for food crop production. Production activities under traditional technology (Technology Set I) entered the plan. Production activities under Technology Set II did not enter the plan. Resources were allocated for increased production due to increased output prices. Maize production generated a marketable surplus of 95,195 tons, while rice production generated a marketable surplus of 181,929 tons. Beans production generated a marketable surplus of 128,245 tons. There has been no marketable surplus from groundnuts production although subsistence food requirement levels have been met. The net value of regional food output increased from 1,641 million Tz. Shs. to 4,884 million Tz. Shs.

Subsidization Through the Price of the Inputs

Input costs for both production activities were reduced by 50 percent. The exercise represented the impact of input subsidies on increased food production. The amount of the marketable surplus remained at the same level as indicated by increased output prices. (See Table 5.4.)

However, the net value of the regional food output increased from 1,641 million Tz. Shs. to 4,923 million Tz. Shs.

Conclusively, increases in output prices and reductions in input costs have led to increased levels of food production and, hence, the level of marketable surplus. The important explanation to be given is that the impact of increased output prices and reduced input costs was largely felt after the initial correction of the limiting factors in the form of labour peaks. Without overcoming the constraints and, given the level of farm implements, supply is constrained and insulated from the impact of price increases.

Table 5.6

THE IMPACT OF INCREASED OUTPUT PRICES ON MARKETABLE SURPLUS

Crops	Output Price per Kilogram	Level of Marketable Surplus (in M/Tons)
Maize	4.00 Tz. Shs.	16,766
	12.00 Tz. Shs.	95,195
Rice	6.00 Tz. Shs.	8,565
	18.00 Tz. Shs.	181,929
Beans	8.00 Tz. Shs.	15,926
	24.00 Tz. Shs.	128,245

The Level of Mbeya Region's Urban Food Demand Relative to the Region's Marketable Surplus Potential

Regional urban food requirements are calculated based on 1985 expected urban population data, assuming each household consists of eight members. The objective, here, is to compare the level of potential marketable surplus generated by the different runs with the urban food needs in Mbeya region. With an expected population of approximately 174,000 in 1985, Mbeya urban areas will consist of approximately 21,750 households. The table below shows the annual food requirements in urban areas in Mbeya region, given existing food habits.

Table 5.7

URBAN AREAS ANNUAL FOOD REQUIREMENTS

Crop	Annual Requirements per Household	Total Number of Households	Total Number of Kilograms	Metric Tons
Maize	473	21,750	10,387,750	10,288
Rice	65	21,750	1,413,750	1,414
Groundnuts	6	21,750	130,500	131
Beans	100	21,750	2,175,000	2,175

Table 5.8

THE LEVEL OF MARKETABLE SURPLUS GENERATED COMPARED TO THE REGIONAL URBAN FOOD REQUIREMENTS (In Metric Tons)[a]

	Amount Generated	Annual Regional Urban Food Requirement	Food Balance Deficit (-) or Surplus (+)
	Metric Tons		
A. RUN I			
Maize	115	10,288	- 10,173
Rice	4,804	1,414	+ 3,390
Beans	6,910	2,175	+ 4,735
Groundnuts	-	131	- 131
B. RUN II			
Maize	1,563	10,288	- 8,725
Rice	10,464	1,414	+ 9,050
Beans	11,965	2,175	+ 9,790
Groundnuts	-	131	- 131
C. RUN III			
Maize	16,766	10,288	+ 6,478
Rice	8,565	1,414	+ 7,151
Beans	15,926	2,175	+ 13,751
Groundnuts	-	131	- 131
D. RUN IV			
Maize	95,195	10,288	+ 84,907
Rice	181,929	1,414	+180,515
Beans	128,245	2,175	+126,070
Groundnuts	-	131	- 131

[a]The level of marketable surplus generated is as shown in the runs.

Conclusion

The comparison shows that only through overcoming most of the bottlenecks, more marketable surplus for maize could be generated. There is a considerable amount of marketable surplus in the region in terms of rice and beans. Runs I and II on the food balance section of the table shows the region to have a deficit in maize. All amounts in surpluses implies the region's possibility in inter-regional trade. With a considerable amount of surplus for other food crops, it is possible for the region to buy from other regions. Noteworthy, there has been no marketable surplus for groundnuts throughout the entire analysis.

