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POTENTIAL SELF-SUFFICIENCY IN MAJOR EGYPTIAN CROPS: NECESSARY PRODUCTION AND PRICE POLICIES AS ESTIMATED BY AN ECONOMETRIC MODEL

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Potential self-sufficiency in major Egyptian crops:

Necessary production and price policies as

estimated by an econometric model

by

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CHAPTER I. INTRODUCTION

Agriculture was and still is one of the major sources for Egyptian national income. About 33 percent of the Egyptian national income originates in the agricultural sector. On the other hand, around 50 percent of the Egyptian population is in the agricultural sector.

The cultivated area in Egypt is about 5.64 million feddan.[1] Further, it is usually cultivated three times a year. This area lies around the Nile region. Egyptian farmers, on the other hand, have had their own technologies for thousands of years.

The rates of growth in the productivity per feddan of most of the agricultural products are very low. This is because of the structural changes in the Egyptian agriculture. Further, the policies concerning the natural resources use have been changed since 1952.

Egypt's current population is about 42 million. The natural increase is about 2.7 (%)[2]. If this rate of growth persists for the next 20 years, then, Egypt's population will be about 80 million by the year 2000. Due to higher population growth rate, the aggregate demand of the Egyptian society has dramatically increased during the past 30 years. This shift in the aggregate demand has led the Egyptian government to follow different consumption policies such as: rationing, subsidies, different regional allocations, etc. This holds true for wheat, beans, meat, vegetables, etc.

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[1]Feddan = 1.03805 acres = 0.42 hectares.

As a consequence of the reduction in the rate of productivity growth in agriculture as well as a higher population growth rate, short or intermediate-run shortage of some items exists. In order to satisfy the higher demand for goods and services, the government of Egypt is now concerned with self-sufficiency by the year 2000. To achieve this goal, however, the government of Egypt has successfully started several food security programs. The objective of these programs is to satisfy the nation's needs and to reduce the size of imports. But, in order to achieve a desired balance between the rate of growth in the demand and supply sides, this study will analyze the policies of self-sufficiency, i.e., both the demand and the supply sides will be studied in order to configurate an efficient, long-run, self-sufficiency policy.

Statement of the Problem

Due to the higher world wide inflation rate, the higher population growth rate in Egypt and the lagged supplies behind the demands for most of the agricultural products, Egypt is now concerned with self-sufficiency by the year 2000. Achieving self-sufficiency for a country like Egypt, however, is not an easy task. This is because of the limited amount of farmland available to the Egyptian society. The main issue in this study is to analyze the current production and consumption policies and to infer whether or not Egypt is able to achieve the desired self-sufficiency under the extensive use of the land resources. If, on the other hand, Egypt is not able to achieve the desired self-sufficiency in the main agricultural crops under this study's proposed policy, then this study will analyze the other options available to Egypt such as: other policy alternative, Sudan-Egypt integration, adopting a new importation policy, etc.

To summarize, the main problem in this study is to infer an efficient way of achieving the desired self-sufficiency of the main agricultural crops such as: wheat, corn, rice, beans, sugarcane, etc., by the year 2000.

Objective of the Study

This study will review the current and the previous production and price policies. The structure of the agricultural sector will also be studied in relation to the farmers' response and the consumers' demand for the main agricultural products.

Egypt lately turned out to be one of the major importing countries for most of the consumptive products (Table A.1 in the Appendix). Due to the fluctuation in the world market supplies, as well as the fluctuation in the worldwide political and economical circumstances, it is significant that Egypt achieve a reasonable degree of self-sufficiency by the year 2000. Therefore, the objective of this study could be formulated as follows:

(1) To study the previous and current production and price policies. This will help in configurating a comprehensive, long-run, self-sufficiency policy,

(2) To study the structure of the agricultural sector in Egypt,

(3) To estimate the supply and demand functions for each crop and to analyze their economic implications. The estimation

will be done under this study's proposed policy and for the year 2000, and

(4) To use the knowledge in (1)-(3) above to derive some policy recommendations.

The data period used in the study will be from 1960-1979. This period, however, will be different between the crops and the functions for the same crop. The functions of the model will be estimated as accurately as possible. In some cases, when the fit is difficult to be obtained, this study will leave the estimation for future studies, when better data are available.

The outline of this dissertation is as follows:

In Chapter II, we review the previous studies on Egypt. In Chapter III, the theoretical and statistical model will be presented. In Chapter IV, the structure of the agricultural sector will be analyzed. In Chapter V, the study will focus on the potential self-sufficiency of the main agricultural products such as: wheat, beans, rice, corn, and sugarcane in relation to other crops in the agricultural rotation. In Chapter VI, the study will consider the alternative policies for achieving the potential self-sufficiency in relation to the costs of these policies. Summary, conclusions, and policy implications then will be presented.

CHAPTER II. REVIEW OF LITERATURE

This part of the study is concerned with the previous studies done on production, consumption, and prices for the major crops in Egypt. The previous studies related to the study's theoretical model will also be presented in Chapter III.

On the production side, Dorner (8a) stated that the agricultural development is like developing an overall economy. It includes all the complex processes such as: increased investments, improved technology, institutional change, redistribution, and the imbalance inherent in these processes. For the agricultural sector in Egypt to develop, Egypt has followed several production policies. Emarah (9) stated that the objective of any of these policies is increasing the productivity of the agricultural resources used, i.e., to reach the optimal allocation of the resources, where every factor is paid the value of its marginal product. Moreover, another major objective is to achieve the maximum output possible from these resources. Heady (17) showed that the importance of increasing the agricultural productivity of the resources is due to the improvement of food production and human nutrition, where the agricultural development in most of the developing countries has lagged and many people suffer poverty and malnutrition. In order to improve the agricultural productivity, however, the natural resources of Egypt should be economically allocated and used. Timmons (45, 46) indicated the way in which the natural resources should be used. Further, Timmons showed how people affect natural resources while using them. The conflict in using the natural resources, according to Timmons, arises because of different objectives between what the institutions want to do, and how to achieve a standard level of quality.

The first major structural change in the agricultural sector in Egypt was in 1952. This structural change could be summarized in the policies of agrarian reform in Egypt. These policies were not only a change in the land ownership matrix in Egypt, but also a change in the technology used in agriculture and in the role of the agricultural sector in the Egyptian economy. Gadalla (13) stated that the objective of the law was to satisfy the wild hunger of the landless (Figure A.1 in the Appendix), in order to improve the living conditions of those who work on land, and to remedy the maladies of the tenure system which contributed to instability, insecurity, and unrest. Parker (36), on the contrary, stated that land reform in Egypt did little to change the basic structure of land ownership. The reason, as Parker stated, is due to the combined effects of the land reforms and the Moslem inheritance laws. These laws led to an explosion in the number of small holdings of uneconomical size.

Land reform itself is a very ancient idea. Many economists in one way or another supported the land reform policies. But the success of such policies hinges largely on the provision of the supporting services. The World Land Reform Conference (40) maintained that cooperatives, more than any other supporting institutions, ensured the success of land reform programs. The cooperatives in Egypt, as in many other developing countries, played a major role in supporting small farmers. The credit provided to some extent lessened the dominance of money-lenders, traders, and landlords. Furthermore, the cooperatives provide the farmers with their needs in the factors of production and help them to market their final product at higher prices, because of the size effect or economies of scale. The cooperatives also provide advice, training programs, etc. Klöwer and Spatzker (25) summarized the role of the cooperatives in Egypt. They stated that "too much has been expected from cooperatives as initiators of an efficient social and economic development policy. Cooperatives reflect the general economic and social organization in which they are created. They are not strong enough to overcome the underlying deep economic and social polarity in Egypt." Radwan (39) studied the relation between the land reform as a way to change the matrix of land ownership and the cooperative system. He showed that both the Egyptian's cooperative and land reform policies have been more successful than many others, mainly due to the package of measures introduced and the government enthusiasm during the 1960s.

As for the efficiency of the cooperative policies, Radwan (39) argued that the cooperative system should be radically restructured in such a way as to replace the present cooperatives with real producers' cooperatives.

After the structural changes in the agriculture in Egypt, the production policies are mainly formulated through the cooperative system and its supporting programs. The farmers cultivate their lands by the means provided by the cooperatives. In this matter, two main issues arise. The first is: The sufficiency of the amount of capital provided by the cooperatives. Many studies in Egypt have shown that the credit is the most critical source for financing the agricultural sector. This is due to the fact that the other sources such as inheritance, rental income, and savings are limited in quantity. Therefore, it was expected that the cooperatives would be able to break down the poor cycles existing on both the demand and supply sides. Emarah (Author, unpublished class paper, Department of Economics, Iowa State University, 1980) found that the elasticity of the demand for capital is still high. The estimated elasticity was about 0.676 which reflects the fact that current short and intermediate-run loans available for agriculture are lower than the needs of the farmers. The second issue, concerning the production through the cooperatives, is land consolidation. Many economists and soil experts argued for consolidation of fragmented land parcels with mandatory crop rotation, collective use of farm machinery, and subsidies for tractor or import tax relief. These ideas are mainly related to what is called Arabic Socialism. The idea behind the whole theory is to carry out the agricultural policy through the land reform supported by an effective cooperative system. Further, the policies for carrying the required social change are maintained through the incentives of the scale economies.

