EWUP TECHNICAL REPORT NO. 43

PLANNING IRRIGATION IMPROVEMENTS IN EGYPT: THE IMPACT OF POLICIES AND PRICES ON FARM INCCME AND RESOURCE USE

By:

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EGYPT WATER USE AND MANAGEMENT PROJECT

22 El Galaa St., Bulak, Cairo, Egypt

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Abstract

The most profitable use of resources on a typical Egyptian farm is analyzed in view of resource, institutional and government policies. The linear programming model of a farm management decision problem is based on an average sized farm found in a survey of 50 farms in Kafr El Sheikh. By solution of the model one can observe the interdependencies. Further, changes in the method of irrigation or in the government's system of water supply are evaluated with the model.

Four sets of policy alternatives are examined. The base run reflects existing policies, a second option includes only administered prices. Additionally, a free market alternative is tested and finally, a free market coupled with a system to charge farmers for the delivery of water.

Results show that existing policies do not greatly distort the optimal mix of enterprises but it is likely that farmers would have incentive to achieve higher crop yields under different price policies. As yields associated with higher commodity prices are achieved, farmer's incentive and ability to adopt improved water management practices would be enhanced.

73 Pages , 16 Tables, 3 Figures

ملخص

تتناول هذه الدراسه تحليل الاستخدام الأكثر اربحية للموارد فى المزرعه النمطية المصرية من ناحيه الموارد والنظم والسياسات الحكومية المتبعة . وقد اعتمد نموذج البرمجة الخطية والخاص بمشكله اتخاذ قرارات تتعلق بالادارة المزرعية على المزرعة متوسطه الحجم بالنسبه للحصر الذى اجرى على خمسين مزرعه فى محافظة كفر الشيخ .

وباستخدام النموذج المشار اليه يمكن ملاحظة التأثيرات المتداخله ، هذا بالاضافة الى أنه قد تم تقييم التغيرات فى طرق الرى أو فى النظام الحكومى لتوزيع المياه باستخدام هذا النموذج .

وفى هذا المجال تم اختبار أربعه بدائل للسياسات وهذه البدائل هى السياسات الراهنه والمتبعه ، والبديل الثانى باستخدام الأسعار المفروضه والمحددة ، والبديل الثالث هو سياسه السوق الحرة وأخيرا السوق الحرة مع فرض رسوم تكلفه توصيل المياه الى المزارعين .

وقد أظهرت نتائج هذه الدراسة أن السياسات الراهنه لاتحدث ضررا كبيرا على منوال انتاج المحاصيل ولكنها تعطى المزارعين حافزا لانتاج محاصيل زراعية ذات انتاجية أعلى فى ظل سياسات سعرية مختلفة .

وعند الوصول الى انتاج حاصلات مرتفعه الأسعار فان حافز وقابليه المزارع لتبنى واتباع استخدام نظم الرى المحسنه يكونا اقوى .

٧٢ صفحه ، ١٦ جدول ، ٣ اشكال

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SECTION I

INTRODUCTION

A. Focus of the Study

The Egypt Water Use and Management Project (EWUP), of which this study is part, was initiated in 1977. The goals of EWUP are to improve the economic and social well-being of Egyptian farmers through improvements in on-farm water use efficiency. To implement the improvements in irrigation practices on farms, it is necessary to know of the economic and institutional environment under which the farmer operates. Egyptian farmers are faced with a number of institutional constraints, in particular, obligations imposed by the government on cropping requirements. Changes in irrigation practices which imply changes in crops or cultural practices must recognize these operating constraints.

Analysis of the use of resources on Egyptian farms is an important part of increasing water use efficiency. Irrigation water interacts with other inputs. The best use of these inputs relative to each other, their allocations between alternative commodities, and between farms is an important consideration to improvements in farm water management. It is also necessary to know the extent to which the institutional constraints imposed on the farmers limit their abilities to achieve the most profitable use of water and associated inputs.

This study is designed to evaluate the impact of Egyptian agricultural policies on the allocation of productive agricultural resources and farm income. The impact of agricultural pricing policies and production area quotas on cropping pattern and consequently on water requirement will be assessed. A charge for delivery of water will also be assessed in order to insure an efficient allocation of the scarce water resource and to determine the optimal cropping pattern with all the economic costs and returns considered. If the existing agricultural policies have resulted in a suboptimal cropping pattern, then appropriate modifications of such policies result in enhanced farmers' income leading to an increase in the value of aggregate production of the Egyptian agricultural sector.

Improvement in irrigation system and cropping practices require short- and long-term investments by farmers. Farmers' inability to accumulate reserves for such improvement makes it difficult for various farm research organizations to pass on the benefits of their findings to the farmers. The existing crop prices have made the accumulation of required investment capital difficult (3).

This study will proceed by highlighting Egypt's economic problem in general and of the agricultural sector in particular. The study area is described in Section II and methodology in Section III. The result of the analysis is presented in Section IV and the conclusions in Section V.

B. Problem and Background

Egypt is faced with the fundamental problems of an ever-increasing population and a severe shortage of cultivable land. Its population grew from 26 million in 1960 to 37 million in 1975 and 41 million in 1979. In contrast, the cultivable land area has changed very little. It increased from 5.4 million feddans in 1907 to only 5.6 million feddans in 1972 and has remained nearly the same thereafter, if not declining due to urban encroachment on agricultural land.

Completion of High Aswan Dam in 1970 enabled cropping intensity to increase on old land such that there are almost always two crops per year in the same field, giving a cropping index of 2.0 or 200 percent. Vegetable crop areas have a cropping index of 3.0, while the perennial sugar cane and permanent orchards have an index of only 1.0. During the early 1950's the cropped area per capita was 0.44 feddan, dropping continuously to 0.33 feddan per capita in 1965-69 and to 0.27 feddan per capita in 1979 (Table 1).

Adding to the population factor is the demand effect of per capita income growing in real terms at a rate approaching five percent per year. In addition to greater demand for more food, there is an increased demand for better quality foods--especially higher protein food (4).

Major food items are provided for low-income group at subsidized rates. The consumer subsidization of the basic food commodities cost the Egyptian government L.E. 885 million in 1979 (8).

Table 1. Cropped Area by Season and Population in Thousands, Egypt, 1950-79.

	1950-54	1955-59	1960-64	1965-69	1970-74	1975	1976	1977	1978	1979
					IN THOUSANDS OF FEDDANS					
Winter Season Cropped Area	4,478	4,711	4,759	4,783	4,860	5,069	5,042	4,958	5,025	5,063
Summer Season Cropped Area	2,979	3,285	3,716	4,868	5,067	5,083	5,122	5.082	4,968	5,051
Nili Season Cropped Area	1,861	1,967	1,730	678	632	723	734	750	824	781
Orchards	94	114	147	208	256	285	313	321	332	342
Total Cropped Area	9,412	10,077	10,352	10,537	10,767	11,160	11,211	11,111	11,149	11,237
Population	21,400	24,300	27,250	30,830	34,560	37,010	37,865	38,845	39,880	41,000
Cropped Area Per Capita (Feddans)	.439	.415	.380	.342	.310	.302	.296	.285	.280	.272

Source: Statistical Yearbook, Central Agency for Public Mobilization and Statistics, Cairo, 1980.

Egypt's rapid population increase has been accompanied by an even faster growth (4 percent) in urbanization. Egyptian agricultural policy of procuring agricultural produce at prices substantially below world market prices have lowered rural income. At the same time the policy of providing food to the population at highly subsidized prices are viewed as encouraging the migration from rural to urban area (10). Urbanization and the accompanied changes in consumption patterns led to higher prices for livestock and the primary feed product, berseem. The increased profitability of berseem which currently occupies some 25 percent of the winter cropland make it difficult to increase the production of wheat, a basic consumption commodity, and the export crop of cotton.

Food security for Egypt has economic significance as well as political importance. The economic significance of food to Egypt is evident in the country's balance of trade in agricultural products; imports annually exceed exports by more than $1 billion (4). Egypt relies heavily on international trade for satisfying the food needs of its population which has increased at a relatively high rate compared to rates of growth in food production. In 1979 imports accounted for approximately 40 percent of the basic food commodities consumed in Egypt.

Agricultural development policies. Egyptian agricultural development strategy is based on two sets of policy objectives. One objective is distributional in intention and is rooted in the revolutionary reaction to conditions in the countryside prior to the 1952 revolution. With the land reform, a number of physical controls, crop production and marketing quotas, and subsidies were introduced. The second objective was to achieve an industry-led economic development which was fashionable in the 1950's. The Egyptian government agricultural pricing policies, coupled with crop production quotas with compulsory procurement, were then aimed at extracting the agricultural surplus for investment in the industrial sector. These policies have succeeded in extracting the surplus from the agricultural sector and keeping the prices of the basic food items low. However, agriculture remains the predominant employer and contributor to GNP and export (11).

The Egyptian planners' implicit assumption has been that prices do not matter. This has been based on the following reasoning: First, non-price controls can be applied to direct resource allocation in place of price signals. Second, direct state investment can divert resources to projects regardless of market signals about profit expectations. And third, offsetting measures like consumer subsidies can be used to correct income imbalances (1).

However, a number of events and complaints made by the farmers indicate that these policies may have led to an inefficient allocation of agricultural resources and curtailed the rate of adoption of improved inputs and production techniques. In 1974 some 180,000 farmers refused to comply with cotton production quotas and were cited for such violations. Again in 1979 some 100,000 feddans designated for cotton production were instead planted in maize. The Ministry of Agriculture penalized these farmers by withholding fertilizer subsidies from them (11). Understanding of these impacts are necessary to plan for the adoption of improved irrigation practices and to evaluate the potentials for their adoption in view of the policies in effect.

Public administrators complain of the farmers' lack of acceptance of new technology and of not cooperating with state production plans. Farmers complain of low prices, fertilizer shortages, water shortages, marketing quotas, and other restrictions imposed on them (10).

Given the agricultural resources and nature of the problems, three options are available for increasing the output of the agricultural sector. They are: (1) reclamation of new land, (2) achieving higher productivity in the old land, and (3) selection of an optimal cropping pattern on the old land. In this paper the selection of optimal cropping pattern as means of increasing agricultural output and income will be explored. The analyses also have implications to increasing productivity, but no direct evidence of such possibilities are introduced.

Major crops. About 70 percent of 11.1 million crop feddans is planted to the five major field crops of berseem, maize, wheat, cotton, and rice. Berseem, with a production area of 2.8 million feddans or 25 percent of the total cropland, is the number one crop in terms of land area allocated to its production. Berseem, in addition to being used as livestock feed, adds to the productivity of the soil (Table 2).

Maize is the second most important crop in terms of land area. Maize is primarily produced for rural consumption. The leaves and

Table 2. Area Planted to Winter, Spring, Nili and Orchard Crops, Egypt, 1978-79 Average.

Crop	Area Planted (thousand feddans)	Percent of Total
Winter Crops	(5046)	(45.08)
Berseem clover	2780	24.84
Wheat	1385	12.37
Broad beans	280	2.50
Winter vegetables	243	2.17
Barley	110	0.98
Lentils	29	0.26
Others	219	1.96
Summer Crops	(5009)	(44.75)
Corn	1409	12.59
Cotton	1192	10.65
Rice	1031	9.21
Summer vegetables	483	4.32
Millet & sorghum	403	3.60
Sugar cane	248	2.22
Others	243	2.17
Nili Crops	(803)	(7.17)
Corn	483	4.32
Nili vegetables	251	2.24
Millet	19	0.17
Others	50	0.45
Orchards	(337)	(3.01)
Total	11,193	100,000

Source: Statistical Yearbook, Central Agency for Public Mobilization and Statistics, Cairo, 1980.

tassels of maize are used as green forage for livestock in the summer season.