Mbeya Region's Input Handling Capacity

One of the aims of the study was to determine if the Mbeya region has enough capacity in its input system to handle the needed volume of purchased inputs required in the different runs. The determination of the region's input system's capacity is based on secondary data covering storage and the amount of fertilizer used. The following table shows the primary and secondary storage capacities in Mbeya region.

Table 5.9

REGIONAL STORAGE CAPACITY IN MBEYA, 1985
(in Metric Tons)

PRIMARY		SECONDARY		TOTAL
Number	Capacity	Number	Capacity	Capacity
1	10,000	6	9,000	19,000

SOURCE: The United Republic of Tanzania, The National Food Strategy, Main Report, Ministry of Agriculture, Dar-es-Salaam, June, 1982.

The region has a total storage capacity of 19,000 metric tons. The amounts of fertilizer used in Runs I, II, and III were 3,863 M/T, 3,504 M/T, and 7,369 M/T, respectively. This could easily be stored and handled in the region. The amount of land used in Runs I, II, and III were 333,156 has., 509,768 has., and 669,980 has., respectively. Given the fact that on the average maize, rice, beans, and groundnuts require 25 kg./ha., 89 kg./ha., 60 kg./ha., and 25 kg./ha., respectively,[2] in terms of seed, the regional input handling systems might need to be expanded if food production reacts positively to economic incentives. The issue becomes evident considering the fact that the study has assumed only traditional food producers based on several households. For instance, in 1985, the area under maize production in the region is estimated at 127,000 has.[3] This one crop, alone, will require approximately 3,175 tons of seed and on the average 12,700 metric tons of fertilizer. Combining total requirments for the region's food crop production sub-sector, expansion of input handling system is inevitable.

Application and Limitation of the Study

Data Limitations

The data used for improved production conditions (Technology Set II) were not actual but production cost estimates. These were taken to reflect the potentiality of Mbeya region. This might explain why when compared to the existing production conditions, the production activities under Technology Set II did not enter the plan.

The data used were taken as a representative sample of the traditional food producers in Mbeya region. The producers were assumed to be homogeneous. However, different levels of resources and efficiencies are common for a gamut of producers. Environment plays a dominant role in shaping the modus operandi of producers given different localities.

The free market solution for Mbeya region was taken to be the black market. However, credible data on black market prices is lacking. High levels of variability and fluctuations can be expected as regards the level of black market prices. These prices largely depend on time, space, and distance of the specific localities. Percentage increases for the level of government fixed prices presented a procedure to estimate as realistically as possible the range between the two price sets.

The improvisation of data based on Runs II and III was necessary due to lack of data during the time the study was conducted. The results, however, indicated a closeness to the actual situation.

Limitation of the Model and Application

Linear programming models are not free from limitations mostly originating from its basic assumptions. These are constant returns, additivity and linearity, finiteness and single value expectations.[4] The question of the reality of constant returns is especially pertinent. There are many production situations where given the input-output coefficients, these relations may be non-linear.

The model was static, and did not take into account risk and uncertainty. Traditional food producers are high level risk averters. Their risks evolve around variability in the level of subsistence requirements and income that lies below the normal prospects. The variation may originate from the state, market, and weather. Consequently, the results are purely normative rather than what really exists.

The model assumed that all land used in the area is put under food crop production. However, the Mbeya region also indulges in cash crop production which competes with food crops in terms of resource availabilities. It is suggestive that a future study should employ runs on both food and cash crops. This was not the task of the present study.

Noteworthy, the model has been useful in shedding light on the major bottlenecks encountered by traditional food producers in Mbeya region. It has also indicated how food production could be increased by working through the existing production conditions.

FOOTNOTES

[1] Credible information about producers' savings in the food crop sub-sector is hard to get. However, the availability of owned capital is relatively low in traditional agriculture and, hence, the pessimistic assumption.

[2] J. M. Stainburn. Production Costs of Major Agricultural Commodities in Tanzania. Marketing Development Bureau, Dar-es-Salaam, October 1982 R2/82.

[3] "Feasibility Study for Establishing a Subregional Maize Research Institute for Eastern and Southern Africa Country Note: Tanzania." Prepared by the Joint ECA/FAO Agriculture Division, United Nations, June 1983, p. 15.