Along with these structural changes in the Egyptian agricultural sector, there was another major policy action which included the building of the High Dam in the Aswan governorate. Jordan (24a) and Smith (44), among many others, viewed the Nile as an "exotic" stream in a sense that the sources of its water lies right outside the boundaries of the country.

It flows through and serves the country. The Nile formed the black land of Egypt. Jordan (24a) stated that "Egypt would now be, not the black land that the ancient Egyptians called 'Kemet' by the virtue of its rich, productive mud. In other words, 'the gift of the Nile' has changed."

After the dam had been completed, there were major changes in the policies of land and water uses, as well as in the agricultural rotations. A lot of controversy among economists about the advantages and disadvantages of the High Dam prevailed. But in general, there is a social change involved. Ulmer (48) examined the side-effects of the High Dam. He showed that the side-effects of this major technological change are:

(1) The absence of sluices in the dam has resulted in millions of tons of rich silt being trapped, and hence made unusable as fertilizer. Such silt, formerly deposited by annual flooding of the Nile, was the source of nutriment for innumerable acres of the most fertile land on earth. Artificial fertilizers of comparable amount and quality would, it has been estimated, cost $100 million annually. Agronomists now predict that millions of acres will be reduced to useless land because of the lack of silting.

(2) Silt, which formerly entered the Mediterranean, provided an abundant source of food for fish and other organisms of Commercial significance. The effect of this break in the food chain has decimated the planktonic forms of life and has resulted in the disappearance of sardines, mackerel, lobster, and shrimp

from this part of the Mediterranean. The possible effects on other forms of marine plant and animal life have yet to be assessed.

(3) Because the silt, which previously added to the Nile delta, no longer is deposited, the Egyptian coastline is subject to increasing erosion.

(4) Increased soil salinity resulting from the lack of flooding, which formerly flushed out natural salts from the soil, will probably increase to the point where millions of acres will be irretrievably lost to cultivation.

(5) An explosive increase in one of man's most debilitating parasitic diseases, schistosomiasis or bilharziasis.

The most critical result of Ulmer's work is the reduction of the quality of the limited farmland. Ricardo (41) as well as many other classical, political economists explained the causes of the reduction in the productivity of the agricultural farmland. The reduction in the productivity, according to them, is due to the use of worse farmland. Therefore, the dam as a major technological change is one of the reasons for the lower rate of agricultural productivity growth in Egypt. Many economists, agronomists, etc., blamed the problem of the reduction in the productivity growth rates not to the dam itself, but to the other supporting programs such as drainage system, irrigation system, etc. However, this study is concerned with the reduction in the rates of productivity growth, not with the causes. The dam is a major technological change in the Egyptian agriculture. Such major changes should be carefully carried out. Schultz (42), among other eonomists, argued that care must be taken in transferring technology because most of the technologies are specific to the biological and other circumstances of the country where they have been developed.

So far the land-use policies, as well as the High Dam were the major policy changes. To overcome the side effects of these changes, attention has been directed toward vertical and horizontal agricultural policies. Such policies are now significant to Egypt. In the following chapters, this study will show that these policies are the basis for the proposed, long-run, self-sufficiency policy.

The vertical policy programs are concerned with increasing the efficiency of the units of production. The vertical policy programs in Egypt include: improving the quality of the current supply of the farmland, using improved methods of production and technologies, improving the varieties of the crops, etc. All of these programs are very important to Egypt.

The horizontal policy programs, on the other hand, are concerned with increasing the current supply of the productive units. Further, these programs are now vital to Egypt because of the higher demand relative to the current supply of land resources. Worth noting also is that both vertical and horizontal programs have helped the Egyptian economy to survive. These programs also have provided the maximum return on investment that Egypt has ever had.

As for the consumption and price policies, Egypt has tried several policies in the last three decades. Comparing Egypt to other developing countries, there are some similarities and some differences. As for the similarities, Egypt suffers high inflation and population growth rates. As for the differences, Egypt had faced four military conflicts. These conflicts had major effects on consumption and price policies. For instance, the consumption policies in Egypt fluctuated between complete rationing to higher subsidy levels. Because of the fact that the price levels, as well as the current household income, determine the household's demands for goods and services, the consumption and price policies in Egypt are not a mutually exclusive set of actions. From this fact, this study will consider both policies as one set.

To configurate the current consumption and price policies, there are several doctrines of the structure of the economy in Egypt that are worth studying. As stated before, one advantage of the cooperative system is to supply the farmers with inputs according to their needs at low prices compared to the existing market prices. Similarly, the farmers are required to market some of their products through the cooperatives. This implies that the farmers are price takers. Where the prices are set to them, the farmers, according to this marketing policy, are required to market a determinate share to the cooperatives. The final output (or by-product if there is any), whether marketed through the cooperatives or not, goes to the market. In the processes of distributing this final output on the total effective demands, the middlemen charge a marketing margin which is largely influenced by the current rate of inflation. The consumer's price is a composite price which includes the costs of all the intermediate processes. Because of these regulations on the market and prices, the market information is not sufficient. The deficiency in the amount of information restricts the efficiency of the market.

Similar to the producers' cooperatives, there are consumer cooperatives in Egypt. These cooperatives are one way in which the government provides the limited income groups with goods at lower than market prices. The government pays the total value of the subsidies which is equal to the difference between the actual price and the cooperative price. The economic rationale behind the subsidies is stated by Layard and Walters (29) as follows: "The government should subsidize the most inferior good, for the share of rich in the consumption of the good will be lower, the less the consumption will rise with income." By this rule stated in the economic theory, the Egyptian government is over-subsidizing. The reason for subsidizing the consumers is the reduction in the purchasing power of the money income. But the most important issue is what should be subsidized and whom should not be subsidized. In other words, the issue of subsidies should be considered along with the current cost of living.

The allocation of the inputs and the outputs in Egypt does not satisfy the marginal conditions stated in the Paretian allocation criteria. Further, the income distribution is not equal, i.e., a pound in the hands of the rich is not equal in utility to a pound in the hands of the poor. In other words, the Egyptian economy is a second best type of economy. The inequality of the income distribution, according to many economists, has led to rural poverty. Abdel-Fadil (1) and Radwan

(39) examined the issues of rural poverty. Abdel-Fadil believes that the land ownership has an impact on rural poverty. Houthakker (20), as summarized by Starleaf (1969), pointed out a different set of reasoning for lower income in farming as compared to the nonfarming sector. The reasons are: (1) low income elasticity of the demand for farm products, (2) the rapid increase in farm productivity, and (3) the difficulty of moving resources from farm to nonfarm occupations. Houthakker explained the first reason in relation to Engle's law, i.e., because of the fact that the food goods are normal necessities, the elasticity of the demand, as well as the income elasticity are low. On the other hand, Houthakker explained the second reason in relation to the technology. Further, the third reason is related to the nature of the agricultural workers. The first and the third reasons may well explain the causes of low farm income in Egypt, while the second may not. The same study suggests the following solutions: (1) curtailing the growth of farm productivity, (2) speeding up the movement of resources out of agriculture, and (3) making direct payments to farmers. The third solution is suitable for Egypt, but the first and the second are not.

Many other economists offer different sets of reasons for rural poverty and low farm income. This study believes the following reasons explain this phenomenon in Egypt well: (1) low unstable farm prices compared to nonfarm prices, (2) low investment in the farm compared to the nonfarm sector, (3) immobility of the factors of productions, and (4) lack of rural industries to absorb the excess rural labor.

Besides low farm income which causes rural poverty in Egypt, there exists a regional difference in the quality of the goods and services of the rural poor and the rich. To explain this phenomenon and others, Abdel-Fadil (1) utilized the national sample survey of household consumption 1958-1959 and 1964-1965. Abdel-Fadil (1) showed the consumption pattern of the rural poor is doomed to be marked by the endless monotony of a cereal-based diet. Some other few items, such as vegetables which are not expensive and are available to the poor, could be added to their diet. He also showed that there is little room for "substitutability" on nonsaturation of prime needs and necessities for the low income group. The budget study in Egypt confirms Abdel-Fadil's views. The same study had shown a high percentage of expenditure on cereals and starches in the consumption bundle of the rural poor (those with income less than ĿE 50 per annum).[1] This may be attributed to the fact that the proportion of calorie intake from cereals and starchy food is particularly high in relation to their prices.

The results of a 1964-1965 survey showed that the income elasticity of demand for food and beverages amounts to 0.75 for low income groups, 0.64 for medium income groups, and 0.55 for high income groups in rural areas. The higher elasticity of demand for dry beans, cereals, and

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[1]In Abdel-Fadil's study, as well as most of the other studies on Egypt, the annual per capita income is underestimated, because per capita income does not include: (1) the free services received by villagers (such as health, education, and economic subsidies) as part of income, and (2) revenues from livestock and business expense incurred by farmers as part of total income to the rural household. If these items are included, the published figures would be a multiple of the current figures. ĿE stands for Egyptian pound = 1.43 dollars.

starchy food for the low income groups demonstrates once again a striking difference from the higher income groups (ŁE 600 and more), where income elasticities are negative for cereals, starchy foods, and dry beans. The average elasticity of demand for all income groups, based on the weighted average of the number of people in each income bracket, is particularly high for fruit, 1.46; milk and dairy products, 1.19; meat, fish, and eggs, 0.92 in contrast with the order of magnitude of these elasticities in developed countries.