Wheat had occupied 1.4 million feddans or 12 percent of the cropland area in 1978-79. Most of the 1.9 million tons of wheat produced in 1979 were consumed in rural areas. Cotton, which is Egypt's number one export and cash crop occupied 1.2 million feddans or 11 percent of total cropland area. The entire output of cotton is procured by the government, most of which is exported.

Rice, as the fifth major crop, occupied slightly over one million feddans in 1978-79. Rice, of which 37 percent was exported in 1970, has gradually lost its role as an export crop as domestic consumption continued to rise. In 1978 only 0.14 million metric tons or 6 percent of total rice output was exported and none was exported in 1979 (4).

The Egyptian government has been following a strategy of insuring itself of a certain output of export crops of cotton and rice by determining the land areas for production of these crops. Farmers are allowed to allocate the rest of the land for production of food grains such as wheat and maize, vegetables, and berseem for livestock feed to meet the food demand in rural areas.

With limited cultivable land and the high cost of reclamation of the desert land, it is essential that Egypt's limited farmland be utilized efficiently. Technically, there is a large scope for altering the cropping pattern, but the determination of the optimal cropping pattern for Egypt is rather complex and requires a close examination of the available options.

The major policy questions regarding cropping patterns are as follows:

(1) Should Egypt further pursue specialization and trade in agricultural commodities? This involves the export of cotton, rice, citrus fruits, and imports of wheat.

(2) Since cotton and rice directly compete with each other, the production and export of which one of these crops should be encouraged more?

(3) Should the option of self-sufficiency in food grains which would require the reallocation of cotton land into rice and wheat be pursued?

(4) Should mechanization in land preparation and water lifting be encouraged in order to reduce the number of work animals and the land area allocated to berseem production? Land saved from the production of feed for livestock and put into the production of wheat would reduce the burden of import. This option is of direct interest to EWUP.

C. Study Objectives

The main objective of this study is to analyze the impact of Government of Egypt price intervention and production and marketing controls on agricultural commodities on cropping patterns, resource requirements, and farm income.

The information on agricultural policies, Egypt's economic situation, and study area will provide insight into the complexities of institutional and agro-economic factors of the Egyptian farming system. The sub-objectives investigated in this study are: (1) evaluate the economic rationale of Egyptian farmers in choice of crops under existing irrigation water delivery practices, crop area production policies, and price cost structure, (2) determine the magnitude of suboptimality in cropping pattern and related misallocation in agricultural resources and loss of income brought about by agricultural policies, and (3) explore the impact of change in the cropping pattern on irrigation water requirement and (4) the impact of water delivery charge on cropping pattern and farm income.

SECTION II

STUDY AREA

A. Location, Background, and Water Distribution System

The Abu Raya Cooperative District which was selected as the study site is located in the governorate of Kafr El Sheikh. This governorate includes of 815,335 feddans which lie in the lower Nile Delta nearly midway between the two branches of the Nile, Rossitta and Damietta (Figure 1). The agricultural conditions of this governorate are similar to those found in the other lower Nile governorates of Behera, Sharkiya, and Dakahliya (6).

Most of the area is composed of newly reclaimed land still under partial reclamation. The reclamation project was started by Behera Company in 1883. The sale of the reclaimed land to the farmers began in 1906. Some further reclamation was attempted from 1954 to 1967 by the Ministry of Reclamation. Following the construction of the High Aswan Dam and high demand for water in the summer from the increased cultivated land, insufficient water was available for further land reclamation.

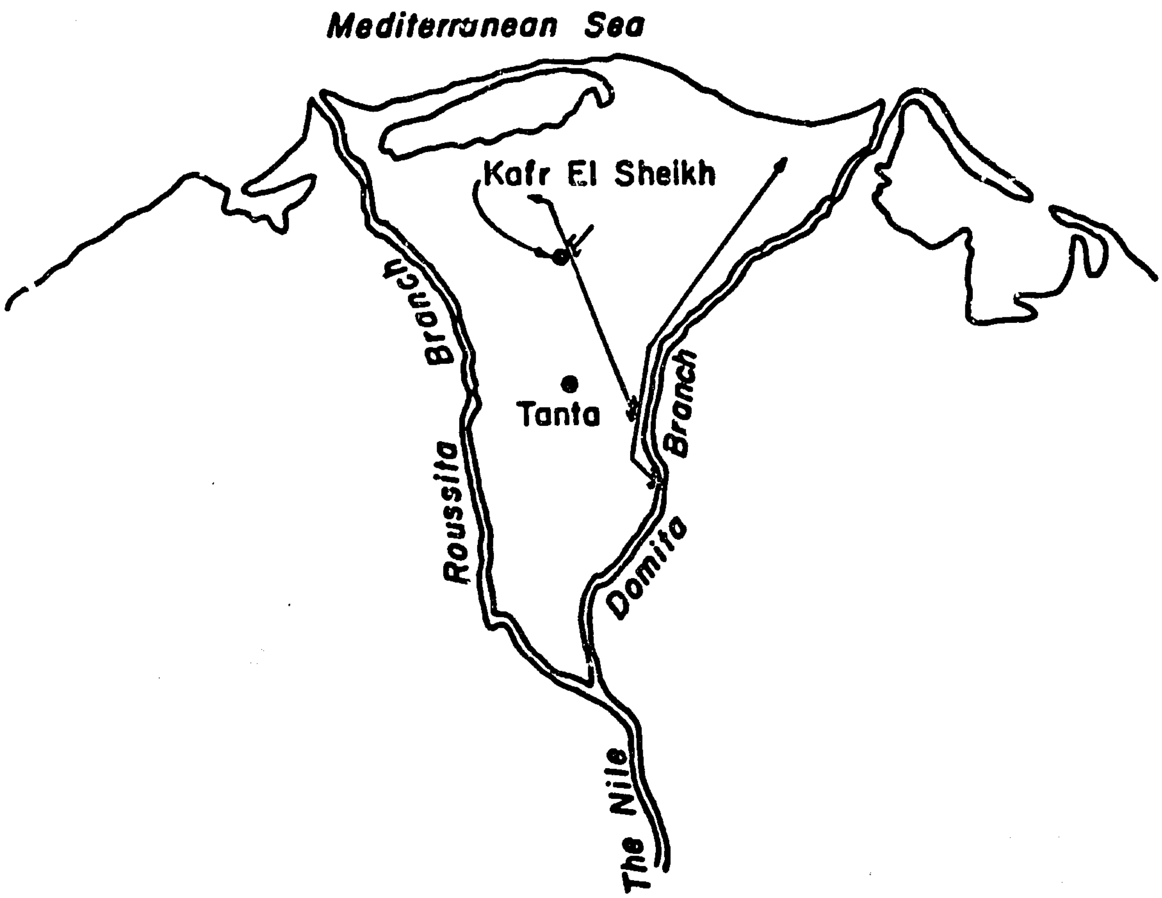

Figure 1. Geographic Location of Kafr El Sheikh Governorate and Main Distributary Canals for Delivery of Water to Kafr El Sheikh.

The irrigation water for Kafr El Sheikh district and the Abu Raya cooperative farming area is diverted at the Zefta Barrage of the Damietta Branch of the Nile. Through a series of canals,part of this diverted water is channeled into the Dakalt Canal which brings in the water into the Abu Raya farming area. There are two regulators on the canal for controlling and rotating the water in the canal. The basic rotation is four days on and four days off during the summer months and seven days on and seven days off during the winter months.

The water is distributed from the Dakalt Canal into branch canals or mesqas for distribution on the fields or farms. The Dakalt Canal not only serves as a carrier but also has legal outlets for on-farm irrigation. Manshiya, Helal, Hammad, and Om'Sen are the major distributories of the Dakalt Canal within the Abu Raya farming area (Figure 2).

Water is primarily lifted by saqias from the canals and mesqas and into the marwas. The water is then distributed from the marwas into small flat basins with or without furrows. The basins are filled with water until the surface is completely covered. Pre-planting irrigations are generally the rule before seeds are sown for most crops.

B. Farm Size and Land Tenureship

The average farm size for the fifty farms surveyed in Abu Raya was 5.35 feddans, and ranging from 1.25 to 11.5 feddans. Because of

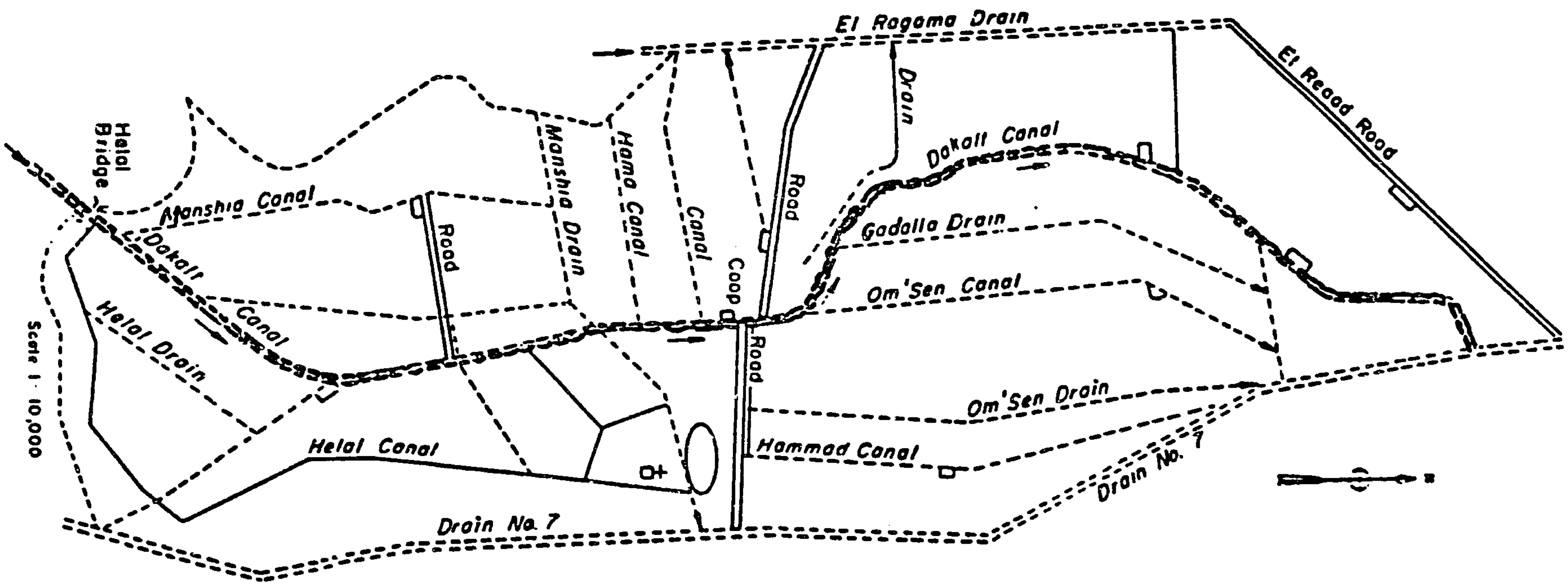

Figure 2. Boundaries of Abu Raya Cooperative District and Irrigation Network.

differences in relative amounts of resources among farms of various sizes, the surveyed farms were broken down into three size categories of small (0-3.5 feddans), medium (3.6-6.0 feddans), and large (6.1-11.5 feddans). The farm family size, cropping pattern, crop disposition, yield and other characteristics of these farms will be studied along these farm size breakdowns (Table 3).

Of the fifty farms surveyed, eighteen were in the small size category, twenty-one in the medium, and eleven in the large. These farms were made up of one to four parcels and located on different points along the mesqa. Seventy-five percent of the farms were made up of two or more non-contiguous parcels. This land fragmentation pattern is the result of the agrarian reform program in which farmers received holdings in several separate parcels so they can produce cash crops, food, and forage crops in the same year. Each parcel falls within a crop zone as specified by the land use consolidation program.