[4] E. O. Heady and Wilfred Candler. Linear Programming Methods. The Iowa State University Press, Ames, Iowa, pp. 17-18.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Research Findings

The primary objectives of this study were to determine the potential impacts of (a) increased output prices, (b) reduction of input costs, and (c) improved technology on increasing food production, specifically marketable surplus in the Mbeya region of Tanzania. The study dealt with production activities of a mix of commodities consisting of maize, rice, beans, and groundnuts. The study also investigated whether the regional input systems have enough capacity to handle the needed volume of inputs, given a positive response on the part of food producers.

Throughout the analysis, a comparison between the existing production conditions (Technology Set I) in the region, and improved production conditions (Technology Set II) was made. The former is a proxy for existing production conditions, i.e., traditional agriculture. Currently, most of the traditional food producers in the region use traditional farm implements dominated by handtools (the jembe) and a relatively low level of working capital. The latter represents technology that has been determined to be physically possible in research trials in the region.

Model I (which was represented by Run I) technical coefficients reflected current farm budget costs plus those for improved technology (See Appendix C). Current levels of official government producer prices were used. The intention was to determine the profit maximizing output for the region, especially the available marketable surplus.

Production activities under traditional technology entered the plan, while those under Technology Set II did not initially in Model I. Technology Set II reflected potential yields and corresponding input requirements. It did not enter the plan due to its lack of relative profitability. At present prices the technology appeared to be physically possible but not economically feasible. The dominant limitations to output in Model I were in the form of labour bottlenecks. Labour demands were high for land preparation, weeding, and harvesting. This translates into poor quality cultivation and incomplete task performance (scanty weeding and untimely harvesting) resulting in low output in terms of both quality and quantity.

The results from Model I indicated a high marginal productivity of additional labour in these peak seasons. Although producers try hard to produce the maximum under the situation they have to work with, their capital-labour mix severely constrains their ability to be more productive.

The prevalence of labour bottlenecks led to the formulation of Model II (represented by Run II — See Appendix D). The technical coefficients were constructed to reflect animal traction. The initial level of the coefficients was reduced to be able to differentiate between hand labour and animal power as sources of farm energy. With the introduction of bottleneck-breaking implements, increased levels of (1) fertilizer use, (2) working capital, and (3) food output were noted. A considerable amount of marketable surplus for rice and beans was generated after land preparation and weeding bottlenecks were overcome. Maize production activities did not generate a sizeable marketable surplus, however.

Model III (represented by Run III – See Appendix E) was taken to represent a situation free of labour bottlenecks. The major correction was that of overcoming harvesting bottlenecks. A significant increase of marketable surplus from all crops, especially maize, was noted. Based on the analysis, regional rural families require a total of 93,629 tons of food crops per year, for their subsistence food needs. Urban areas in the region require 14,008 tons per year. The mix of food crops included maize, rice, beans, and groundnuts. The first two are the most preferred.

Model I had a marketable surplus of 11,829 tons of all food crops. This amount is less than that required to satisfy minimum food needs of the urban population in the region. Models II and III produced a marketable surplus of 23,992 tons and 65,249 tons of food crops, respectively. Clearly both levels of production would more than meet the region's urban subsistence needs.

In conceptualizing the problem a number of frameworks were developed to analyze a number of different scenarios. These were based on subsidization through increased product prices, subsidization through input prices and improved levels of technology.

Improved Level Technology

With the introduction of bottleneck-breaking technology in Model III, results have indicated an increased level of marketable surplus from 11,829 tons in Model 1 to 65,249 tons. The correction of the limiting factors, namely land preparation, weeding, and harvesting, enabled additional production to be forthcoming. This explains the importance of adopting improved farm implements rather than the continued use of handhoes. Improved farm implements enable food producers to (1) complete the important farm tasks in a timely manner, (2) reduce crop losses due to complete weeding, (3) allow good seedbed preparation, and (4) reduces physical burden on the part of the food producers.

Subsidization Through Output and Input Prices

Changes were made from the existing prices of outputs in Model III. Output prices for all crops were increased by approximately 200% of the official government price level. Increased output prices had the expected effect of increasing the level of food production and, hence, the level of marketable surplus (See Table 5.6).