Abdel-Fadil set the fundamentals for the analysis of rural poverty in Egypt. Radwan (39) and Harik and Randolph (15) had viewed the same problem with extended data and a different approach. Abdel-Fadil's work was an excellent utilization of economic theory while the other approaches emphasized the methodology rather than the theory. Harik and Randolph (15) stated that when the rural population is concerned in terms of income distributions, sharp variations appear; but more striking is the large proportion of people living at or below subsistence. The last part of this statement is not correct, because of the downward biased measure of income utilized by Radwan and all others as explained in the footnote on page 15 of this dissertation. Radwan (39) used the 1974-1975 budget study to estimate the number of rural poor households and individuals. This estimation, however, had been done after the 1973 war, and hence, Radwan had to make an adjustment for both income and consumption. But, he did not do so. Radwan, on the other hand, constructed a poverty line (PL) on a weak and misleading base. He considered a family with an annual income below ŁE 270 as poor and above this amount as rich.

This estimator is an arbitrary one. Further, upon this biased estimate, the percentage of poor households is 44 percent and this counts for 5,832,400 poor rural individuals in 1974-1975.

Harik and Randolph (15) tried to overcome some of the mistakes in Radwan's study. Harik estimated a PL based on the average rural family size instead of the national average size as in Radwan's study. She used the 1974-1975 household budget survey. Furthermore, she used all four rounds of 1974-1975 to overcome the seasonal variations. The estimated percentage of rural poor in this study is 39 percent of the rural population and the estimated number of rural poor is 3,661,000. Notably, the PL in Harik's study is ₤E 50 per capita.

Mayfield (31) used El-Kammash's data and concluded that the per capita income in the urban areas of Egypt is consistently double what it is in the rural areas.

Upon the underestimated income/expenditure, the budget study showed that roughly 60 percent of Egyptians have no problem keeping up with the national standard. Further, the common consumption pattern reflects the phenomenon of "keeping up with the Joneses."

So far, the major issues are: the production policies, the allocation of the final output on the total effective demands, the price policies, the rural poverty, and the consumption pattern. Further, the main conclusions show there is:

(1) Low productivity of the resources,

(2) A higher demand of goods and services due to higher population growth rate, and

(3) Existence of regional differences in the allocation of goods and services and income differential between rural and urban areas.

From conclusions (1) and (2), there exists a lag of supplies behind demands for the main crops in Egypt. Murdoch (34) compared Egypt to other large poor countries which suffer from lagging supplies and high population growth rate. Murdoch's study showed a decline in per capita food supply. Further, the projected food deficit in year 1990 is higher than the actual 1975 deficit. As a result of the deficit in food supply, the current government of Egypt is successfully involved in many food security programs. For these programs to be effective in reducing the food deficit, many economists argue for a structural change in the policies concerning the use of natural resources in Egypt. On the other hand, these programs are based on a long-run plan; therefore, the success of these programs will help Egypt to achieve a reasonable degree of self-sufficiency by the year 2000.

As for the self-sufficiency in Egypt, this study will analyze all the possibilities of achieving this national goal. Paulsen (37) specified two criteria for self-sufficiency. The first criterion, self-sufficiency, means minimum dependence on imports of essential foods, while the second criterion, self-sufficiency, means minimizing imports minus exports of the agricultural products. Upon Paulsen's specification of the self-sufficiency, Egypt is not self-sufficient. Barker and Hayami (3) defined the self-sufficiency requirement as the percentage increase in output needed to avoid importations. Further, Barker and

Hayami (3) stated that the goal of the self-sufficiency is a nationalistic desire to minimize foreign power leverages in order to reduce the foreign exchange requirements for the import of foodstuffs. Barker and Hayami (3) analyzed the cost of the self-sufficiency under two alternative policy actions: (1) price support, and (2) input subsidization. Moreover, the price support and input subsidization were the two policy alternatives for achieving the self-sufficiency.

This study, however, will analyze the issues concerning self-sufficiency. These issues are:

(1) What is required for Egypt to be self-sufficient?

(2) If self-sufficiency is not possible, given the resources and the technology, then what are the other options available to Egypt?

To consider these issues, this study will offer the following policy for achieving self-sufficiency:

Given that self-sufficiency means minimum dependence on the imports, then, in a free market framework, Egypt could be self-sufficient through:

(a) A shift in the aggregate supply function through appropriate technology,

(b) A shift in the consumption patterns and tastes through appropriate policies, and

(c) Efficient control policies in using and allocating the resources.

If this set of policy actions is met, the food deficit will be reduced. Further, the price variations will be adjusted downward.

Finally, the policies specified in (a) - (c) above are more comprehensive than the food security programs. The current food security programs are a successful direction of the flow of investments. All of these programs are working toward shifting the aggregate supply function, i.e., policy (a). But there are some issues behind the current food security programs to be handled. These issues are: (1) The possibility of further shift in the aggregate demand. If this possibility exists, then, the food security programs will turn out to be a short-run solution, and (2) The possibility of further reduction in the quality of the agricultural farmland due to the intensive use. Furthermore, the current supply of the cultivated area is decreasing at a rate of 52,000 feddan per year as estimated by El-Nagar and Aita (8b).

These issues and others will be considered in this study.

CHAPTER III. THEORETICAL AND STATISTICAL MODEL

In this chapter the main concern centers around the theoretical model. To build a good model, one should take into account several considerations such as: (1) The model should be representative and include all the interrelationships involved. (2) All the variables should be rationally determined and specified. Furthermore, these variables should be classified into: exogenous and endogenous, controllable and uncontrollable, etc. (3) The model should be statistically identified. And finally, (4) The model should be easy enough to understand, and flexible enough to allow for adding more information.

To satisfy the requirements above, this study will utilize the ordinary theory of the firm and the consumer. Further, for improving the estimations and the predictions, this study will utilize the statistical theory and methods. On the other hand, several variables will be combined together in order to improve the quality of fit. For satisfying the assumptions of the model, the data will be transformed if necessary.

Two main hypotheses are of great importance for the purpose of this study. These hypotheses are: (1) Given the resources and the population growth rate, Egypt could be self-sufficient by the year 2000. (2) Given that self-sufficiency of the main crops is possible to be achieved under this study's policies, it is cheaper for Egypt to follow these policies rather than importing the same products.

Theoretical Model

The model is classified into four parts as follows:

1. The supplies. Assume that perfect competition exists on the production side in Egypt. Then, let every firm in Egypt be rational and maximize a profit function, i.e., let:

$$Q^j_{it} = f(X^j_{1t}, X^j_{2t}, X^j_{3t} \ldots X^j_{nt}, \bar{L}^j_c, \bar{C}^j_t, T) \tag{3.1}$$

be a simple production function, twice differentiable, and well-behaved. Then, let us assume that the marginal physical product of each factor of production is positive but diminishing, and that all prices are given where:

Q^j_{it} = production of jth main crop by using ith input in period t.

Where:

j could be: wheat, rice, corn, beans -- or any other crop under study.

i = 1 ... n inputs in the production process. Some of these inputs could be specified in quantity and some of them are not measurable.

t = time, and t = 1, 2 ... 19, i.e., the study period.

X^j_{1t} = quantity of labor per man-hours per feddan used in the production of jth crop in time period t,

X^j_{2t} = amount of water per cubic meter per feddan used in production of jth crop in period t,

X^j_{3t} = quantity of fertilizer per kilogram per feddan used in the production of jth crop in period t,

X^j_{4t} = amount of seeds per kilogram per feddan used in the production of jth crop in period t,

X^j_{5t} .... X^j_{nt} = other factors of production used in the production process of jth crop in period t. Some of these factors could be specified in quantity, while others could not be specified, such as: sunshine, oxygen, weather conditions, etc. Notably, the weather conditions in Egypt are stable. And hence, there will not be much concentration on this factor.

$\bar{L}^j_c$ = land class c, where c = 1, 2 .... 4 used in the production of jth crop in period t. The land is limited in both the quantity and the quality,

$\bar{C}^j_t$ = limited amount of capital available for the production of jth crop in period t. The word "capital" for this study's purpose includes the machinery owned by the farmer or rented from the cooperative, short-run loans per pound per feddan available for the jth crop in period t,[1] the farmer's internal financing, etc. The supply of capital, on the other hand, is limited, and

T = technology used in the production of jth crop in period t.

This study assumes that labor is abundant. Then, from the ordinary theory of the firm, the short-run profit function could be written as:

$$\pi = P_j f(X^j_{1t}, X^j_{2t}, X^j_{3t} \dots X^j_{nt}, \bar{L}^j_c, \bar{C}^j_t, T) - (W_1 X^j_{1t} + W_2 X^j_{2t} + W_3 X^j_{3t} \dots W_n X^j_{nt}) - F \quad (3.2)$$

[1]Pound stands for Egyptian pound (£E). The pound = 1.43 American dollars.