Overall, fifteen farmers had rented out land and twelve others had rented in land. Crop share was the most common rental practice, particularly for small and medium-sized farms. Twenty-nine percent of all rentals were on a cash basis, with the greater use of this practice by larger farms.

In the sharecropping arrangement the owner pays for half of the all-cash costs of seed, fertilizer, chemicals, machinery, and hired labor, and receives from the tenant half of the output of crop and crop residue. In the case of cotton the owner receives one-half of the cash obtained from the sale of the crop to the government. The

Table 3. Average Cultivated Area by Farm Size, Range, and Number of Parcels, Abu Raya Kafr El Sheikh, 1980.

Farm Size	Number of Farms	Average Cultivated Area				Number of Parcels		
		Mean	Standard Deviation	Minimum	Maximum	Mean	Minimum	Maximum
Small	18	2.71	0.60	1.25	3.50	1.72	1	3
Medium	21	5.06	0.81	3.66	6.00	2.29	1	4
Large	11	8.29	1.72	6.50	11.50	2.55	1	4
Average All	50	4.92	2.31	1.25	11.50	2.14	1	4

Source: Egypt Water Use and Management Project's Farm Management Survey.

average cash rent per feddan per year was L.E. 72. The maximum rent paid for land in this area was L.E. 100 per feddan per year. Eighty percent of the land rented was for a period of one year or longer.

C. Existing Cropping Pattern

The agricultural year begins in November with the planting of winter crops and ends in October with the harvest of the summer crops. The winter crops in the survey area included wheat, Egyptian clover or berseem, broad beans, flax, and vegetables. Summer crops included cotton, rice, maize, and summer vegetables.

The planting of winter crops may start in October and continue into November and December. Harvesting usually begins in April and continues into May and June. Planting of summer crops starts as early as March for cotton and continues into June when rice is transplanted. The winter crop of berseem and the summer crops of rice and maize overlap for a short period of time as berseem seed is sowed in the last irrigation of rice and maize. This practice is viewed as necessary for fitting the multiple cropping pattern into the available growing season, and for increasing the production of berseem for livestock (see Figure 3).

The Abu Raya farming district follows the three-year cotton rotation in which the area is divided into three approximately equal blocks. Short-term berseem is planted in the first block from which only one or two cuttings are obtained and is then followed by cotton

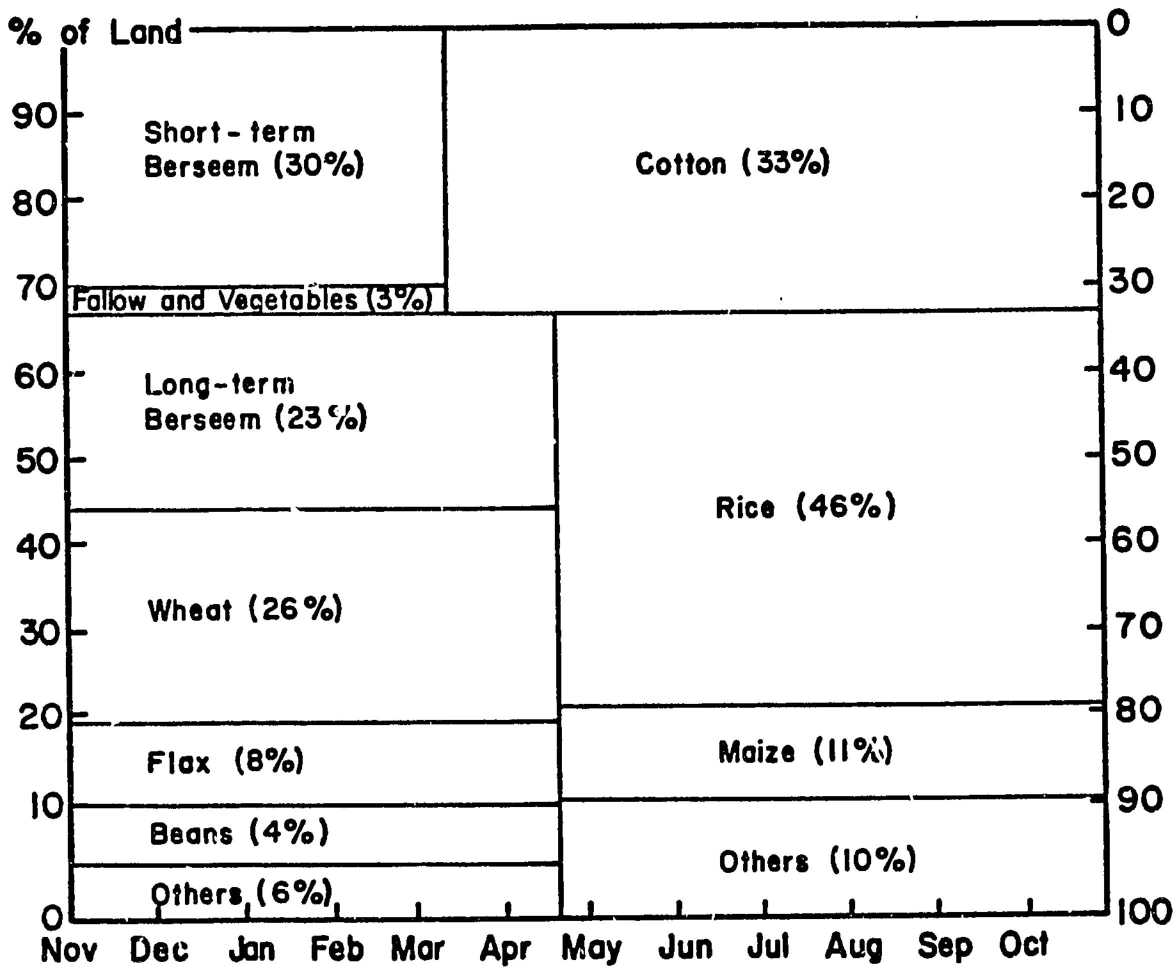

Figure 3. Proportionate Area Allocated to Specified Crops, 1979-80, Abu Raya, Kafr El Sheikh.

in March as a summer crop. The second block is planted with long-term berseem and the third block is planted with wheat, flax, or broad beans, or some combination of the three in the winter season. The crops in the second and third blocks are then followed by rice or maize as a summer crop.

The average distribution of land among winter crops in Abu Raya was 26 percent in wheat, 8 percent in flax, 4 percent in broad beans, 23 percent in long-term berseem, and 30 percent in short-term berseem. Of the remaining nine percent, six percent was used in the production of fruits and vegetables, and the other three percent was kept as fallow (Table 4). About equal percentage of winter cropland was allocated to the production of wheat, flax, and broad beans in all three farm size categories. The small and medium-size farms had allocated a greater percentage of the winter cropland in the production of long-term berseem in order to maintain their minimum number of three livestock for farm work and as a source of milk.

The overall average area allocated to production of cotton was 33%, as is planned by the government under the three year cotton rotation system. The distribution by farm size, however, indicated small farms as having allocated more than one-third (37%) of their land area into cotton and medium sized farms less than one-third (29%). Small and medium sized farms had allocated 48% and 49% of their summer cropland area to production of rice respectively. Large farms produced rice on 41% of their summer cropland area. The actual area put into rice production is 81% of planned area with large farmers as having the most deviation from the plan. Large farms have

Table 4. Farm Size and Percent of Area in Various Winter and Summer Crops, Abu Raya, Kafr El Sheikh, 1980.

Crops	Small (2.71AC)	Medium (5.06AC)	Large (8.29AC)	Average All (4.92AC)	Planned[2]
			Percent		
Winter Crops					
Wheat	25	28	25	26	28
Flax	8	8	7	8	7
Broad Beans	3	5	4	4	1
Long Berseem	28	24	19	23	28
Short Berseem	34	28	28	30	33
Others[1]	3	7	17	9	3
Summer Crops					
Cotton	37	29	34	33	33
Rice	48	49	41	46	57
Maize	14	12	9	11	10
Others[1]	1	10	16	10	0

[1]Include area in fruit tree, vegetables, and fallow.

[2]The planned area for cotton and rice is to be enforced by the agricultural cooperatives.

Source: Egypt Water Use and Management Survey.

allocated a high of 16% of their summer cropland for production of fruits, vegetables, and other crops compared with only one percent by small farms.

D. Land Preparation

Land preparation activities and costs vary from crop to crop. Cotton, sugar beets, and broad beans require three to four plowings, smoothing, and furrowing while berseem requires only one plowing when it follows cotton and corn and generally no plowing when it follows rice. Land is generally plowed twice for wheat, flax, rice, and corn.

Tractors were used for plowing by all farms and for smoothing and furrowing by 75 percent of the farms. Twenty-one percent of the farmers had relied entirely on animal power for smoothing and furrowing while the remaining 4 percent used both tractor and animal.

The average time required per feddan for various land preparation activities as reported by the farmers were 1.77 hours for one plowing, 3.13 hours for two-way plowing, and 4.23 hours for a three-way plowing. Smoothing and furrowing activities took less than one hour per feddan. Based on the cost paid for different number of plowings and time required for each plowing, the average cost of tractor in plowing was about L.E. 1.7 per hour (Table 5).

Table 5. Land Preparation Activities by Tractor, Hours, and Cost per Feddan, Abu Raya, Kafr El Sheikh, 1980.

Activities	Hours per Feddan	Cost per Feddan
	-----Hours------	------L.E.-----
One plowing	1.77	3.03
Two plowing	3.13	5.39
Three plowing	4.23	7.25
Smoothing	0.96	2.20
Furrowing	0.85	1.83

Source: EWUP Farm Management Survey.

E. Labor Utilization

Labor makes up a major part of the variable costs from seeding to harvesting. Labor cost ranged from 59 percent of the variable cost of cotton crop to 37 percent of the variable cost of wheat crop. The highest per feddan labor cost was L.E. 101 which incurred in production of cotton. Sugar beet was the second highest labor use crop with a total labor cost of L.E. 62.19 per feddan, followed by rice with a total labor cost of L.E. 58.10 or 53 percent of total variable cost of rice production. These estimates do not include the labor share of the cost of tractor operation and labor that operated camels and donkeys in transport of inputs and products.

Labor use occurs throughout the crop season and is made up of different types (men, women, and children) of labor. A number of operations for each crop enterprise are carried out entirely by specific type of labor such as application of water and hoeing by men, while most other operations use men, women, and children.

The average wage rate was estimated as L.E. 1.8 per day for men, L.E. 1.2 per day for women, and L.E. 0.90 per day for boys and girls. The average work day is considered to be six hours. The actual hours worked per day and the wages paid vary by the type of operation and time of the year. Daily wages also vary throughout the season due to labor demand and supply situation.

Threshing operations for rice and wheat crops are done with threshing machine, and the payments for the use of machine and labor operating are jointly made on an hourly basis. Winnowing of berseem seed, broad beans, rice, and wheat are done as custom operation and the compensation for this task is made by payment in kind. The established rates for wheat and berseem seed were one kaila per ardab and for rice and broad beans half a kaila per ardab of grain processed.

F. Purchased Inputs

The seed for government crops of cotton and sugar beets used by all the farmers and of rice used by 77 percent of the farmers was purchased from the cooperative. Fifty-eight percent of the farmers that produced wheat and eight percent of the farmers that produced maize also purchased the seeds for these two crops from the cooperative. The balance of the farmers that produced rice, wheat, and maize and all the seed for the flax and berseem crops were either purchased from the market and other farmers or came from their own farms (Tables 6 and 7).

Table 8 indicates the varieties of nitrogen and phosphorus fertilizer used by the farmers. The volume of different fertilizers used for various crops is calculated as a simple arithmetic mean of the per feddan fertilizer application rate by the farmers producing those crops. The small application rate values such as seven kilograms of ammonium sulfate per feddan of maize and five kilograms of ammonium nitrate per feddan of rice indicates their use by a small group of farmers (Table 8).