Reduction of input costs by approximately 50% in the model had the same effect on the level of marketable surplus as with increased output prices. However, the former exercise had a net value of regional food output amounting to 4,884 million Tz. Shs., while the latter had 4,923 million Tz. Shs. Before doing parametric routines for increased prices and reduced input costs, it was first and foremost necessary to correct the bottlenecks which pertained in Model III.

Results from Model III and information provided by secondary data have shown that the Mbeya region does have adequate storage capacity as far as the present level of inputs is concerned. Fertilizer is the major input considered in the model. The region has a handling capacity of 19,000 metric tons for fertilizers, seeds, and herbicides. This is the amount of storage now available in the region. Model III required approximately 7,369 metric tons of fertilizer alone. However, traditional food producers are likely to respond positively to the right kind of technology and economic incentives. This will necessitate the expansion of the storage capacity in order that optimum quantities of input requirements (seeds, fertilizers, and herbicides) could be stored to satisfy the input requirements of the region's food crop sub-sector.[2]

The model has indicated an increased level of income for the region's food producers. Being in a form of net profit the generated revenue could be invested in capital items, e.g., machinery to improve the level of food yields. Alternatively, increased revenue could change the consumption pattern of food producers to types of food with high income elasticities of demand. The two specific hypotheses of the study were (a) if output prices for Mbeya region producers were to be increased, increases in food production to allow marketable surplus will not occur, (b) if new production technology is available for Mbeya region producers, i.e., if more inputs were made available through the marketing system, more production to allow marketable surplus will not occur. Based on the research findings, the two hypotheses will be accepted if and only if technology in terms of farm implements is not improved and updated.

Conclusions

There are different supply responses that one can anticipate if the alternative scenarios in the study are pursued and if food producers react in response to economic incentives. The model's results have indicated that in the short run the first and foremost viable alternative for the region's food producers is to improve the level of technology. Greater emphasis should specifically focus on moving away from the traditional handtools implements (handhoes). Subsidization of prices for both the products and inputs without improved technology will not have a considerable impact on increased food production. The net effect is inflating both producer and consumer prices without a corresponding supply of food in the urban sector.

Only through improved implements will it be possible to get the impact of increased prices on the level of food production and, hence, marketable surplus.

Provision of labor saving technology for key activities and credit to enable food producers in the region to adopt it, could be expected to have a stimulating effect on the production of marketable surplus.

Recommendations

There are a number of recommendations that can be brought forward given the analytical findings.

The Mbeya region's traditional producers do not have the right kind of technology which can exploit the potentials of increased food production. A change in the use of farm implements from the jembe to bottleneck-breaking tools is inevitable in order to increase food crop production in the region. Introduction of wheeled hoes for weeding, hand operated mechanical seeders, etc., are necessary to reduce the food producer's burden.[3]

The study highly recommends that price policies focusing on producer price increases and reduction of input costs should be accompanied by technological improvement. If the producers' supply is constrained at a certain level, price increases will not have an effective impact on increasing food production and, hence, the marketable surplus.

Although the model is static and short run in nature, the increase in the region's rural revenue has far reaching implications for consumption and production. Producers should insist on buying more inputs and developing other resources. They should also be able to purchase goods in the market outside the traditional agricultural setting. Consumer goods play the role of commercializing the food crop sub-sector and this allows the generation of more marketable surplus.

There is a need for time sequencing of regional agricultural policies in the areas of pricing, input subsidies, and technological change. There is no single policy which is going to be a necessary and sufficient condition for generating an increased level of marketable surplus. A number of issues have to be considered before a comprehensive strategized approach for regional food needs is implemented.

Increased producer prices without the right kind of technology will inflate both producer and consumer prices. Higher prices for consumers not accompanied by enough food in the market might lead to consumer revolt. Reduction of input prices accompanied by a constrained supply of inputs will not lead to positive results. The region has to improve its input storage system. The provision of inputs (fertilizer, seeds, and herbicides) has to be improved, coordinated, and reorganized. Food producers should be developed as the potential customer and, hence, the source of effective demand for improved inputs. Distribution channels should be expanded and improved in order to develop direct contact with food producers.

External help is vital toward the success of increasing food crop production. Research and extension on food crop production is a case in point. Lack of effective research and extension is an exogenous factor contributing to food producers' inefficiencies. Lack of functional and institutional linkages between research and extension can depress producers' motivations for food production.