Where, all X^j_{it}, $\bar{L}^j_c$, $\bar{C}^j_t$, and T are specified as before, and,

P_j = price of jth output per pound per unit,

W_i = ith factor's price per unit. Further, let P_j and W_i's are exogenous to the farm,

F = fixed cost per pound. Notably, that F includes: the rent of land class c, where, c = 1,..4, and all other payments the farmer bears whether he produces or not. Further, if the farmer is paying part of his loans for the services of the capital, then this payment will be a fixed cost.

Differentiating (3.2) with respect to X^j_{it}, i.e., the choice variables, then, the resulting "n" (f.o.c.) "first order conditions" are:

$$P_j f_i(X^j_{1t}, X^j_{2t} \;\ldots\; X^j_{nt}, \bar{L}^j_c, \bar{C}^j_t, T) - W_i = 0 \tag{3.3}$$

and this at the maximum profit. Then, by the assumptions stated before about the properties of the production function, let that the (s.o.c.) "second order conditions" are met. The "n" f.o.c. could be solved to get "n" input demand functions as:

$$X^j_{nt} = X^{*j}_{nt}(W_1, W_2 \;\ldots\; W_n, P_j, \bar{L}^j_c, \bar{C}^j_t, T) \tag{3.3$'$}$$

Where X^j_{nt} = nth input (specified before) used in the production of jth crop. X^{*j}_{nt} is the optimum quantity of this input since X^{*j}_{nt} results from the maximization process.

Due to the fact that these input demand functions are homogeneous of degree zero in all prices, the n+1 price parameters in (3.3)' could be deflated by the general price level to get the n+1 real prices,[1] i.e., (3.3)' could be written as:

$$X^{*j}_{nt} = X^{*j}_{nt}(P^{x}_{nt}, P^{0}_{it}, P^{j}_{t}, \bar{C}^{j}_{t}, \bar{L}^{j}_{c}, T) \tag{3.4}$$

Where:

P^{x}_{nt} = real price of input x in period t, i.e., the price of input x deflated by the general price level in period t, where: t = 1 19,

P^{0}_{it} = real price of other inputs in period t,

P^{j}_{t} = real price of jth output in period t,

$\bar{C}^{j}_{t}$ and $\bar{L}^{j}_{c}$ are defined before. Then

$$Q^{*j}_{t} = f(X^{*j}_{nt}, \bar{C}^{j}_{t,} \bar{L}^{j}_{c}, T)$$

$$= f(P^{x}_{nt}, P^{0}_{it}, P^{j}_{t}, \bar{C}^{j}_{t}, \bar{L}^{j}_{c}, T) \tag{3.5}$$

Under certain assumptions, Equations (3.4) and (3.5) could be aggregated to get the national demand and supply functions.

2. <u>The demands</u>. Under the assumptions of utility maximization by the consumer, the demand of jth product can be specified as:[2]

$$D^{j}_{t} = g(P^{j}_{t}, P^{0}_{t}, \bar{Y}_{t}) \tag{3.6}$$

---

[1] Many economists use P_j as a price deflator, but for this study's purpose, the general price level will be used as a deflator.

[2] The maximization processes are similar to the firm's, except in the case of utility maximization, the production function is replaced by a utility function as:

$$U^{j} = U^{j}(Q_1, Q_2 \text{ .... } Q_T), \text{ for all j.}$$

Where D_t^j = per capita demand of jth product in period t, where t = 1, 2 19,

P_t^j = real price per unit of jth product in period t,

P_t^0 = real price per unit of other products, i.e., real price of the other complements and substitutes in period t, and

$\bar{Y}_t$ = limited real income to the household in period t.

Under certain assumptions, Equation (3.6) could be aggregated to the national level.

3. Policies. In this part, this study will analyze the optimal production, consumption, and price policies and regulations.

a. Production policies. As stated before, for Egypt to be self-sufficient, the society's aggregate food supply function should be shifted through the appropriate technology. To achieve the desired shift, however, the impact falls on $\bar{L}_c^j$ and $\bar{C}_t^j$ in Equation (3.1), i.e., if Egypt could direct the investment toward vertical and horizontal policies in the farmland, then, Egypt will have higher supplies by the year 2000. In other words, let Equation (3.1) be written as:

$$Q_{it}^j = f(X_{1t}^j, X_{2t}^j \ldots. X_{nt}^j, L_c^j, \bar{C}_t^j. L_c^j(S_{Lt}^*), T) \qquad (3.7)$$

Where:

X_{1t}^j, X_{2t}^j. X_{3t}^j .... X_{nt}^j, $\bar{C}_t^j$, and T are specified before.

Since the bases of the desired self-sufficiency are longer-run bases, then, the full impact falls on the vertical and horizontal policies in the farmland, as well as on the availability of the capital requirements, i.e., on L_c^j and C_t^j. From this point, this study differs from Paulsen (37), Barker and Hayami (3) analysis, because both studies concentrated on the price mechanism in one way or another. In other words, both studies state, given the natural resources to a society, then, price support or input subsidization can achieve the desired self-sufficiency. But this study is concerned with the fact that, given the prices, the augmentation and the addition to the natural resources in Egypt will achieve higher supplies, and hence will help in achieving self-sufficiency.

Returning to Equation (3.7) or the long-run planning basis, the rest of the variables could be defined as:

L_c^j = number of land class c per feddan, where, c = 1, 2 .... 4 used in the production of jth crop. Notably, L_c^j is no longer fixed, because in a long-run two main issues evolve:

(1) Due to the expansion of housing, the current supply of farmland in Egypt decreases at a rate of 60,000 feddan annually.

(2) The possibility of adding new supplies of farmland through the horizontal policy programs. This addition could be $\gtreqless$ 60,000 feddan as the study will show.

S^*_{Lt} = improvement in land of all classes in period t, where, t = time from 1 to 8.[1] Notably, the improvement programs improve the quality of the existing supply of land, and hence works as a shifter in the production function of the jth crop.

$\bar{C}$ = total amount of capital available to the agricultural sector

$$= \bar{C}_t^j + \bar{C}_r \tag{3.8}$$

[1]The improvement program started in Egypt in the late 1960s.

Where:

$\bar{C}_t^j$ = limited amount of capital available for the production of the the jth crop in period t,

$\bar{C}_r$ = limited amount of capital available for the improvement programs in land class c; where, c = 1, 2 .... 4, and

$$S_{Lt}^* = S_{LT}^*(\bar{C}_r, \beta, T) \tag{3.9}$$

Where:

S_{Lt}^* = improvement in land class c in period t,

β = trained labor required for the improvement, and

T = technology.

Then, under the assumptions of the ordinary theory of the firm, i.e., by following the same maximization process in (3.1) - (3.5), the predicted target output level of jth crop in year 2000 could be specified as:

$$Q_{2000}^{**j} = f(P_{nt}^X, P_{it}^0, P_t^j, P_{It}^j, \bar{C}_t^j, S_{Lt}^*, R_{it}, T) \tag{3.10}$$

Where:

P_{nt}^X, P_{it}^0, P_t^j, $\bar{C}_t^j$, S_{Lt}^*, and T are defined before,

P_{It}^j = real price of jth imported item in period t, and

R_{it} = regulations and underlying production policies; where,

R_{it}: $\varepsilon(0,1)$. This is a dummy variable.

Notably that $\bar{L}_c^j$ is no longer fixed, and S_{Lt}^* is a shifter of the supply of jth main crop, i.e., if there is an improvement, the supply of the jth product and by-product (if any) will increase; and hence, Q_{2000}^{**j} would be the output of the jth main crop required to achieve self-sufficiency by the year 2000.

b. Consumption and price policies. Two main issues are considered in this part of the study. They are: (1) Given the desired shift in the aggregate supply function, then, if the price variations are minimized, the regional allocations would be optimum, and hence, if this is the case, then:

(a) Egypt could overcome the rural poverty, and

(b) Egypt could achieve the desired price stability required for the self-sufficiency by the year 2000. In other words, let:

(i) All prices for all inputs and outputs be related,

(ii) The market adjusts simultaneously to the change in any of these prices. Further,

(iii) Let the prices be random variables.[1]

Therefore, Egypt could achieve (a) - (b) by minimizing the variance-covariance matrix of the prices subject to the self-sufficiency output level, i.e.,

$$\text{Minimize} \qquad V = \begin{bmatrix} \sigma_{11}^2 & \sigma_{12} & \cdots & \sigma_{1n} \\ \vdots & \sigma_{22}^2 & \cdots & \sigma_{2n} \\ \vdots & \vdots & \sigma_{ij}^2 & \vdots \\ \sigma_{n1} & \cdots & \cdots & \sigma_{nn}^2 \end{bmatrix} \tag{3.11}$$

= Variance-covariance matrix of ith and jth prices. For i, j = 1 .... n.

[1] No need to specify the distribution of the prices in this stage of the model.

Subject to $\quad Q_t^j \geq \overset{**j}{Q}_{2000}$ (3.12)

Where:

Q_t^j = actual output of jth crop, for all t, and

Q_{2000}^j = desired self-sufficiency output of jth crop in the year 2000.