Table 6. Source of Seed for Major Crops, Abu Raya, Kafr El Sheikh, 1980.

Crops	Sources				
	Cooperative	Market	Own Farm	Other Farms	Total
			percent		
Berseem	0	34	64	0	100
Cotton	100	0	0	0	100
Flax	0	50	36	14	100
Maize	8	13	61	18	100
Rice	77	0	17	6	100
Sugar Beets	100	0	0	0	100
Wheat	58	8	32	2	100

Source: EWUP Farm Management Survey.

Table 7. Seeding Rate and Price of Seed per Unit, Abu Raya, Kafr El Sheikh, 1980.

Crops	Unit[1]	Seed Applied per Feddan	Price per Unit	
			Government	Market
			----L.E.----	
Berseem	Kaila	1.60	----	5.000
Broad Beans	Kaila	6.00	2.033	2.870
Cotton	Kaila	6.74	0.273	----
Flax	Kg	67.91	----	0.272
Maize	Kaila	2.30	1.810	1.383
Rice	Kaila	5.95	1.140	0.850
Sugar Beets	Kg	7.00	2.000	----
Wheat	Kaila	6.13	0.888	0.925

Source: EWUP Farm Management Survey, Abu Raya Cooperative.

[1]See Appendix A for conversion factor to kilogram.

Table 8. Actual Chemical Fertilizer Application and Recommendation for Major Crops, Abu Raya, Kafr El Sheikh, 1980[1].

Type of Fertilizer	Cotton	Rice	Maize	Wheat	Flax	Broad Bean	Long Term Berseem	Sugar Beets
	---------- Kilogram per feddan ----------							
Ammonium Sulfate 20.6		141	7					
Ammonium Nitrate 31.0	17		13					
Ammonium Nitrate 33.5	82	5	80	60	77		5	200
Urea 46.0	34	12	53	33	12		7	
Super Phosphate 15.5	16		14	5		7	12	
Triple super phosphate	28	14					9	
Total Nitrogen Applied	48	36	57	35	31	0	5	67
Nitrogen Recommended	62	39	78	54	47	8	8	
Nitrogen Provided by Cooperative	59	31	69	42	34			
Total Phosphate Applied	14	6	2	1	0	1	6	0
Phosphate Recommended	15	15	0	8	0	0	45	

[1]Fertilizer application data for all crops except for sugar beets is based on average per feddan application rate by the fifty surveyed farms. Fertilizer application rate for sugar beets is based on EWUP farm records. In addition to the chemical fertilizers, most surveyed farmers had applied manure to their fields.

Source: Egypt Water Use and Management Project Farm Management Survey, Agricultural Credit Bank.

Comparison of the total chemical nitrogen and phosphate applied in different crops with the rate recommended by the Agricultural Credit Bank suggestsa possible deficiency in application of nitrogen fertilizer. The actual chemical nitrogen applied per feddan is less than the amount allocated through agricultural cooperatives at subsidized rate for most crops. Cotton's net nitrogen application per feddan was 81 percent of what was allocated by the cooperative. Nitrogen application as percent of cooperative allocation was 83 percent for maize and wheat and 91 percent for flax. Actual nitrogen applied in rice was more than the cooperative allocation quota.

The discrepancy between the volume of fertilizer that farmers are entitled to purchase at subsidized prices from the cooperative and the actual application might be due to; (1) inability of some of the farmers to obtain their quota of fertilizer from the cooperative due to violation of the cropping pattern, (2) reallocation of fertilizer to fruits, vegetables, and other minor crops, (3) the selling part of the fertilizer to the market at higher prices, and (4) unavailability of the fertilizer at the time it is needed.

On the average 70 percent of the fertilizer applied was purchased from the cooperative and the balance from the market. Since all the fertilizer is initially sold through the cooperatives, the purchase of 30 percent of fertilizer from the market indicates the existence of an active market where fertilizer is sold by farmers. The market prices paid for fertilizer is generally about twice the government subsidized price (Table 9).

Table 9. Sources and Prices of Fertilizers Purchased, Abu Raya, Kafr El Sheikh, 1980.

	Sources		Prices per Kg		
Fertilizer Type	Market	Government	Market	Government	Weighted Average
Ammonium Sulfate 20.6	10.2	89.8	0.08	0.044	0.048
Ammonium Nitrate 33.5	21.8	78.2	0.10	0.067	0.077
Ammonium Nitrate 31.5	22.6	77.4	0.13	0.062	0.074
Urea 46	23.7	76.3	0.16	0.092	0.108
Super Phosphate 15.5	26.8	73.2	0.09	0.030	0.046
Triple Super Phosphate 42.0	17.2	82.8	0.12	0.082	0.089

Source: EWUP Farm Management Survey, Abu Raya Cooperative.

G. Crop Production, Value, and Disposition

The yield for staple crops of maize and wheat was 9.4 and 7.7 ardabs, respectively. The expected yield for these two crops was higher than the actual yield and closely approximated the national average yield. The average yield of 3.9 ardabs per feddan of broad beans in this area was also significantly below the national average yield of 6.1 ardab per feddan (Table 10).

Flax is an early maturing winter crop which is harvested in March and April. It is grown as a dual purpose crop for both fiber and seed. The average yield of flax seed in Abu Raya was somewhat higher than the national average. The flax output is sold to flax

Table 10. Actual, Expected, and National Average Yield for Cotton, Flax, and Major Staple Crops.

Crops	Unit	Output per Feddan Abu Raia (1979-80) Actual	Expected	National Average (1976-78)
Cotton	Kentar	5.2	7.5	6.5
Rice	Ton	1.8	2.4	2.3
Maize	Ardab	9.4	10.7	11.7
Wheat	Ardab	7.7	9.3	9.4
Flax	Ton	0.6	0.8	0.5
Broad Beans	Ardab	3.9	3.4	6.1

Source: Egypt Water Use and Management Farm Management Survey, Statistical Year Book, Central Agency for Public Mobilization and Statistics, Cairo, 1979.

netting and processing companies. The seed is used for making linseed oil, mostly for paint, and the straw is used for making domestic linen.

The farmers in Abu Raya had achieved an average output of 5.2 kentar of cotton and 1.8 tons of rice per feddan for these two governmental cash crops. The yield expectation which is based on a historical level of yield achievement and the yield obtained by better farmers in the area was significantly higher.

The entire output of the crop of cotton is collected from the farmers by the cooperatives. The government policy requires farmers in Abu Raya to sell to the government 1.5 tons of rice for each feddan of rice produced. Since the rice yield in this area is significantly below the national average and also because of the need to meet the household consumption requirement of rice, the actual average rice delivered to the cooperative has been 900 kilograms per feddan or 50 percent of the total rice output. The small farmers had achieved slightly higher average yields compared to larger farmers but had delivered to the cooperative considerably larger portions of their rice output (Table 11).

On the average, fifteen percent of rice is given out as payment in kind to farm laborers and as zakah or "charity". Only two percent of total rice output was marketed. The portion of rice marketed was higher for larger farms compared to medium-sized farms and no rice was marketed by the farmers in the small farm size category.

Broad beans, maize and wheat are primarily produced for farm household consumption. The small farms achieved a higher average yield for broad beans and wheat compared to farms in the middle and large farm size category and a somewhat higher yield for maize compared to the large farm size category. On the average, 22 percent of broad beans, 13 percent of maize, and 8 percent of all wheat production was marketed. Ten percent of broad beans and maize output and 26 percent of wheat output was disposed in the form of payment in kind to farm laborers and charity (Table 12).

Crop residue is used as fuel and livestock feed. Cotton stalk, maize stalk, and rice straw are used as fuel, and wheat and broad beans straw as animal feed. A small number of farmers had mixed some

Table 11. Cooperative's Requirement and Actual Volume of Rice Received from the Farmers, by Farm Size, Abu Raya, Kafr El Sheikh, 1980.

Farm Size	Area in Feddans	Cooperative Quota Per Feddan[1]	Total Requirement by Cooperative	Actual Volume Received by Cooperative	Actual as Percent of Required
	Feddans	-------------------	---------Kg---------	-------------------	Percent
Small	1.31	1500	1950	1378	71
Medium	2.47	1500	3705	2159	58
Large	3.44	1500	5160	2734	53
Average All	2.27	1500	3405	2044	60

[1]Cooperative rice quota of 1500 kilograms (1.5 metric ton) is based on yield expectation of over 2000 kilograms per feddan.

Source: Egypt Water Use and Management Project's Farm Management Survey.

Table 12. Production and Disposition of Rice, Broad Beans, Wheat, and Maize by Average Farm, Abu Raya, Kafr El Sheikh, 1980.

Crop	Crop Production			Crop Disposition				
	Area in Feddans	Output per Feddan	Total Production	Sold to Cooperative	Payment In Kind[1]	Marketed	Household Consumption[2]	Total
	Feddans	----------Kg----------		----------Percent of Total Output----------				
Rice	2.27	1801	4088	50	15	2	30	100
Broad Beans	0.21	606	127	0	10	22	68	100
Wheat	1.28	1155	1479	0	26	8	66	100
Maize	0.56	1313	735	0	10	13	77	100

[1] Include payment to laborers used in post harvest operations, saqia repairman, barber, and _zakah_ or "charity".

[2] Output retained for household consumption may vary from actual annual consumption.

Source: Egypt Water Use and Management Project's Farm Management Survey.

rice straw with other livestock feed in order to maintain their livestock during the non-berseem season. About 12 percent of the wheat straw was marketed and it had a market value of L.E. 9.6 per camel load. Wheat straw accounted for approximately 36 percent of the total value of the crop.

H. Livestock on the Farm

Most farms in Abu Raya, Kafr El Sheikh kept one buffalo, one cow, and one donkey. There were a number of small farms which kept one buffalo or cow and three small farms that did not have any buffalo or cow. Large farms maintained an average of three to four buffalos and cows. On the average, one sheep or goat was kept on one out of every three small- and medium-sized farms and on two out of three large farms. Buffalos and cows are used for puddling the rice fields, furrowing, smoothing, and for turning the sakia. Buffalos and cows were used by 25 percent of the surveyed farmers in land preparation and by 90 percent of the farmers as source of power for lifting water. Donkeys are used for hauling manure and harvested crops as well as a means of transportation to the field and the market. Besides power, both buffalos and cows produce milk and meat for family consumption (Table 13).

Table 13. Average Number of Livestock Maintained and Value by Farm Size, Abu Raya, Kafr El Sheikh, 1980[1]

Farm Size		Average Number					Average Investment				
Category	Feddans	Buffalo	Cows	Donkeys	Sheep & Goats	All Livestock	Buffalo	Cows	Donkeys	Sheep & Goats	All Livestock
Small	2.70	1	1	1	a	3	467	169	22	10	669
Medium	5.10	1	1	1	a	3	440	390	39	9	878
Large	8.30	2	2	1	b	5	715	451	57	14	1237
Average All	4.90	1	1	1	a	3	510	324	37	11	882

Source: Egypt Water Use and Management Farm Management Survey.

a. One out of every three farms kept a sheep or goat.

b. One out of every two farms kept a sheep or goat.

SECTION III

METHODOLOGY

A. Choice of Analytical Tool

Choice of optimal mix of crops and livestock for subsistence Egyptian farms which are faced with government price and allotment policies, agronomic and resource constraints, and the need to meet the farm household subsistence, food and animal feed requirements, needs to be systematically analyzed. Improvements in the irrigation systems must be considered in light of this operating environment. The method of analysis used for this study must take full account of physical and financial flows within the small Egyptian farms, and thus be able to capture the utilization of crops, animals and their by-products for food, animal feed, fertilizer, fuel, and cash income.