Additional Research Needs

A dynamic model is more appealing to analyze the magnitude of the food problem in Mbeya region of Tanzania. The research has been conducted using Mbeya region as a case study. The Mbeya region is one of the regions with the highest potentials in food crop production in the country. Given enough resources in terms of time, such research should be undertaken for all regions in Tanzania. Future linear programming models should encompass both food and cash crops, to grasp the level of competition in terms of resources between these two crop categories.

A further study needs to be done on nutritional aspects of food demand in Mbeya region. The study specifically focused on the supply side. However, a number of interesting issues arise such as income elasticities of demand of both urban and food producers. The mix of food crops in the region was limited. An expansive mix can be considered in future studies.

Conclusions

The results indicate that moderate technological improvement is needed in order to attain increased food production in Mbeya region. Labour bottlenecks have to be overcome. Once they are corrected attention should be placed on efficient provision of inputs, i.e., fertilizers, seeds, and herbicides, etc. This calls for an adequate regional storage capacity. Placing priorities on overcoming the major constraints in the food crop sub-sector remains as the single vital task for the region and the nation at large.

Food inadequacy (and hence hunger and famine) is a social fact, not a natural one. It is a result of human arrangements and not an act of God. The problem is the failure of developing social systems to meet the challenges of nature. The importance of a food self-reliance position stands out to be the viable solution.[4]

Some agricultural economists have advocated increased agricultural commodity prices to stimulate agricultural food production in labour surplus, handhoe technology oriented developing economies. However, this study has indicated that little additional production is likely to be forthcoming in the short run due to labour shortages at specific times for key activities during the crop year, e.g., weeding, harvesting, etc. The study has indicated that in order to obtain sustained increases in food output there is a need to introduce bottleneck-breaking technology which will perform better than the crude tool technology now being used. Only after doing this will increased output prices have a positive impact on the level of production. Increased output prices affect producers' total food output only up to a level imposed by physical and technical aspects. Correction of physical constraints on production through improved technology is one condition and necessarily an important factor in determining increased food output.

FOOTNOTES

[1] William G. Tomek and K. L. Robinson. <u>Agricultural Product Prices</u>. 2nd Edition. Cornell University Press, Ithaca and London, 1981, pp. 76-77.

[2] On the average, maize, rice, beans, and groundnuts require 25 kg./ha., 60 kg./ha., and 25 kg./ha., respectively, in terms of seeds.

[3] A caveat is given against premature use of large tractors which would displace a great deal of human labour. Animal power should probably be followed by two-wheel tractors before four-wheel tractors are considered in the process of developing the food crop production in the region.

[4] F. M. Lappé and Joseph Collins with Cary Fowler. <u>Food First: Beyond the Myth of Scarcity</u>. Houghton Mifflin, 1977.

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APPENDIX A

Conversion From Kilocalories to Kilograms

1. 33 grams of rice = 117 kilocalorie number per day
   1 gram of rice = 3.54
   1000 grams = 3545 kilocalories number per day

2. 237 grams of maize = 766 kilocalorie number per day
   1 gram = 3.23
   1000 grams = 3232 kilocalories number per day

3. 3 grams of nuts = 5 kilocalories number per day
   1 gram = 1.67
   1000 grams = 1 kilogram = 1667 kilocalories number per day

4. 51 grams of pulse = 170 kilocalorie number per day
   1 gram = 3.41
   1000 grams = 1 kilogram = 3410 kilocalories number per day

Conversion From Protein Grams to Kilograms

1. 33 grams of rice = 2.3 grams of protein per day
   1 gram of rice = 0.069
   1000 grams = 1 kilogram = 69.7 grams of protein/day

2. 237 grams of maize = 17.8 grams of protein per day
   1 gram = 0.075
   1000 grams = 1 kilogram = 75 grams of protein/day

3. 3 grams of nuts = 0.4 grams of protein per day
   1 gram = 0.13
   1000 grams = 1 kilogram = 133 grams of protein/day

4. 51 grams of pulse = 11.3 grams of protein per day
   1 gram = 0.22
   1000 grams = 1 kilogram = 222 grams of protein/day

APPENDIX B

APPENDIX TABLE 1

MBEYA REGION'S TOTAL POPULATION BY DISTRICTS AND SELECTED CHARACTERISTICS (as expected in 1985)[a]