Notably, both Q_t^j and Q_{2000}^{*j} are functions of real prices, therefore, the solution of (3.11) - (3.12) will result in the optimal price variability. Even though, the minimization procedure in (3.11) - (3.12) is simple, it will complicate the model. Therefore, the prices will be assumed to be exogenous. Future studies in this area could fit the model with (3.11) - (3.12). (2) Given the desired shift in the aggregate supply function, and given the fact that population growth rate will persist at 2.7 (%)[2], then, if the tastes could be changed and if the consumption of the jth item could be regulated through optimal consumption and allocation policies, then these regulations could help Egypt to be self-sufficient by the year 2000. In other words, Equation (3.6) could be generalized to get the target requirements of the jth product by the year 2000. Consider,

$$\overset{**j}{C}_{2000} = R(P_t^j, P_t^0, \bar{Y}_t, P_{pL}^*, I^*, F_L^j, N_g) \qquad (3.13)$$

Where:

C_{2000}^{**j} = the predicted target requirements of jth product by the year 2000,

P_t^j, P_t^0 and $\bar{Y}_t$ are defined in Equation (3.6),

P_{pL}^* = optimal price policies and regulations,

I^* = optimal consumption policies,

F_L^j = world market supplies of jth product, and

N_g = total population in million individuals.

Therefore, Q_{2000}^{**j} and C_{2000}^{**j} are the required self-sufficiency production and consumption of the jth main crop.

4. Comparing the self-sufficiency alternatives. In this part of the model, this study will compare the proposed policies, on page 19 of this study, to the other self-sufficiency alternatives.

Consider that the following options are available to a policymaker.

(1) Egypt could follow an importation policy rather than being self-sufficient.

(2) Egypt could follow one or a combination of the following policies to be self-sufficient rather than following an importation policy:

(a) Input subsidization policy,

(b) Output price support policy, or

(c) Investment in the Egyptian natural resources and taste adoption policies, i.e., this study's proposed policy. Then, the economic rationale suggests that a good policy is one which provides a positive net present value (NPV), i.e.,

$$NPV = \int_0^\infty e^{-rt}(R_t - C_t)dt > 0, \text{ for all } t \qquad (3.14)$$

Where:

R_t = benefits of the proposed policy for all t, where t = 0, 1, 2 ...∞.

C_t = costs of the proposed policy for all t, where t = 0, 1 ... ∞.

Equation (3.14) is difficult to be estimated. This is because of the data limitations. In Chapter VI of this study, a theoretical comparison among all of these alternatives will be presented.

Equations (3.1) - (3.13) are this study's theoretical model. In the next part of this chapter, the functions of the model, as well as the statistical procedure will be specified.

Structural Equations

Before specifying the structural equations and the variables in the model, it is reasonable to specify the model. The economic threory imposes some conditions, while the proposed policy imposes others.

These conditions are:

(1) The input and output demand functions are homogeneous of degree zero in all prices and all prices and income, respectively,

(2) The supply functions are homogeneous of degree zero in all prices,

(3) An equilibrium condition, and

(4) The stability of the equilibrium.

Conditions (1) and (2) are imposed by the economic theory, while conditions (3) and (4) are requirements of the desired self-sufficiency policy, i.e., the policy proposed before by this study assumes that even if there is imbalance between the demands and the supplies for the time being, it is desirable to have such a balance by the year 2000. Furthermore, the equilibrium or the balance should be stable.

The major estimation procedures in this model are the demand and the supply functions. To get a probabilistic form of Equations (3.10) and (3.13), a random disturbance term should be added to each equation. The distribution of these random terms will be determined later on. As for specifying a form for the supply functions, Askari and Cummings (2) estimated the supply response by using the simple Nerlove model. The model consists of three equations:

$$A_t^D = a_0 + a_1 P_t^e + a_2 Z_t + U_t \tag{3.15}$$

$$P_t^e = P_{t-1}^e + \beta(P_{t-1} - P_{t-1}^e) \tag{3.16}$$

$$A_t = A_{t-1} + \delta(A_t^D - A_{t-1}) \tag{3.17}$$

Where:

A_t = actual area under cultivation at time t,

A_t^D = area desired to be under cultivation at time t,

P_t = actual price at time t,

P_t^e = expected price at time t, and

Z_t = other exogenous factor(s) affecting supply at time t, and β δ are the expectation and adjustment coefficients, respectively where $0 < \beta \leq 1$ and $0 < \delta \leq 1$.

The short and long-run elasticities by crop and region are estimated. Table A.3 in the Appendix includes the results of the study on Egypt as estimated by Askari and Cummings (2). The elasticities, according to their estimations, showed that the farmers turned out to be price responsive. This held true for rice and maize. The farmers were responsive to wheat and beans prices, and tended to be nonresponsive to cotton prices. Pongsihadulchai (38) applied the Nerlove model to Thailand agriculture. He estimated the supply response for rice, corn, cassava, sugarcane, and kenaf. For different assumptions about β and δ, Pongsihadulchai (38) obtained different sets of reduced forms in the observable variables. The basic model in Pongsihadulchai's work is of the form,

$$A_t = \alpha_0 + \alpha_1 P_t^* + U_t \tag{3.18}$$

Where:

A_t = the actual planted area of crop under study,

P_t^* = the expected price of the crop under study, and

U_t = the random disturbance term.

Since P_t^* is unobservable; therefore, additional assumptions are necessary in order to be able to estimate the parameters of the model. He assumed and tested three models. They are:

(a) The naive model, where

$$P_t^* = P_{t-1} \tag{3.19}$$

(b) The intermediate model, where

$$P_t^* = \lambda P_{t-1} + (1 - \lambda)P_{t-2} \tag{3.20}$$

(c) The adaptive expectation or geometric lag model, where

$$P_t^* = P_{t-1}^* + \delta[P_{t-1} - P_{t-1}^*],\ 0 < \delta \leq 1 \tag{3.21}$$

The models are self-explanatory. Further, by substituting different values for P_t^* in (3.19) - (3.21) into (3.18), Pongsihadulchai (38) obtained the reduced forms of his model. Weaver (49) applied a modified version of the Nerlove model to estimate the aggregate supply of soybeans in the United States. The difference between Pongsihadulchai's (38) work and Weaver's (49) work, is that Weaver combined the error in the variable model with the Nerlove model. Weaver specified the following model for the supply of Y_t:

$$E_t = \alpha_0 + \alpha_1 F_{t+1,t} + U_t \tag{3.22}$$

$$P_{t+1} = \beta_0 + \beta_1 E_t + V_t \tag{3.23}$$

$$Y_t = \gamma_0 + \gamma_1 E_t + \gamma_2 Z_t + \varepsilon_t \tag{3.24}$$

Where:

E_t = expected price at time t,

$F_{t+1,t}$ = the future prices of the harvest contract observed at t,

P_{t+1} = the final cash price at harvest,

Y_t = the aggregate supply of soybeans at time t, and

Z_t = other exogenous variable(s) affecting supply at time t.

The choice of Y_t is hypothesized to be determined by relative expected prices. Consistent with this, all prices will be interpreted as relative. For example, Equation (3.22) states that the relative expected output prices are linearly related to relative future prices. In this general form, the model can be thought of as a block recursive simultaneous equation model. In its present form, the model is not identified; however, intuition suggests several prior restrictions which allow identification of the parameters of Equations (3.22) - (3.24). Specifically, if $F_{t+1,t}$ incorporates all relevant information available at time t, then U_t and Z_t may be assumed independent. Further, it is also intuitive that if information which occurs between planting (t) and harvest (t+1) is white noise, then it is reasonable to restrict (3.23) such that,

$$E(P_{t+1}) = E_t \qquad (3.25)$$

That is, the following restrictions appear reasonable:

$\beta_0 = 0$, and $\beta_1 = 1$

Imposing these restrictions, the reduced forms of the structural system may be written in one of the two following ways:

Alternative 1:

$$P_{t+1} = \alpha_0 + \alpha_1 F_{t+1,t} + U_t + V_t \qquad (3.26)$$

$$Y_t = \gamma_0 + \gamma_1 \alpha_0 + \gamma_1 \alpha_1 F_{t+1,t} + \gamma_2 Z_t + \gamma_1 U_t + \varepsilon_t \qquad (3.27)$$

Alternative 2:

$$P_{t+1} = \alpha_0 + \alpha_1 F_{t+1,t} + U_t + V_t \qquad (3.28)$$

$$Y_t = \gamma_0 + \gamma_1 P_{t+1} + \gamma_2 Z_t + \varepsilon_t - \gamma_1 V_t \qquad (3.29)$$

Weaver stated that alternative 2 provides a basis for a clearly less complex estimation method. Equations (3.28) - (3.29) can be thought of as partial, reduced forms which represent a linear in parameters, recursive (in variables, not error structure) simultaneous equations system. The estimations of the reduced forms were done by using a three-stage least-square approach.

In a similar fashion to the procedure used to derive this study's model, Weaver (50) included the future market in estimating the supply and demand functions. But this analysis is in no way related to this study.