Linear programming is commonly used for farm planning and managerial decisions. Linear programming models have been applied to a great number of farm planning studies in developing countries. The various complexities and uniquenesses of the Egyptian farming system can be appropriately incorporated in this model. Apex-II linear programming solution procedure used in this study was developed by Control Data Corporation.

The model developed for this study includes agronomic constraints, government restrictions on production of different crops and the specification of the appropriate quantities of various crops needed for household consumption and maintenance of essential animal stock on Egyptian farm.

The various agricultural resources of land, water, and labor, as required in the production process of various crops are introduced into the model as resource constraints. This feature of the model would then allow the availability of the above resources to play a major role in the choice of an economically optimal crop mix. Based on the marginal contribution of each of these resources to the value of objective function or net income, a value is automatically assigned to each resource. In the case of water, this indicates the value of irrigation water at the given level of water application.

Linear programming model also provides marginal values for various activities that are forced in the solution via a minimum bound and for activities of production which are restricted by specifying an upper bound. This information is valuable in determining the change in the value of objective function that can be brought about by changing the limits imposed on the activities. For example, a minimum bound must be specified to provide the necessary amounts of staple foods for farm household consumption of subsistence farmers. Upper bounds on production activities are needed to satisfy agronomic, market, and policy constraints.

Variation or change in the level of availability of various agricultural resources, commodity prices and input costs can easily be included in this model and the impact of these changes on allocation of agricultural resources among various production activities and on the income of the Egyptian farmers analyzed. Each change in constraints implies a possible difference in values imputed to resources, such as irrigation water. The degree of the stability of the optimal solution to changes in resource availability, product prices, and input costs, and the direction of change in cropping pattern in response to changes in the aforementioned factors is then determined by this analytical model.

B. Model Structure and Specifications

Due to possible differences in farmer's estimation of fixed costs and family laborers, and their impact on resource allocation, models with two different objective functions are constructed. The objective function is defined as return to fixed inputs and family labor in the first model and as net return in the second model. These two models are based on a 4.92 feddans farm with 4.5 feddans of land area available for production of major crops included in this study (Table 14).

Four policy alternatives considered for analysis are the base run reflecting existing policies, administered prices, free market condition, and charging for water (for detail see section on policy alternatives evaluated). These four policy alternatives are evaluated utilizing the aforementioned two models. In addition to the four policy alternatives a sensitivity test of shifting the cotton rotation from existing triennial rotation to a system of biennial rotation is conducted.

Table 14. Characteristics of the Models.

Items	Model One	Model Two
Objective Function	Return to fixed inputs & family labor	Net Return
Farm size	4.92	4.92
Area modeled for major crops	4.5	4.5
Maximum area in cotton crop triennial rotation	1.65	1.65
Maximum area in rice crop	2.35	2.35
Maximum area in flax	0.38	0.38
Household consumption and payment in kind requirements (feddans)		
Broad beans	0.19	0.19
Maize	0.50	0.50
Rice	1.07	1.07
Wheat	1.18	1.18

These two linear programming models simulate the production and disposition of nine crops and five livestock activities. The nine cropping activities generate 19 crops and crop residues. The values of all crops such as cotton, rice, wheat and others are determined in the model through crop selling activities. Berseem and crop residues of wheat straw, broad bean straw, and maize strippings are converted to metabolizable energy (ME) and digestible protein (DP) and transferred as source of feed for livestock activities. Selling activities for these crop residues were included primarily as a means of comparing the profitability of their selling with the alternative of feeding them to livestock.

Crop and livestock production activities are constrained to meet the agronomic constraints, household staple food consumption requirements and payments in kind, and animal power requirements. Government production quotas for cotton and rice are included as minimum bounds only in base run policy alternative.

Agronomic constraints limit the options available for optimization in several ways. First, the number of times a particular crop can be produced in a two-or three-year crop rotation is limited by the season specific production nature of different crops. Secondly, cotton production is limited to a maximum of one-third of the land area due to soil exhaustion and pest control problems. A sensitivity test is conducted, however, by allowing cotton production to take place on the same field every other year with the possibility of a 10% reduction in cotton yield.

Third, rice requires significant amounts of water and can lead to a rise in the water table in the absence of a good drainage system, which is the case for most of the land in the delta. Further, the water delivery system will not be able to deliver more water, particularly in the months of June and July, to expand rice production area. The maximum limit on the production of rice will be set at 50 percent of the summer cropland area. And fourth, since cotton needs to be planted before March, it can only follow short-term berseem in rotation. In this model, cotton and short-term berseem are treated as joint crops occupying the land for the entire crop year.

From the survey, broad beans, maize, rice, and wheat were identified as subsistence staple crops. Production areas for staple crops, equivalent to the amount of these crops consumed on the farm and disposed as payments in kind in 1979-1980 crop year, are set as minimum bounds. This is based on the assumption of maintaining the status quo regarding self-sufficiency in staple crops.

Water lifting and transportation of input and products on the farm are considered as being carried out by animal power. A minimum of two buffalos & two cows or one buffalo and one cow will be selected by the model in order to satisfy the power requirement for the operation of the saqia. One donkey will be included to meet the transportation requirement. The buffalos and cows, in addition to providing power, produce milk for farm household consumption, organic fertilizer for crops, and calves for sale to the market.

The livestock feed requirements can be met by berseem, crop residue and purchase of wheat bran and cotton seed meal as feed supplements. During the winter or berseem season, the livestock feed requirement is met through production of berseem and in the summer season the feed requirements are met by feeding of crop residues.

The production of the required governmental crops of cotton and rice were restricted to one-third and one-half feddans of the summer land, respectively, to meet the government crop production quotas as was enforced in Abu Raya for the 1980 cropping year. Cotton and short term berseem are treated, however, as a joint activity occupying the land for two cropping seasons.

Sugar beet is a newly introduced crop in this area. Like cotton and rice, the land area for sugar beet is determined by the cooperative. In this study sugar beet will be introduced as an activity with an upper bound of zero. This set up of sugar beet activity in the model will indicate the increase in income that can be achieved if sugar beet was allowed to replace other winter crops. The demand for flax, another winter cash crop, is determined by the flax processing companies& is assigned an upper production limit equivalent to the area's share of flax production by the survey's average farm in the two models.

The monthly supply of labor at the average wages of L.E. 0.30 per hour for men, L.E. 0.20 per hour for women and L.E. 0.15 per hour for child labor was limited to 150 hours of man labor and 300 hours of woman and child labor. Labor use in excess of the aforementioned monthly constraints result in an increase in hourly wage rate of L.E. 0.10 for men and L.E. 0.06 for women and children. The aforementioned monthly labor limits were established on the basis of peak labor use month in 1980. May was identified as the highest man labor requirement month and September as the highest women and children labor use month.

Crop water requirements are given on a monthly basis to determine the high water use months and recognize to shift in monthly water requirement as cropping patterns change. Due to lack of data on monthly availability of water, a constraint was not imposed on the availability of water.

C. Mathematical Statement of the L.P. Model

$$\text{Max } Z = \sum_{i=1}^{14} \Pi_i X_i$$

Subject to

1. Resource Constraints

a) Land Constraint

$$\sum_{i=1}^{3} X_i \leq 4.5L_1$$

$$\sum_{i=4}^{9} X_i \leq 4.5L_2$$

b) Total Monthly Labor Availability at 1980 Annual Average Wage Rate

$$\sum_{i=1}^{14} A_i X_{ij} \leq 150 \text{ man hour}$$

$$\sum_{i=1}^{14} B_i X_{ij} \leq 300 \text{ woman and child hour}$$

2. Agronomic Constraints

a) Cotton $X_1 \leq .33L_3$

b) Rice $X_2 \leq .50L_3$

c) Cotton rotation $X_1 = X_8$

3. Staple Crop Requirement for Farm Household Consumption and Payment in Kind

$X_i \geq K_i L_i \quad i = (2,3,4,6)$

4. Animal Power Requirement

a) Lifting water $X_{10} + X_{11} \geq 2$

b) Transportation $X_{14} \geq 1$

5. Institutional Constraint

a) Cotton X_1 = 1.60 feddans

b) Rice X_2 = 2.30 feddans

NOTATION

Π_i = return per feddan of crop i
X_i = cropping and livestock activities
X_1 = cotton
X_2 = rice
X_3 = corn
X_4 = wheat
X_5 = flax
X_6 = broad bean
X_7 = long-term berseem
X_8 = short-term berseem
X_9 = sugar beets
X_{10} = buffalo
X_{11} = cattle
X_{12} = sheep
X_{13} = goats
X_{14} = donkeys

L_i = actual feddans of crop i
L_1 = summer cropland area for crops modeled
L_2 = winter cropland area for crops modeled
L_3 = total summer cropland area
L_4 = total winter cropland area
K_i = a vector of minimum staple crop requirement for crops 2, 3, 4, and 6
$A_i X_{ij}$ = man labor requirement by activity i in month j
$B_i X_{ij}$ = woman and child labor requirement by activity i in month j

D. Policy Alternatives Evaluated

1. Base run. The optimal cropping pattern and livestock holdings are determined utilizing the farm-level product and input prices that prevailed in 1980. Further, the government production quotas for crops of rice and cotton equal to the area designated for production of these two crops are included as a minimum area requirement. The result of this alternative indicates the degree of improvement in the allocation of farm resources and farm income that can be achieved under the existing government policies. Further, it will become a base against which other alternatives can be compared.

2. Administered prices. This alternative removes the production quotas on cotton and rice but maintains the 1980 farm level prices. The differences in optimal cropping pattern and livestock holdings between the base (alternative one) and this alternative, if any, indicates the discrepancies that may exist between the crop production quotas and the pricing policies. In the absence of enforcement

of the crop production quotas, the enterprises toward which farm resources should be reallocated will become apparent by the solution for the administered price alternative.

3. Free market condition. The objective of the third alterntive is to determine the optimal combination of farm enterprises in the absence of price distortions and crop area interference. A comparison of the result of the free market alternative with that of the base alternative indicates whether or not government production quota has forced cultivators to adopt a cropping pattern similar to what they would have chosen had the domestic prices been equal to international market prices. Should this be the case, the government has performed as well as the market forces would have done at the given international prices without area control.

In contrast, the difference in cropping pattern between this alternative and base run indicates the degree of misallocation in farm resources that may have occurred as a result of government intervention. Comparison between the result of this alternative and alternative two (administered prices)shows the difference between the result of private market forces at actual domestic prices and what might be achieved under perfectly free trade, thus illustrating the effect of price distortion on allocation of agricultural resources.

4. Free market condition and charge for cost of water delivery. The rationale for inclusion of a water charge of L.E. 0.005 per cubic meter of water utilized by the farmer is twofold. First, since part

of the money extracted by the government through the differentials between government purchase prices and prices under a free market system is returned back to the agricultural sector in the form of provision of free water, then under the situation of free market system all the costs of production including water should be borne by the production unit or the farm. Second, each crop will be charged a delivery cost equal to the volume of water the crop requires in its production and therefore a better economic profitability comparison of various crops can be made.

E. Sources of Data

1. Primary data collection

Data on economic relevant facets of farming system for Abu Raya Cooperative district was obtained by conducting a farm management survey. The specific areas of focus of these surveys were the availability of resources, production practices, quantities of inputs used and output generated, prices, and economic and institutional constraints under which these farmers operate.

Farm management survey of a representative sample of farms is a reliable method of collecting information on economic aspects of a particular farming system. Simple arithmetic means of the data gathered from the surveyed farms can be used to construct a representative farm. The representative model of the existing farms can then be used in assessing the impact of government agricultural policies on farm income and resource use (see EWUP Technical Report No. 11 for detail).