DISTRICT	POPULATION				
	Total	Urban Areas	Rural	15 Yrs.	Adults in Rural Areas
1. Mbozi	305,583	39,726	265,857	122,294	143,563
2. Mbeya	334,852	43,531	291,321	134,008	157,313
3. Rungwe	306,961	39,905	267,056	122,846	144,210
4. Ileje	104,490	13,584	90,906	41,817	49,089
5. Chunya	126,675	16,468	110,207	50,695	59,512
6. Kyela	158,326	20,582	137,744	63,362	74,382
	1,336,887	173,796	1,163,091	535,022	628,069

[a]The district population calculations are based on 1985 population projections as indicated in, "The United Republic of Tanzania," National Food Strategy, Main Report, Ministry of Agriculture, Dar-es-Salaam, June 1982.

APPENDIX C - MODEL I

RESOURCE	MAIZE	MAIZE^1	MAIZE^2	MAIZE^3	RICE	RICE^1	RICE^2	GNUTS	BEANS	MAIZSAL	MAIZSAL^1	MAIZSAL^2	MAIZSAL^3	RICSAL	RICSAL^1	RICSAL^2	GNUTSAL	BEASAL	MAICO	MAICO^1	MAICO^2	MAICO^3	RICCO	RICCO^1	RICCO^2	GNUTSCO	BEACO		RESOURCE LEVEL
C	-289	-297	-591	-785	-440	-700	-950	-502	-168	4.0	4.0	4.0	4.0	6.0	6.0	6.0	8.0	8.0											
LAA	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																			-	667,700
LAB	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																			-	3,029,520
LAC	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																			-	1,877,850
LAD	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																			-	1,310,374
L11	13	40	40	40																								-	842,070
L12	7	10	10	10																								-	842,070
L13	22	25	25	25																								-	842,070
L14	15	55	60	70																								-	842,070
L21					13	46	46																					-	842,070
L22					14	123	123																					-	842,070
L23					55	105	105																					-	842,070
L24					21	110	110																					-	842,070
L31								45	28																			-	842,070
L32								25	15																			-	842,070
L33								30	28																			-	842,070
L34								100	17																			-	842,070
WOCAP	60	60	60	254	254	254	254	60	60																			-	13,000,000
FERT	49	10	160	210			175	100																				-	20,254,000
Y01	-1363									1.0									1.0									=	0
Y02		-1500									1.0									1.0								=	0
Y03			-2200									1.0									1.0							=	0
Y04				-2700									1.0									1.0						=	0
Y05					-2500									1.0									1.0					=	0
Y06						-3000									1.0									1.0				=	0
Y07							-3600									1.0									1.0			=	0
Y08								-1428									1.0									1.0		=	0
Y09									-2400									1.0									1.0	=	0
F01																			1.0	1.0	1.0	1.0						-	68,767,578
F02																							1.0	1.0	1.0			-	9,450,090
F03																										1.0		-	872,316
F04																											1.0	-	14,538,600

APPENDIX D - MODEL II

RESOURCE	MAIZE	MAIZE^1	MAIZE^2	MAIZE^3	RICE	RICE^1	RICE^2	GNUTS	BEANS	MAIZSAL	MAIZSAL^1	MAIZSAL^2	MAIZSAL^3	RICSAL	RICSAL^1	RICSAL^2	GNUTSAL	BEASAL	MAICO	MAICO^1	MAICO^2	MAICO^3	RICCO	RICCO^1	RICCO^2	GNUTSCO	BEACO		RESOURCE LEVEL
C	-289	-297	-591	-785	-440	-700	-950	-502	-168	4.0	4.0	4.0	4.0	6.0	6.0	6.0	8.0	8.0											
LAA	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																			-	667,700
LAB	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																			-	3,029,520
LAC	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																			-	1,877,850
LAD	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																			-	1,310,374
L11	7	20	20	20																								-	842,070
L12	4	5	5	5																								-	842,070
L13	11	11	11	11																								-	842,070
L14	15	25	30	35																								-	842,070
L21					7	23	23																					-	842,070
L22					7	63	63																					-	842,070
L23					27	53	53																					-	842,070
L24					21	110	110																					-	842,070
L31								23	14																			-	842,070
L32								13	8																			-	842,070
L33								15	14																			-	842,070
L34								100	8																			-	842,070
WOCAP	60	60	60	254	254	254	254	60	60																			-	13,000,000
FERT	49	10	160	210			175	100																				-	20,254,000
Y01	-1363									1.0									1.0									=	0
Y02		-1500									1.0									1.0								=	0
Y03			-2200									1.0									1.0							=	0
Y04				-2700									1.0									1.0						=	0
Y05					-2500									1.0									1.0					=	0
Y06						-3000									1.0									1.0				=	0
Y07							-3600									1.0									1.0			=	0
Y08								-1428									1.0									1.0		=	0
Y09									-2400									1.0									1.0	=	0
F01																			1.0	1.0	1.0	1.0						-	68,767,578
F02																							1.0	1.0	1.0			-	9,450,090
F03																										1.0		-	872,316
F04																											1.0	-	14,538,600