Heady, Faber, and Sonka (18) used a programming model to estimate national production, acreage, and yield under different alternatives. The results were a solution to the cost minimization model. They stated that the objective of the production problem is to find a set of Xs such that the function:

$$f(c) = CX \qquad (3.30)$$

is a minimum subject to the following restraints:

$$AX \geqq b \qquad (3.31)$$

$$X \geqq 0 \qquad (3.32)$$

Where:

X = a column vector of production, transfer, and transportation activities,

C = a row vector of unit costs for these activities,

A = a matrix of transformation or input-output coefficients, and

b = a column vector of resource restraints and demand requirements.

The allocation was also solved using the system represented in Equations (3.30) - (3.32). The pricing question is solved using the dual formulation of that system. The dual problem can be described as:

Maximize $\quad g(P) = Pb \qquad (3.33)$

Subject to $\quad PA \leqq C \qquad (3.34)$

$\quad P \geqq 0 \qquad (3.35)$

Where:

P = a row vector of land rents and supply prices for the products, and

b, A, and C are defined previously.

Heady, Short, and English (19) extended the previous programming models to allow for the demand estimations, as well as the existence of a stable equilibrium in the commodity market. This model is close to this study's model except for using different techniques and conditions.

Several other studies have been done to estimate the demand functions. Ladd and Martin (27) used a Koyck model to measure contemporaneous and lagged effects. To explain this model, suppose that current demand Y_t can reasonably be stated a linear function of current and past prices X_{1t} and X_{1t-i}, and current and past income X_{2t} and X_{2t-i}. Ignoring the constant terms, current demand is of the form,

$$Y_t = \Sigma\, b_{1i}\, X_{1t-i} + \Sigma\, b_{2i}\, X_{2t-i} + U_t \qquad (3.36)$$

for all $i = 1, 2 \ldots n$. If $b_{1i} = b_{2i} = 0$, for all $i \geq 1$, this reduces to a conventional static linear demand equation. Assume that,

$$\frac{b_{1i}}{b_{1i-1}} = \frac{b_{2i}}{b_{2i-1}} = \lambda; \text{ for } i \geq 1, \text{ and } -1 < \lambda < 1 \tag{3.37}$$

Substituting Equation (3.37) into Equation (3.36), then,

$$Y_t = b_{10}\, \Sigma\, \lambda^i\, X_{1t-i} + b_{20}\, \Sigma\, \lambda^i\, X_{2t-i} + U_t \tag{3.38}$$

Multiplying Equation (3.38) lagged one period by λ and subtracting from Equation (3.36) yields:

$$Y_t = b_{10}\, X_{1t} + b_{20}\, X_{2t} + \lambda\, y_{t-1} + U_t - \lambda\, U_{t-1} \tag{3.39}$$

Assume that, up to time period zero, X_{1t} and X_{2t} have been zero and that, between time periods zero and one X_{1t} rises to 1 and then remains constant. Assume also that $U_{t-j} = 0$ for all j. After this, once for all change in X_{1t}, actual demand has achieved the new equilibrium level of demand when $Y_t = Y_{t-1}$. Denote this equilibrium level by $(Y)_t$.

$$(Y)_t = \frac{b_{10}}{1-\lambda} \tag{3.40}$$

Then $\dfrac{b_{10}\, \bar{X}}{(1-\lambda)\bar{Y}}$ is the long run elasticity. Actual consumption at any time will be,

$$Y_t = b_{10}\, \frac{1-\lambda^t}{1-\lambda}\text{, since} \tag{3.41}$$

$$Y_t - Y_{t-1} = b_{10}\, \lambda^{t-1}\text{, and} \tag{3.42}$$

$$(Y)_t - Y_{t-1} = \frac{b_{10}\, \lambda^{t-1}}{1-\lambda} \tag{3.43}$$

It follows that:

$$Y_t - Y_{t-1} = (1-\lambda)[(Y)_t - Y_{t-1}]\text{, and} \tag{3.44}$$

also that,

$$\frac{Y_t}{(Y)_t} = 1 - \lambda^t \tag{3.45}$$

This indicates that, at the end of each period t, the proportion $1 - \lambda^t$ of the total adjustment will have taken place. From Equation (3.44)

$$(Y)_t = \frac{Y_t - \lambda Y_{t-1}}{1 - \lambda} \tag{3.46}$$

Substituting (3.39), then,

$$(Y)_t = \frac{b_{10}}{1 - \lambda} X_{1t} + \frac{b_{20}}{1 - \lambda} X_{2t} + \frac{U_t - \lambda U_{t-1}}{1 - \lambda} \tag{3.47}$$

The same study showed that under different assumptions the Nerlove model gives a similar argument. Koyck assumes Equations (3.36) and (3.37). Replacing $(1 - \lambda)$ by γ in Equation (3.44), then, the resultant equation is the basic Nerlove equation as:

$$Y_t - Y_{t-1} = \gamma[(Y)_t - Y_{t-1}] + W_t \tag{3.48}$$

and (3.46) could be written as:

$$(Y)_t = \frac{Y_t - \lambda Y_{t-1}}{\gamma} \tag{3.49}$$

and (3.47) could be written as:

$$(Y)_t = a_{10} X_{1t} + a_{20} X_{2t} + V_t \tag{3.50}$$

Where:

$$a_{10} = \frac{b_{10}}{1 - \lambda}, \quad a_{20} = \frac{b_{20}}{1 - \lambda} \quad \text{for} \quad -1 < \lambda < 1$$

$$\text{or} \quad 0 < \gamma < 2$$

and $V_t = \dfrac{U_t - \lambda U_{t-1}}{1 - \lambda}$

Ladd and Martin (27) also proved that except for the stochastic term, Nerlove's assumptions are conclusions in Koyck's analysis. And hence, in their economic content, the two procedures simply exchange assumptions and conclusions. Luppold and Havlicek (30) specified a recursive model with a causal flow originating from the demand relationship and continuing through the supply relationship and ending with the price relationship. The model specified demand, supply, price, and one equilibrium identity for hardwood lumber. Intriligator (21) specified different forms for the demand equation. One possible specification of the function is:

$$D_t^j = \alpha_0 + b_1 P_t^j + b_2 \bar{Y}_t + U_t \tag{3.51}$$

Where $b_1 < 0$ to insure negatively sloped demand curve, and $b_2 > 0$ under the assumption that the jth good is normal. Further, P_t^j is the price of jth item and $\bar{Y}_t$ is the limited income to the household. If a demand function is specified in the form (3.51), it will not satisfy the homogeneity condition. Also, $\bar{Y}_t$ is assumed to be exogenous to simplify the estimation procedure. Another possible form is a log linear or constant elasticity form such as:

$$D_t^1 = A_1 P_1^{b_1} P_2^{b_2} \dots P_n^{b_n} Y^c e^{U_t} \tag{3.52}$$

and the homogeneity condition could be written as:

$$b_1 + b_2 \dots b_n + c = 0 \tag{3.53}$$

Taking logarithms leads to the log linear representation:

$$\ln D_t^1 = a_1 + b_1 \ln P_1 + b_2 \ln P_2 \dots P_n \ln P_n + c \ln Y + U_t \tag{3.54}$$

and,

$a_1 = \ln A_1$

The condition in (3.53), the homogeneity condition, could be imposed on (3.54) to get the reduced form. Furthermore, price and income elasticities can easily be computed from (3.54), i.e.:

$b_1 = \varepsilon_1$ = own price elasticity of good 1

$$= \frac{\partial \ln D_t^1}{\partial \ln P_1} = \frac{\partial D_t^1}{\partial P_1} \cdot \frac{P_1}{D_t^1} \tag{3.55}$$

$$b_j = \varepsilon_{1j} = \frac{\partial \ln D_t^1}{\partial \ln P_j} = \frac{\partial D_t^1}{\partial P_j} \cdot \frac{P_j}{D_t^1} \tag{3.56}$$

For all j = 1, 2 .... n

$$C = \frac{\partial \ln D_t^1}{\partial \ln Y} = \frac{\partial D_t^1}{\partial Y} \cdot \frac{Y}{D_t^1} \tag{3.57}$$

Condition (3.53) could be written as:

$$\sum_{i=1}^{n} b_i = - c, \text{ and} \tag{3.53)'}$$

This is the same result as Euler's theorem or the Caurnot application. Alternatively, Equation (3.54) could be written as:

$$\ln D_t^j = a_j + \varepsilon_j \ln P_j + \eta_j \ln Y + \delta_j t + U_j \tag{3.58}$$

Where:

D_t^j = per capita expenditure on jth good in constant prices,

P_j = relative price of jth good,

Y = total per capita expenditure in constant prices, and

t = time.

ε_j = own price elasticity for jth good. and ε_j could be $\gtrless 0$ depending upon the nature of the income effect,

η_j = income elasticity. Also, $\eta_j \gtrless 0$ depends upon the nature of the good, i.e., normal or inferior,

δ_j = an estimate of the trend in demand.