2. Secondary Data Sources

The data obtained by the farm management survey was supplemented by Egypt Water Use and Management Project's (EWUP) Farm Records for preparing crop enterprise budgets and constructing the linear programming model. Information on supply and prices of fertilizer was obtained from agricultural credit banks. The Abu Raya Agricultural Cooperative furnished information on government crop procurement policy and prices paid to farmers. Data on irrigation and agronomic practices of Egyptian farmers was obtained from various EWUP project and staff papers.

SECTION IV

ANALYSIS OF POLICY ALTERNATIVES

The optimal combination of crop and livestock enterprises for policy alternatives considered are presented in this section. The results for the four alternatives are compared with actual farming situations and with each other and their impact on allocation of farm resources, water requirement, and farm income is discussed. The result of the first model where the objective function is defined as return to fixed inputs and family labor are presented first and then followed by the result of the second model in which return to all factors are endogenous to the model.

A. Return to fixed inputs and family labor

1. Base solution. In this analysis, the actual prices that existed in 1980 and the quotas on production and marketing of cotton and rice crops are included. The resulting optimal combination of crop enterprises is similar to the actual cropping pattern with some minor differences (Table 15). The similarity between the result of the base run and actual cropping pattern is to be partly expected due to the crop production limitations imposed on the model to satisfy the government policy and farm household consumption and livestock feed requirements. Because the base model solution closely approximates the actual cropping pattern, it can be seen that the model is correctly specified.

Table 15. Optimal Combination of Farm Enterprises and Return to Fixed Inputs and Family Labor For 4.5 Feddan Farm Under Alternative Policies.

				Free Market Condition			
				Triennial Cotton Rotation		Biennial Cotton Rotation	
	Actual	Base Run	Administered Prices	No Water Charge	Water Charge	No Yield Loss	10 Percent Yield Loss
Summer Crops (Feddan)							
Cotton	1.60	1.60	0.00	1.65	1.65	2.45	1.55
Maize	0.56	0.60	3.43	0.50	0.50	0.50	0.50
Rice	2.30	2.30	1.07	2.35	2.35	1.55	2.45
Winter Crops (Feddan)							
L.T. Berseem	1.14	1.15	2.75	0.50	0.50	0.50	0.50
S.T. Berseem	1.48	1.60	0.00	1.65	1.65	2.45	1.55
Broad Beans	0.21	0.19	0.19	0.19	0.19	0.19	0.19
Flax	0.38	0.38	0.38	0.00	0.00	0.00	0.00
Wheat	1.28	1.18	1.18	2.16	2.16	1.36	2.26
Livestock (No.)							
Buffalo	1	0	0	0	0	0	0
Cow	1	2	2	2	2	2	2
Donkey	1	1	1	1	1	1	1
Goats	0	3	8	1	1	1	1
Sheep	1	4	8	0	0	2	2
Water and Hired Labor Requirements							
Water requirements (C.M./Feddan)	8,902	9,040	8,890	8,434	8,434	8,177	8,467
Total man labor hired (hrs.)	315	322	401	276	276	222	283
Total woman labor hired (hrs.)	270	267	272	284	284	342	277
Total child labor hired (hrs.)	151	147	100	132	132	229	120
TOTAL RETURN (L.E.)	720.00	747.00	821.00	1,623.13	1,434.34	1,643.42	1,545.17
RETURN PER FEDDAN (L.E.)	160.00	166.00	182.44	360.70	318.74	365.20	343.37

The allocations of 1.6 feddans into cotton production and 2.3 feddans into rice production are made to satisfy government production area quotas for these two crops. Maize, as the most profitable summer crop, occupied the allocable summer cropland area of 0.60 feddans. The choice of maize as the profitable summer crop is consistent with the farmers' actual allocation of the 0.56 feddan of summer land in maize production. If government policy would permit, replacement of each feddan of cotton and rice by maize at the margin would have resulted in a net increase of L.E. 43 and L.E. 31 in farm income, respectively. The net gain from substituting one feddan of cotton or rice by maize is, however, less than the L.E. 50 per feddan penalty set by the Egyptian government for violation of cotton and rice production area quotas.

The selection of optimal cropping patterns for the winter cropping season is restricted by the required 1.6 feddans of short-term berseem associated with cotton production and minimum requirements of subsistence staple crops which include 1.18 feddans of wheat and 0.19 feddan of beans. The slight difference between the actual wheat and broad beans production area and the result of the base run accounts for the small portion of wheat and broad bean output sold in the rural market. Part of the winter cropland (8%) preceding cotton was kept as fallow by Abu Raya farmers in 1979-80.

Sugar beets which were introduced into this area in 1979 is the most profitable winter crop. Its production is, however, limited to a limited number of farms, the area and location of which are determined by the cooperative. The total area that will be eventually allocated into the production of sugar beets in Kafr El Sheikh is limited by the capacity of the newly built sugar beet factory. Flax is the second most profitable winter crop. Production of flax was limited to a maximum of 0.38 feddan which is the actual area allocated to its production on the average per 5 feddans area in Abu Raya in 1979-80 cropping year. A reallocation of land from berseem to sugar beets and flax at the margin will result in an increase of L.E. 30 and L.E. 20 per feddan, respectively.

Given the limited available market for the profitable winter crops of sugar beets and flax, production of berseem and raising sheep and goats appear to be the most profitable venture for Abu Raya farmers under the existing situation. Recent interest by farmers in the study area to raise livestock, particularly improved breeds of cows for market, supports this finding.

The buffalo and cow livestock activities included in the model represent the existing breed of these animals which are maintained primarily as a source of power for land preparation and for turning the saqia. Two cows and one donkey were included in the solution in order to meet the farm draft power needs.

With the limited 4.5 feddan land area for production of major crops and the available option of expanding the production of berseem, the allocation of 1.18 feddans for wheat and 0.19 feddan for broad beans to meet the household food consumption requirements resulted in a net reduction of L.E. 110 in farm income. On the margin, the loss in farm income from the production of wheat is L.E. 87 per feddan and from the production of broad beans, L.E. 43 per feddan.

The mix of major crops and livestock for the 4.5 feddan area resulted in a return of L.E. 747 to fixed inputs, including water, and family labor. The actual return to fixed inputs and family labor was a total of L.E. 720 or L.E. 160 per feddan in 1979-80 crop year.

The L.E. 747 farm income (return to fixed inputs and family labor) includes the values of crops, crop residues, and livestock by products consumed on the farm. The net cash that can be retained by the farm household for purchase of farm equipment, livestock and food not produced on the farm such as tea, sugar, and other expenses is about $400 per year for the base solution. This is equivalent to L.E. 50 per capita per year.

The resulting cropping pattern for the base run alternative requires a total of 40,679 cubic meters of water for the 4.5 feddans of major crops or 9,040 cubic meters per feddan per year. June and July were the highest water use months with 1,657 and 1,209 cubic meters of water requirements per feddan, respectively. Return to water for the 4.5 feddan farm was L.E. 0.02 per cubic meter of water utilized.

A total of 322 man hours, 267 woman hours, and 147 child labor hours were hired to supplement the family labor in non-irrigation cropping activities. October requires 209 hours of man labor which is the highest man labor use month followed by May with a man labor requirement of 147 hours. The highest woman and child labor requirement month was September with 349 hours, followed by October and June with 309 and 247 hours, respectively.

2. Administered prices. When the government quotas for production of cotton and rice are removed as minimum bounds on the production of these two crops but the administered prices retained, cotton was not produced and rice production was limited to 1.07 feddans necessary to satisfy the farm family consumption requirement. The remaining 3.43 feddans of summer cropland is allocated to the production of maize.

Replacement of the cotton area by maize in the summer cropping season released the land area occupied by short-term berseem which was then reallocated to the production of a larger area of long-term berseem. The increased berseem is then used to produce an expanded number of 16 goats and sheep. Sugar beets remained the most profitable winter crop and flax the next most profitable. The production of these two crops was restricted by the upper bound.

With the existing price-cost structure and the crop and livestock activities considered, the removal of government quotas for production of cotton and rice led to an increase in return to fixed factors and family labor of L.E. 16 per feddan above the base run alternative and to an increase of L.E. 22 per feddan above the actual 1980 level of farm return.

3. Free market condition. Incorporating international equivalent prices at the farm gate level for farm inputs and products as a proxy for simulating free market conditions in the model resulted in a summer cropping pattern that closely approximated the actual situation. Major differences in the winter cropping pattern between actual and free market conditions are in the production of long-term berseem and wheat.

Wheat, which was produced at the minimum level for the household consumption requirement under the administered prices, became the most profitable winter crop when free market prices were used. The 2.16 feddans of winter land allocated to wheat production is considerably larger than the actual wheat production area of 1.28 feddans. Long-term berseem was no longer profitable and produced at its minimum required area of 0.5 feddan necessary to provide green forage for the months of March, April, and May.

Cotton is produced at its upper agronomic constraint level of 1.65 feddans or 33 percent of the total farm area. Maize was produced on 0.5 feddan for farm household consumption and the balance of the land (2.35 feddans) is allocated to rice production. Return to fixed inputs and family labor under free market condition is L.E. 1623 or L.E. 361 per feddan. This is an improvement of L.E. 200 per feddan in farm income over the actual situation.

Reallocating land from rice and wheat to cotton production at the margin within a narrow range (1.65 to 1.84 feddans in cotton) is shown as having the potential of raising farm income by L.E. 34 per feddan. Relaxation of the agronomic constraint on cotton from 33 percent to 50 percent of the land area resulted in an increase in cotton production from 1.65 feddans to 2.45 feddans, or 50 percent of the total land area. The production areas of rice and wheat correspondingly decreased by 0.8 feddan. This change in cropping pattern led to an increase of L.E. 20.29 in farm income.

The slight increase in farm income brought about by the above reallocation of land from rice and wheat to short-term berseem-cotton crops was based on the assumption that change from the three-year cotton rotation to a biennial cotton rotation will not have any effect on cotton yield and cost of production. It has been estimated that the shift from the biennial to triennial cotton rotation system following the post-war cotton boom had resulted in an increase of 20 percent in cotton yield (62-p. 7, 80-p. 1).

A sensitivity test of optimal cropping pattern under a biennial cotton rotation system to cotton yield indicated that a mere 10 percent reduction in cotton yield associated with biennial cotton production would change the relative profitability position of short-term berseem-cotton crops over wheat rice rotation crops. The optimal cropping pattern, given a 10 percent reduction in cotton yield, is similar to the cropping pattern under the triennial cotton rotation system. This finding suggests that where the potential for a loss of 10 percent in cotton yield exists, the optimal cropping pattern will include cotton production in one-third of the land area.

Water requirements for the optimal cropping mix of the 4.5 feddan farm is 37,955 cubic meters for the case of triennial cotton rotation and 36,797 cubic meters for the case of biennial cotton rotation. Return to water under free market condition was L.E. 0.04 per cubic meter, twice that of the base solution. Given the three-year cotton rotation, the reduction in water requirement of about 2,000 cubic meters compared to actual for 1980-81 crop year is primarily due to reallocation of part of the land from berseem, a high winter water consuming crop, to wheat. Biennial cotton rotation, which led to reallocation of part of the summer land from rice to cotton, led to a further reduction of 1,000 cubic meters in water requirement.

Requirements for hired labor in the case of three-year cotton rotation are 276 man-hours, 284 woman-hours, and 132 child-labor hours. October is the highest man labor use (214 hours) month, followed by May. October and September are the two highest woman and child labor use months.

4. Assessment of water charge. A charge of L.E. 0.005 per cubic meter of water which is estimated by the Ministry of Irrigation (34) as the cost of storing and delivering water to the farm did not alter the optimal cropping pattern obtained under free market conditions. The only difference is reflected in the farm income which is reduced by a total of L.E. 189 or L.E. 42 per feddan.