APPENDIX E - MODEL III

RESOURCE	MAIZE	$MAIZE^1$	$MAIZE^2$	$MAIZE^3$	RICE	$RICE^1$	$RICE^2$	GNUTS	BEANS	MAIZSAL	$MAIZSAL^1$	$MAIZSAL^2$	$MAIZSAL^3$	RICSAL	$RICSAL^1$	$RICSAL^2$	GNUTSAL	BEASAL	MAICO	$MAICO^1$	$MAICO^2$	$MAICO^3$	RICCO	$RICCO^1$	$RICCO^2$	GNUTSCO	BEACO		RESOURCE LEVEL
C	-289	-297	-591	-785	-440	-700	-950	-502	-168	4.0	4.0	4.0	4.0	6.0	6.0	6.0	8.0	8.0											
LAA	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																			-	667,700
LAB	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																			-	3,029,520
LAC	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																			-	1,877,850
LAD	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0																			-	1,310,374
L11	7	20	20	20																								-	842,070
L12	4	5	5	5																								-	842,070
L13	11	11	11	11																								-	842,070
L14	7	12	15	15																								-	842,070
L21					7	23	23																					-	842,070
L22					7	63	63																					-	842,070
L23					27	53	53																					-	842,070
L24					11	55	55																					-	842,070
L31								23	14																			-	842,070
L32								13	8																			-	842,070
L33								15	14																			-	842,070
L34								50	9																			-	842,070
WOCAP	60	60	60	254	254	254	254	60	60																			-	30,000,000
FERT	49	10	160	210			175	100																				-	20,254,000
Y01	-1363									1.0									1.0									=	0
Y02		-1500									1.0									1.0								=	0
Y03			-2200									1.0									1.0							=	0
Y04				-2700									1.0									1.0						=	0
Y05					-2500									1.0									1.0					=	0
Y06						-3000									1.0									1.0				=	0
Y07							-3600									1.0									1.0			=	0
Y08								-1428									1.0									1.0		=	0
Y09									-2400									1.0									1.0	=	0
F01																			1.0	1.0	1.0	1.0						-	68,767,578
F02																							1.0	1.0	1.0			-	9,450,090
F03																										1.0		-	872,316
Fo4																											1.0	-	14,538,600

NOTES:

LAA = Soils of low fertility in areas of high rainfall

LAB = Soils of low to medium fertility with moderate potential

LAC = Various alluvial or colluvial soils of considerable potential but often requiring flood control drainage or special management

LAD = Soils of medium to high fertility with high potential

L11 = Land preparation labour for maize

L12 = Planting labour for maize

L13 = Weeding labour for maize

L14 = Harvesting labour for maize

L21 = Land preparation labour for rice

L22 = Planting labour for rice

L23 = Weeding labour for rice

L31 = Land preparation labour for groundnuts and beans

L32 = Planting labour for groundnuts and beans

L33 = Weeding labour for groundnuts and beans

L34 = Harvesting labour for groundnuts and beans

WOCAP = Working Capital

Fert = Fertilizer

YO1 = Yield/kg. given respective production activities

FO1 = Amount of subsistence food given respective crop

VITA

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In January 1981, he initiated a Ph.D. program in Agricultural Economics with a specialty in International Development at the University of Missouri-Columbia.

He worked in the Prime Minister's Office from 1975-1978 and then transferred to the Ministry of Finance and Planning. He is currently working in the Ministry of Economic Affairs and Planning in the Vice President's Office, Dar-es-Salaam, Tanzania.