The form of (3.58) can be extended to any number of variables besides providing computational ease. In econometric literature, there are many other forms. Some of these forms are easy and some others are difficult. For instance, according to Intriligator (21), Stone specified the following demand function:

$$\ln D_j = a_j + \varepsilon_j \ln P_j + \sum_{j'} \varepsilon_{jj'} \ln P_{j'} + \eta_j \ln Y + \delta_j t + U_j \tag{3.59}$$

Where:

D_j = per capita consumption of jth good,

P_j = real price of jth good,

$P_{j'}$ = real price of other related goods,

Y = per capita real income,

$\varepsilon_{jj'}$ = the cross price elasticity of demand, and

ε_j, η_j and δ_j are defined in (3.58).

Fox specified an inverse demand function as:

$$\ln P_j = \alpha_j + \beta_j \ln D_j + \gamma_j \ln Y + \psi_j \ln Z_j + U_j \tag{3.60}$$

Where:

Z_j = variables other than the quantity and the income that could lead to a shift in the demand function.

This formula reflects the fact that the quantity, rather than the price, is exogenous.

So far, the previous studies have been reviewed. In this part of this chapter, the structural model for this study will be formulated.

Basically, it seems reasonable, under the current price and production policies in Egypt, to assume that the farmers are relative profit (non) responsive.[1] Because of this fact, the Nerlove model in (3.15)-(3.17) could be modified and written as:

$$A_t^D = a_0 + a_1 \pi_t^e + a_2 Z_t + U_t \qquad (3.61)$$

$$\pi_t^e = \pi_{t-1}^e + \beta(\pi_{t-1} - \pi_{t-1}^e) \qquad (3.62)$$

$$A_t = A_{t-1} + \delta(A_t^D - A_{t-1}) \qquad (3.63)$$

Where:

$0 < \beta \leq 1$, $0 < \delta \leq 1$, all the arguments are specified in (3.15)-(3.17), and

π_t^e = expected relative profit of jth and kth competitive crops, for j, k = 1, 2 ... n, per Egyptian pound (ŁE) per feddan in year t.

π_{t-1} = relative profit of jth and kth competitive crops, for j, k = 1, 2 ... n, per ŁE per feddan in year t-1.

π_{t-1}^e = expected relative profit of jth and kth competitive crops, for j, k = 1, 2 ... n, per ŁE feddan in year t-1.

---

[1]Relative profit means profit of jth crop relative to profit of kth competitive crop, i.e., both are in the same rotation for j, k = 1, 2 ... n.

To calculate π_t for any crop, however, one further specification is needed. Let,

$$\pi_t^j = P_t^j \cdot Q_t^j - \sum_{i=1}^{n} W_{it} X_{it} - F \tag{3.64}$$

Where:

π_t^j = profitability of jth crop in period t,

P_t^j = price per unit per ₤E of jth crop in period t,

Q_t^j = production of jth crop in period t,

W_{it} = price per unit per ₤E of ith input used in the production of jth crop in period t.

X_{it} = ith input used in the production of jth crop in period t,

F = fixed cost of the production of jth crop per ₤E. And,

$$P_t^j = P_{ft}^j + P_{bt}^j \tag{3.65}$$

Equation (3.65) states that the (real) price of jth crop includes two permanent components. They are:

P_{ft}^j = price per unit per ₤E of final output of jth crop in period t, and

P_{bt}^j = price per unit per ₤E of by-product (if there is any) of jth crop in period t.

The specification in (3.65) is often neglected. The importance of such specification is that it gives some insight about the way of formulating the agricultural production decisions in Egypt. Substitute (3.65) in (3.64), then, the computational formula for this study could be written as:

$$\pi_t^j = [(P_{ft}^j \cdot Q_{ft}^j) + (P_{bt}^j \cdot Q_{bt}^j)] - \sum_{i=1}^{n} w_{it} X_{it} - F \tag{3.66}$$

Where:

$$Q_t^j = Q_{ft}^j + Q_{bt}^j \tag{3.67}$$

and Q_{ft}^j = final output of jth crop in period t,

Q_{bt}^j = by-product of jth crop in period t.

To get the reduced form of this model, substitute (3.62) in (3.61).

$$A_t^D = a_0 + a_1(\pi_{t-1}^e + \beta(\pi_{t-1} + \beta(\pi_{t-1} - \pi_{t-1}^e)) + a_2 Z_t + U_t$$

$$= a_0 + a_1 \pi_{t-1}^e(1 - \beta) + a_1 \beta \pi_{t-1} + a_2 Z_t + U_t \tag{3.68}$$

From (3.63),

$$A_t = A_{t-1} + \delta A_t^D - \delta A_{t-1} \tag{3.69}$$

Then, it follows that

$$A_t^D = \frac{A_t}{\delta} - \frac{(1-\delta)}{\delta} A_{t-1} \tag{3.70}$$

Substitute (3.70) in (3.68). Then,

$$\begin{aligned} A_t = {} & (1-\delta) A_{t-1} + a_0 \delta + a_1 \delta(1-\beta)\pi_{t-1}^e + a_1 \delta \beta \pi_{t-1} \\ & + a_2 \delta Z_t + \delta U_t \end{aligned} \tag{3.71}$$

Now, in this stage of the model, a number of testable hypotheses could be made. The hypotheses are:

(1) $\beta = 1$, or adaptive expectation hypothesis,

(2) $\delta = 1$, or partial adjustment hypothesis, and

(3) $a_2 = 0$, or the area planted in year t depends only on the relative profitability and the planted area in year t-1. Also, a combination of these hypotheses could carefully be stated.

Let, $\beta = 1$; then, Equation (3.71) reduces to:

$$A_t = a_0 \delta + (1-\delta) A_{t-1} + a_1 \delta \pi_{t-1} + a_2 \delta Z_t + \delta U_t \tag{3.72}$$

This equation could be written as:

$$A_t = \psi_0 + \psi_1 A_{t-1} + \psi_2 \pi_{t-1} + \psi_3 Z_t + V_t \tag{3.73}$$

Where:

$\psi_0 = a_0 \delta$,

$\psi_1 = (1-\delta)$,

$\psi_2 = a_1 \delta$,

$\psi_3 = a_2 \delta$, and

$V_t = \delta U_t$

Equation (3.73) is just identified, provided that A_t and A_{t-1} are endogenous variables and π_{t-1} and Z_t are exogenous variables. Further, if instead δ is assumed to be equal to 1, then Equation (3.71) reduces to:

$$A_t = a_0 + a_1(1-\beta) \pi^e_{t-1} + a_1 \beta \pi_{t-1} + a_2 Z_t + U_t \tag{3.74}$$

Equation (3.74) could be written as:

$$A_t = a_0 + \psi_1' \pi^e_{t-1} + \psi_2' \pi_{t-1} + \psi_3' Z_t + U_t \tag{3.75}$$

Where:

$\psi_1' = a_1(1-\beta)$, $\psi_2' = a_1 \beta$, and $\psi_3' = a_2$.

Equation (3.75) is over identified. But π^e_{t-1} is not observable, and hence, further specification should be made. If, on the other hand, $\delta = \beta = 1$ and $a_2 = 0$, then, Equation (3.71) reduces to:

$$A_t = a_0 + a_1 \pi_{t-1} + U_t \tag{3.76}$$

Equation (3.76) is just identified. Furthermore, all the variables are observable. Equation (3.76) is an easy form for estimation. The time variable could be added to Equation (3.76) to represent the technology. Then (3.76) could be written as:

$$A_t = a_0 + a_1 \pi_{t-1} + a_3 T + U_t \tag{3.77}$$

Where:

T = time variable, and $T = 1, 2 \ldots . 8$ in this case.

This study will estimate Equation (3.77) provided that T is not correlated with either U_t or π_{t-1}. The estimation period will be from 1971-1979. This is because of many considerations, such as:

(1) All the structural changes in the Egyptian agricultural sector had been completed by the end of the 1960s. Therefore, it seems reasonable to study the farmer's responses after 1970.

(2) The data available to the researcher are limited. Future research in this area could estimate (3.71) under different assumptions. Equation (3.77) is the first reduced form in this study's model. It states that the farmers take into consideration the relative profitability for the jth and kth crop in period t-1, when they make their cultivation decision in period t. Because of the limited availability of the

agricultural farmland in Egypt, the model specified (3.61)-(3.77) and the assumption about the profit response are very realistic. This study will also estimate the profitability matrix to configurate the farmers' production preference among all the alternative crops.[1]

As for estimating Equations (3.10), this study will estimate a functional form which is flexible to include all the possible shifters such as: all other commodity prices, input prices, technology, etc. Consider the case where the supply function of jth crop could be written as:

$$Q_t^{*j} = f(P_{nt}^X, P_{it}^0, P_t^j, \bar{C}_t^j, S_{Lt}^*, R_{it}, T, U_t) \tag{3.78}$$

$$\begin{aligned} &= \alpha_0 + \alpha_1 P_{ft-1}^j - \alpha_2 \sum_{i=1}^{n} P_X + \alpha_3 \bar{C}_t^j + \alpha_4 S_{Lt}^* \\ &+ \delta_1 R_{it} + \delta_2 T + U_t \end{aligned} \tag{3.79}$$

Where:

Q_t^{*j} = optimal output of jth crop in period t,

P_{ft-1}^j = real per unit of final output of jth crop in period t-1,

$\sum_{i=1}^{n} P_X$ = composite real payment to n inputs used to produce jth crop in period t.