The increase in water charge of up to L.E. 0.03 per cubic meter continued not to have any impact on the cropping pattern. As the water charge was increased to L.E. 0.035 per cubic meter, the rice production area was reallocated to the production of maize, and a further increase in water charge at L.E. 0.04 per cubic meter made maize production unprofitable as well. Cotton is the only summer crop that can be profitably produced with a water charge of L.E. 0.04 per cubic meter. The winter cropping pattern was not altered by pricing the water.

B. Net return analysis

In this model the objective function to be maximized is defined as return above all costs. When fixed costs are allocated among enterprises, the relative profitability of these enterprises may change because of different per feddan allocations of these costs. A per feddan rental cost of L.E. 72 per year is assessed. Land tax, depreciation cost of saqia, and all family labor used in cropping and livestock production activities are included.

The four policy alternatives considered indicate the following changes in cropping pattern from the existing situation as profit maximizing (Table 16):

1. Under the existing price-cost structure and government crop production quota, it is more profitable to reduce the area in long-term berseem and increase the production of broad beans. However, this shift in cropping pattern proved to be sensitive to the imposition of production quotas for cotton and rice.

2. In the absence of crop production quotas or where it can be evaded, the farmers can increase their profits by reallocating the farm resources from cotton to production of maize. Profits can also be increased by increasing berseem production. Given the cost of raising livestock, the existing type of work animals and breed of sheep and goats held by the majorty of Egyptian farmers cannot profitably be produced for market.

3. Under free market conditions, the optimal cropping mix for the summer season is similar to the existing cropping pattern. The major changes for the winter cropping mix in this case entails an increase in wheat production from the existing 1.28 feddans to 2.16 feddans, and a decrease in berseem production from 1.14 feddans to

Table 16. Optimal Combination of Farm Enterprises and Return Above All Costs Under Alternative Policies.

	Actual	Base Run	Administered Prices	Free Market Condition: Triennial Cotton Rotation: No Water Charge	Water Charge	Biennial Cotton Rotation: No Yield Loss	10 Percent Yield Loss
Summer Crops (L.E.)							
Cotton	1.60	1.60	0.00	1.65	1.65	1.97	1.55
Maize	0.56	0.60	3.43	0.50	0.50	0.50	0.50
Rice	2.30	2.30	1.07	2.35	2.35	2.03	2.45
Winter Crops (L.E.)							
L.T. Berseem	1.14	0.50	2.50	0.50	0.50	0.50	0.50
S.T. Berseem	1.48	1.60	0.00	1.65	1.65	1.97	1.55
Broad Beans	0.21	0.84	0.44	0.19	0.19	0.19	0.19
Flax	0.38	0.38	0.38	0.00	0.00	0.00	0.00
Wheat	1.28	1.18	1.18	2.16	2.16	1.84	2.26
Livestock (No.)							
Buffalo	1	0	0	0	0	0	0
Cow	1	2	2	2	2	2	2
Donkey	1	1	1	1	1	1	1
Goats	0	0	0	0	0	0	0
Sheep	1	0	0	0	0	0	0
Water requirements per feddan (C.M.)	8,902	8,453	8,660	8,434	8,434	8,331	8,463
Total Man Labor Used (Hrs.)	1,039	1,024	1,037	993	993	989	994
Total Woman Labor Used (Hrs.)	925	875	882	879	879	902	872
Total Boy Child Labor Used (Hrs.)	747	772	506	718	718	757	706
TOTAL RETURN (L.E.)	(189.00)	(172.00)	(56.00)	738.00	549.00	742.00	661.77
RETURN PER FEDDAN (L.E.)	(42.00)	(38.22)	(12.44)	164.00	122.00	164.89	147.06

0.5 feddan. Under free market conditions, flax is less profitable than wheat.

When comparing the results of the two models, it will be observed that including fixed costs and family labor in the objective function does not alter the relative profitability position of the summer crops of cotton, rice, and maize for any of the policy alternatives considered. The slight gain in relative profitability position of broad beans against berseem in the second model can be attributed to the broad beans lower labor and land costs compared with berseem.

Estimation of profitability based on net return indicates the farmers incurring a net loss of L.E. 42 per feddan per year. Under the administered price situation where the government production quotas are waived, the net loss incurred per feddan would be lowered to L.E. 12.44. The optimal combination of crops and livestock under free market alternative resulted in a positive net return of L.E. 738 for the 4.5 feddans of major crops or L.E. 164 per feddan.

A water charge of L.E. 0.005 per cubic meter of water used does not affect the optimal cropping pattern achieved under a free market condition. The assessment of this charge for recovery of the cost of water by the Egyptian government resulted in a reduction of L.E. 189 or L.E. 42 per feddan in net farm income. Increasing the water charge up to L.E. 0.02 will result in extraction of the entire L.E. 738 net farm income, and yet the optimal cropping pattern remains unaltered. A slight increase in water charge above L.E. 0.02 makes rice production unprofitable and results in unused summer cropland.

Relaxing the agronomic constraint on cotton from one-third to one-half the land area resulted in a somewhat different response in the amount of land area reallocated from rice to cotton compared with the first model. Cotton reached a maximum profitable production area of 1.97 feddans, significantly short of its 2.45 feddans biennial rotation upper limit. This difference in cotton profitability between the two models is due to the high fixed costs and hired labor requirement associated with cotton production which are treated as endogeneous in the net return analysis model.

The total water requirement remained nearly at the same level as in the case of the first model, except for the base run alternative where allocation of a smaller area in berseem production led to reduction in water requirement of about 2,500 cubic meters compared with the result of the first model.

SECTION V

SUMMARY OF FINDINGS AND DISCUSSION OF THE RESULTS

A. Summary of Findings

The objective of this study was to evaluate the impact of Egypt's agricultural policies on cropping patterns, resource requirements and farm income. Two models reflecting the differences in farmer's evaluation of profitability were constructed. The degree of suboptimality in cropping pattern and misallocation of productive agricultural resources were determined by considering four policy alternatives.

The objective function was first defined as return to fixed inputs and family labor. This objective function specification reflects farmer's decision environment in the short run. Alternatively, the objective function in the second model was specified to include all costs, reflecting a long run decision environment. Under existing policies and prices, returns are not adequate to cover costs. Only when prices approximate world commodity price levels and production quotas are removed does long run profitablity appear.

Due to the high degree of similarity found in the relative profitability of major crops for the corresponding policy in the cases of the two models, the values obtained in the first model will be utilized for elaboration of findings in this section. The differences found between the result of the two models will be presented at the end of this section.

The optimal solution of the basic model closely approximates the actual situation. This is to be expected from a properly specified model since actual farm data were used and the institutional constraint of crop area production quota, market limitations, farm household staple crop consumption requirements, livestock food requirements, and technical constraint of rotations restrict the freedom of allocation to a great degree.

Sugar beets is the most profitable winter crop followed by flax. Given the market limitations for these two crops, production of berseem and raising livestock becomes the most profitable option for the Egyptian farmers. Maize is the most profitable summer crop. It is produced on the residual summer land area after the government crops of cotton and rice are produced. The actual farm income (return to fixed inputs and family labor) in the 1979-80 cropping year was L.E. 160 per feddan. Given the existing agricultural policies, the solution to the model reveals it can be increased only to L.E. 166 per feddan. Thus, the actual practices are near optimal given the constraints imposed.

If government policy would permit, the replacement of each feddan of cotton and rice with maize at the margin would have resulted in a net increase of L.E. 43 and L.E. 31 in farm income, respectively. This net gain from the substitution of one feddan of cotton or rice with maize is, however, less than the L.E. 50 per feddan penalty set by the Egyptian government for violation of cotton and rice production area quotas. In terms of winter crops, the higher profitability of berseem over wheat and broad beans under existing distorted prices indicate a loss (income foregone) of L.E. 87 per feddan from production of wheat and L.E. 43 per feddan from production of broad beans for household consumption.

The relative profitability of berseem as a winter crop and maize as a summer crop is even more apparent when crop production quota restrictions are removed. All the allocable cropland in the winter season is used for the production of berseem and in the summer season for the production of maize. Though this result is valid for the case of an individual farm or micro analysis, it should not be expected that in the absence of government crop production area enforcement policies, all the allocable land will be used in the production of berseem in the winter and maize in the summer cropping season. Local market and transportation conditions would not permit such specialization in Egypt.

The results of the administered price alternative, however, explain the economic rationale for the farmer's attempt to get two cuttings from short-term berseem instead of one and an illegal reallocation of summer cropland from cotton to maize as is reported to be occurring. Violation of the area production quotas for cotton would allow the farm income to increase to L.E. 182 per feddan or an improvement of L.E. 22 from the existing situation.

Water required for the actual 1979-80 crop year was 8,902 cubic meters per feddan. Under the administered price alternative with no production area restriction, the reduced water requirement from reallocation of the summer land from the high water consuming crops of cotton and rice to maize is offset by the increased production of berseem in the winter season, which is also a high water user crop. The water requirement under administered price alternative is 8,890 cubic meters per feddan.

The optimal summer cropping pattern with the free market policy alternative closely approximates the actual area brought about by government intervention in the three summer crops of cotton, rice, and maize. In spite of reported violations in the production area of government crops, the government area production quota has succeeded in neutralizing the land allocation effects of price distortion and in bringing about a summer cropping pattern similar to what farmers would have chosen under the free market condition. In view of the agronomic constraints of the triennial rotation for cotton and biennial rotation for rice, the economic efficiency criteria in allocation of summer cropland have been met.

Comparison of the optimal winter cropping pattern under the free market condition with one that farmers find profitable under the existing price-cost structure indicates the misallocation of agricultural resources that can occur due to price distortion. Among the winter crops included in this study, the production of long-term berseem and raising livestock is currently the most profitable option for Egyptian farmers, while under the free market condition wheat production would be most profitable.

The optimal cropping pattern under the free market condition resulted in a return to fixed inputs and family labor of L.E. 361 per feddan. The maximum achievable income under existing agricultural policies is L.E. 166 per feddan. Further analysis indicated 97 percent of this improvement in farm income as being due to increase in prices and the remaining 3 percent from the reallocation of resources to the optimal enterprise mix. The loss in value of agricultural output due to the sub-optimal cropping pattern brought about by price distortion is negligible, unless higher prices would stimulate increased production per feddan.

The optimal cropping pattern under free market condition requires 8,434 cubic meters of water per feddan as compared with 8,902 cubic meters of water per feddan for actual 1979-80 cropping pattern. This saving of 468 m^3 of water per feddan is primarily due to substitution of more profitable and less water consuming crop of wheat for berseem.

Assessment of a water delivery charge of L.E. 0.005 per cubic meter of water did not alter the optimal cropping pattern obtained under the free market condition. The only difference is reflected in farm income which is reduced by a total of L.E. 189 or L.E. 42 per feddan. When the water charge was increased to L.E. 0.035 per cubic meter, the rice production area was reallocated to the production of maize. A further increase in water charge to L.E. 0.04 per cubic meter of water made maize production unprofitable as well.

Inclusion of fixed costs and wages for family labor in the net return analysis model did not alter the relative profitability position of the summer crops of cotton, rice, and maize for any of the policy alternatives considered. The winter cropping mix included a somewhat smaller area in berseem for the base run and administered price alternatives compared with the result of the first model. The slight gain in the relative profitability position of broad beans against berseem can be attributed to the broad beans' lower labor and land costs compared with berseem.

So far the results to the various policy alternatives for a given model and between-model comparisons have been made. Several inferences relating to the specific objectives have been drawn. Directly addressing the specific objectives, the following conclusions can be drawn:

1. In view of the government area assignment for cotton and rice, the existing price-cost structure, and farm households consumption requirements, very little change in the cropping pattern is possible. Farmers reported violation of cotton production area quota in favor of maize in the summer and more berseem in the winter is rational and consistent with the relative profitability of maize and berseem.

2. Misallocation of agricultural resources as measured by the difference in the value of actual and optimal cropping pattern is negligible. That is, free market prices would signal about the same crop mix as is practiced under the government programs.

3. Reallocation of 0.65 feddan of winter cropland from berseem to wheat resulted in water savings of 2,700 cubic meters. Considering other minor changes in cropping pattern, the net savings of water from improving the cropping pattern is 2,100 cubic meters from the 4.5 feddan farm or 468 cubic meters per feddan.

B. Discussion of the Result

Although the cropping pattern and aggregate value of output cannot be significantly changed by shifting from existing policies to free market conditions for the 4.5 feddan case study farm, considerable reduction in imports of wheat can be achieved. The amount of water required to supply the needs of crops selected by farmers would also be reduced. Higher prices for cotton, rice, and wheat may also provide farmers with the incentive to use improved seeds, apply more fertilizer, invest in irrigation systems and farm machinery, and adopt new irrigation and crop management practices to achieve higher yield.

While the water saving differences on one 4.5 feddan farm may seem small, the water savings could be substantial if the aggregate comparisons are made. Since berseem requires about four thousand cubic meters of water per feddan more than wheat, the reallocation of every one thousand feddan from berseem to wheat will result in a national water saving of 4 million cubic meters. The reduction in water requirement from reallocating 905,000 feddans from berseem to wheat will be 3.6 billion cubic meters annually. In view of the water saving and possibility of reducing Egypt's dependence on imported wheat, the area allocated to production of berseem needs to be closely examined.

A major shift in winter cropland from berseem to wheat would require increased mechanization of land preparation and water lifting as well as change in pricing policies. Raising of mesqas (distributories) and farmers' investments in pumps which replace animal power need to be investigated. The possibility of introducing improved breeds of livestock for meeting the needs for milk, meat, and other animal products also needs to be studied.

The direct impact of agricultural pricing policies on farmers has been the transfer of income from farmer to other sectors of the economy. The amount of income transfer is equivalent to the deferential in gross revenue from using economic farm gate price and the actual prices farmers received less the input subsidies and cost of government services provided to the farmers. In the case of 4.5 feddan study farm, the government extracted L.E. 355 from cotton and L.E. 201 from rice due to price differences. Government incurred a cost of L.E. 203 from provision of water free of delivery charges and provided a subsidy of L.E. 36 for fertilizer. The net transfer out of agriculture from the aforementioned items have been L.E. 353 from the 4.5 feddan farm or L.E. 78 per feddan. Thus, even if the government chooses to extract a comparable amount of its revenue from farmers, government revenues of up to L.E. 78 per feddan could be extracted through say, land taxes, if free market conditions held. Such policies would not alter the product mix and hold the potential of stimulating production per feddan through the incentive of higher product prices.

The impact of agricultural policies is not limited to cropping patterns. Low crop prices and their consequent low profitability may have reduced the farmer's incentive and prevented the application of an optimal level of purchased inputs and labor. Price distortions can lead to a reallocation of the essential inputs of fertilizer, labor, and others from crops in which Egypt has comparative advantage to those that farmers find profitable. Egypt's Ministry of Economy and Trade Study (4) of prices and taxation of major crops has estimated the 30 percent increase in the farm prices of cotton in 1979 resulted in an increase of about 8 percent in cotton yield in addition to the increase of 85,000 feddans in cotton production area. Further increases in cotton production area and yield is expected by 1981 and 1982 as result of the 1979 cotton price increase. Similar output per feddan increases could be expected for other crops in response to price incentives.

The important long-run effect of producers' incentive may be through a shift in the production function rather than through greater efficiency of resource use with the existing production function. These long-run effects depend upon the extent to which the incentive structure has an effect on adoption of new production techniques, investments related to agriculture, marketing, distributional facilities, and agricultural institutions.

Egypt's limited financial resources and the need for speeding up the development process and provision of food at affordable prices provides a formidable reason to interfere with the market prices of agricultural goods. The alternative is to allow agricultural prices to rise in accordance with conditions of supply and demand, and siphon part of the increase in farm income through taxes. Such a policy would be at the minimum neutral in its effect on the level and composition of agricultural commodity outputs. The tax proceeds could then be used to finance government projects and consumer subsidies.

Given the prevailing low income in the agricultural sector, extracting a substantial agricultural surplus through taxation may prove a difficult task. A more viable option is to devise an agricultural price policy that will: (1) reduce the distortion in relative profitability of crops and bring it in line with an efficient allocation of agricultural resources and Egypt's comparative advantage, and (2) allow for a rise in real income of the agricultural sector which will increase producers' incentive and funds needed for acquisition of more purchased inputs and financing improvement in the physical means of production.

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AMERICAN EQUIVALENTS OF EGYPTIAN ARABIC TERMS AND MEASURES COMMONLY USED IN IRRIGATION WORK

LAND AREA	IN SQ METERS	IN ACRES	IN FEDDANS	IN HECTARES
1 acre	4,046.856	1.000	0.963	0.405
1 feddan	4,200.833	1.038	1.000	0.420
1 hectare (ha)	10,000.000	2.471	2.380	1.000
1 sq. kilometer	100×10^4	247.105	238.048	100.000
1 sq. mile	259×10^6	640.000	616.400	259.000

WATER MEASUREMENTS	FEDDAN-CM	ACRE-FEET	ACRE-INCHES
1 billion m^3	23,809,000.000	810,710.000	
1,000 m^3	23.809	0.811	9.728
1,000 m^3 /Feddan (= 238 mm rainfall)	23.809	0.781	9.372
420 m^3 /Feddan (= 100 mm rainfall)	10.00	0.328	3.936

OTHER CONVERSION		METRIC	U.S.
1 ardab	=	198 liters	5.62 bushels
1 ardab/feddan	=		5.41 bushels/acre
1 kg/feddan	=		2.12 lb/acre
1 donkey load	=	100 kg	
1 camel load	=	250 kg	
1 donkey load of manure	=	0.1 m^3	
1 camel load of manure	=	0.25 m^3	

EGYPTIAN UNITS OF FIELD CROPS

CROP	EG. UNIT	IN KG	IN LBS	IN BUSHELS
Lentils	ardeb	160.0	352.42	5.87
Clover	ardeb	157.0	345.81	5.76
Broadbeans	ardeb	155.0	341.41	6.10
Wheat	ardeb	150.0	330.40	5.51
Maize, Sorghum	ardeb	140.0	308.37	5.51
Barley	ardeb	120.0	264.32	5.51
Cottonseed	ardeb	120.0	264.32	8.26
Sesame	ardeb	120.0	264.32	
Groundnut	ardeb	75.0	165.20	7.51
Rice	dariba	945.0	2081.50	46.26
Chick-peas	ardeb	150.0	330.40	
Lupine	ardeb	150.0	330.40	
Linseed	ardeb	122.0	268.72	
Fenugreek	ardeb	155.0	341.41	
Cotton (unginned)	metric qintar	157.5	346.92	
Cotton (lint or ginned)	metric qintar	50.0	110.13	

EGYPTIAN FARMING AND IRRIGATION TERMS

fara = branch
marwa = small distributer, irrigation ditch
masraf = field drain
mesqa = small canal feeding from 10 to 40 farms
qirat = cf. English "karat", A land measure of 1/24 feddan, 175.03 m^2
qaria = village
sahm = 1/24th of a qirat, 7.29 m^2
saqia = animal powered water wheel
sarf = drain (vb.), or drainage. See also masraf, (n.)

EGYPT WATER USE AND MANAGEMENT PROJECT

PROJECT TECHNICAL REPORTS

NO.	TITLE	AUTHOR
PTR#1	Problem Identification Report for Mansuriya Study Area, 10/77 to 10/78.	Egyptian and American Field Teams.
PTR#2	Preliminary Soil Survey Report for the Beni Magdul and El-Hammami Areas.	A. D. Dotzenko, M. Zanati, A. A. Abdel Wahed, & A. M. Keleg.
PTR#3	Preliminary Evaluation of Mansuriya Canal System, Giza Governorate, Egypt.	American and Egyptian Field Teams
PTR#4	On-farm Irrigation Practices in Mansuriya District, Egypt.	M. El-Kady, W. Clyma & M. Abu-Zeid
PTR#5	Economic Costs of Water Shortage Along Branch Canals.	A. El Shinnawi M. Skold & M. Nasr
PTR#6	Problem Identification Report For Kafr El-Sheikh Study Area.	Egyptian and American Field Teams.
PTR#7	A Procedure for Evaluating the Cost of Lifting Water for Irrigation in Egypt.	H. Wahby, G. Quenemoen & M. Helal
PTR#8	Farm Record Summary and Analysis for Study Cases at Abu Raya and Mansuriya Sites, 1978/1979.	F. Abdel Al & M. Skold
PTR#9	Irrigation & Production of Rice in Abu Raya, Kafr El-Sheikh Governorate.	Kafr El-Sheikh Team as Compiled by T. W. Ley & R. L. Tinsley
PTR#10	Soil Fertility Survey in Kafr El-Sheikh, El Mansuriya and El-Minya Sites.	M. Zanati, P. N. Soltanpour, A.T.A. Mostafa, & A. Keleg.
PTR#11	Kafr El-Sheikh Farm Management Survey Crop Enterprise Budgets and Profitability Analysis.	M. Haider & F. Abdel Al
PTR#12	Use of Feasibility Studies and Evaluation of Irrigation Projects: Procedures for Analysing Alternative Water Distribution System in Egypt.	R. J. McConnen, F. Abdel Al, M. Skold, G. Ayad & E. Sorial

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PTR#21	El-Hammami Pipeline Design.	Fort Collins Staff Team
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PTR#23	Farm Record Summary and Analysis for Study Cases at Abyuha, Mansuriya and Abu Raya Sites, 79/80.	F. Abdel Al, & M. Skold
PTR#24	Agricultural Pests and Their Control: General Concepts.	E. Attalla
PTR#25	Problem Identification Report for El-Minya	R. Brooks

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PTR#32	Accessibility of EWUP Pilot Sites.	A. El-Kayal, S. Saleh, A. Bayoumi & R. L. Tinsley
PTR#33	Soil Survey Report for Abyuha Area Minya Governorate.	A. A. Selim, M. A. El-Nahal, & M. H. Assal
PTR#34	Soil Survey Report for Abu Raya Area, Kafr El-Sheikh Governorate	A. A. Selim, M. A. El-Nahal, M. A. Assal & F. Hawela.
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PTR#58*	Cotton Field Trials, Summer, 1980 Abu Raya.	Kafr El-Sheikh Team as compiled by M. Awad & A. El-Kayal
PTR#59*	Management Plan for a Distributary Canal System	A. Saber, E. Wafik, T. K. Gates, & J. Layton
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PTR#77*	El Hammami Farm Record Summary & Analysis	M. Haider & M. Skold
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PTR#79	Analysis of Low Lift Irrigation Pumping	H. R. Horsey, E. V. Richardson M. Skold & D. K. Sunada

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NO.	TITLE	AUTHOR
MAN.#1	Trapezoidal Flumes for the Egypt Water Use Project.	By: A. R. Robinson.
MAN.#2	Programs for the HP Computer Model 9825 for EWUP Operations.	By: M. Helal, D. Sunada, J. Loftis, M. Quenemoen, W. Ree, R. McConnen, R. King, A. Nazr and R. Stalford.
MAN.#5	Precison Land Leveling Data Analysis Program for HP9825 Desktop Calculator	T. W. Ley
MAN.#8	Thirty Steps to Precision Land Leveling	A. Bayoumi, S. Boctor & N. Dimick
MAN.#9	Alphabetical List of Some Crops and Plants with Their English, Egyptian, Botanical & Arabic Names and Vocabulary of Agricultural and other Terms Commonly Used.	G. Ayad
MAN.#10	EWUP Farm Record System	Farouk Abdel Al, David R. Martella, and Gamal Ayad

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