The objectives of using this composite real variable are:

(a) To reduce the multicollinearity as the study will show,

(b) To simplify the estimation procedure. (Since there is no need to examine the separable effects of the input prices on

[1]The definition "profitability matrix" is original to this study. This definition has no roots in previous work. It stands for an (n x n) matrix as the study will show.

the supply, it seems reasonable to use the composite variable $\sum_{i=1}^{n} P_{X_i})$

$\bar{C}_t^j$ = real limited amount of capital available to jth crop in period t,

S_{Lt}^* = the increase in the production of jth crop due to the improvement in all land classes,

R_{it} = dummy variable. It takes values from 0 to 1 to reflect the underlying production policies,

Note that, if R_{it} is included in the function, the intercept should be deleted in order for the determinate of the matrix to a nonzero value.

T = time. T is also used to represent technology, and

U_t = random disturbance.

As for S_{Lt}^*, it could be calculated from the published figures about the improvement in land productivity. These figures are available from The Ministry of Agriculture (33) (Table A.4 in the Appendix). If one lets (IM) stand for the average improvement in the productivity per feddan of jth crop, then, the increase in the production of jth crop is $(IM \cdot A_t^j)$. This value is observable and is equivalent to S_{Lt}^*. In other words, let,

$$\begin{aligned} Q_t^{*j} &= (P_{rt}^j \cdot A_t^j) + (IM \cdot A_t^j) \\ &= A_t^j\,(P_{rt}^j + IM) \end{aligned} \tag{3.80}$$

Where all the variables are specified before, and

P_{rt}^j = productivity of jth crop per feddan in period t.

Notably, (3.80) is based on the assumption that all land classes need improvement. This assumption is very realistic under the intensive land use, as in Egypt. On the contrary, it seems unreasonable to include the area under improvement only. In the long-run, all the land classes need different improvement treatments. And, since this study proposes a long-run policy, then, the approximation in (3.80) is reasonable. Substitute (3.80) in (3.79):

$$A_t^j(P_{rt}^j + IM) = \alpha_0 + \alpha_1 P_{ft-1}^j - \alpha_2 \sum_{i=1}^{n} P_X + \alpha_3 \bar{C}_t^j + \delta_1 R_{it} + \delta_2 T + U_t \tag{3.81}$$

One further approximation is required at this stage. This approximation is about $\sum_{i=1}^{n} P_X$. This value could be approximated by the real average variable cost of producing the jth crop per feddan (V_t^j), i.e., if this variable is included in (3.81), it reads: The higher the real average variable costs of producing the jth crop, the lower the total output level, and vice versa, provided that all the fixed costs will be paid whether the farmer produces or not. Furthermore, the input subsidizations are included in V_t^j. In other words, if the government of Egypt wants to encourage the production of the jth crop, it should reduce V_t^j. This sense does not contradict the economic theory, and it helps in making the estimation procedure easy and accurate. Then, Equation (3.81) could be written as:

$$A_t^j = \frac{\alpha_0}{(P_{rt}^j + IM)} + \frac{\alpha_1}{(P_{rt}^j + IM)} P_{ft-1}^j - \frac{\alpha_2}{(P_{rt}^j + IM)} V_t^j$$

$$+ \frac{\alpha_3}{(P_{rt}^j + IM)} \bar{C}_t^j + \frac{\delta_2}{(P_{rt}^j + IM)} T + \frac{U_t}{(P_{rt}^j + IM)}, \text{ or} \tag{3.82}$$

$$A_t^j = K_0 + K_1 P_{ft-1}^j - K_2 V_t^j + K_3 \bar{C}_t^j + K_4 T + W_t \tag{3.83}$$

Where:

$$K_i = \frac{\alpha_i}{(P_{rt}^j + IM)}, \text{ for } i = 0, 1 \ldots .3$$

$$K_4 = \frac{\delta_2}{(P_{rt}^j + IM)}, \text{ and}$$

$$W_t = \frac{U_t}{(P_{rt}^j + IM)}.$$

Equation (3.83) is a modified version of the Nerlove model. Both Equations (3.82) and (3.83) are over identified and could be estimated. In a similar fashion, one can estimate S_{Lt}^* by the value $(\Theta'^j \cdot Q_t^{*j})$; where, Θ'^j is the percentage increase in the production of jth crop due to improvement programs. It is worth noting that both IM and Θ'^j are long-run coefficients. If one considers Θ'^j instead of IM in fitting (3.78), the reduced form of this alternative could be inferred as:

$$Q_t^{*j} = \alpha_0 + \alpha_1 P_{ft-1}^j - \alpha_2 V_t^j + \alpha_3 \bar{C}_t^j + \alpha_4 \Theta'^j Q_t^{*j} + \delta_2 T + U_t \tag{3.84}$$

It follows that

$$Q_t^{*j} = \frac{\alpha_0}{1-\alpha_4\,\Theta'^j} + \frac{\alpha_1}{1-\alpha_4\,\Theta'^j}\,P^j_{ft-1} - \frac{\alpha_2}{1-\alpha_4\,\Theta'^j}\,V^j_t + \frac{\alpha_3}{1-\alpha_4\,\Theta'^j}\,\bar{C}^j_t$$

$$+ \frac{\delta_2}{1-\alpha_4\,\Theta'^j}\,T + \frac{U_t}{1-\alpha_4\,\Theta'^j} \tag{3.85}$$

$$= K_0' + K_1'\,P^j_{ft-1} - K_2'\,V^j_t + K_3'\,\bar{C}^j_t + K_4'\,T + M_t \tag{3.86}$$

Where:

$$K_i' = \frac{\alpha_i}{1-\alpha_4\,\Theta'^j}\text{, for } i = 0, 1, 2, 3,$$

$$K_4' = \frac{\delta_2}{1-\alpha_4\,\Theta'^j}\text{, and}$$

$$M_t = \frac{U_t}{1-\alpha_4\,\Theta'^j}.$$

Equation (3.86) is over identified and is estimable. Furthermore, Equations (3.83) and (3.86) are similar, if not the same. But the coefficients of (3.86) are more difficult to be interpreted than the coefficients of (3.83). The estimation procedure for Equations (3.83) and (3.86) is approximately the same. Finally, as in Equation (3.82) or the modified versions, i.e., Equations (3.83) and (3.86), all the expected shifters in the aggregate supply function of the jth crop are included.

Furthermore, any of these equations could be used to analyze all the self-sufficiency policy alternatives.[1]

As for estimating Equation (3.13), the estimation procedures are much more difficult than the supply equation. Several studies have been reviewed in order to obtain a reasonable form of (3.13). But some variables in this function are very hard to be related to their observable equivalence. Let the function be written as:

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[1]Under the input subsidization alternative, Equation (3.2) could be written as:

$$\pi = P_j \, f(X^j_{nt}, \bar{L}^j_c, \bar{C}^j_t, T) - (\sum_{i=1}^{n} (W_i - \delta_t) \, X^j_{it} + F) \tag{3.87}$$

Where all the arguments are specified in (3.2), and δ_t is subsidy provided by the Egyptian government per unit of inputs used. Then, by following the same maximization processes in (3.2)-(3.5), the supply function of jth crop is:

$$Q^{*j}_t = f(P^X_{nt}, P^0_{it}, P^j_t, \Gamma, \bar{C}^j_t, \bar{L}^j_c, T) \tag{3.88}$$

Where all the arguments are specified in (3.2)-(3.5), and Γ is real subsidy provided by the Egyptian government per unit of input used in period t.

Under the price support alternative, Equation (3.2) could be written as:

$$\pi = (P_j + \Theta_t) \, f(X^j_{nt}, \bar{L}^j_c, \bar{C}^j_t, T) - (\sum_{i=1}^{n} W_i \cdot X^j_{it} + F) \tag{3.89}$$

and the resulting output supply function as:

$$Q^{*j}_t = f(P^X_{nt}, P^0_{it}, P^j_t, \Theta_R, \bar{C}^j_t, \bar{L}^j_c, T) \tag{3.90}$$

Where all the arguments are specified in (3.2)-(3.5), and Θ_R = real supports provided by the Egyptian government per unit of output of jth crop in period t.

$$C_t^{*j} = R(P_t^j,\ P_t^0,\ \bar{Y}_t,\ P_{pL}^*,\ I^*,\ F_L^j,\ N_g,\ U_t) \tag{3.91}$$

One possible specification of (3.91) is restricted log linear form.

Let:

$$C_t^{*j} = A_1\ P_t^{j\ \lambda 1}\ P_t^{0i\ \sum_{i=2}^{n} \lambda i}\ \bar{Y}_t^{\ \lambda n+1}\ \bar{e}^{\ \delta_1 K \cdot (I-E) + \delta_2 N_g + \delta_3 F_L^j} \cdot e^{Ut} \tag{3.92}$$

and

$$\sum_{r=1}^{n} \lambda_r = -\lambda_{n+1} \tag{3.93}$$

Taking the logarithms of both sides, then,

$$\ln C_t^{*j} = a_1 + \lambda_1 \ln P_t^j + \sum_{i=2}^{n} \lambda_i \ln P_t^{0i} + \lambda_{n+1} \ln \bar{Y}_t - \delta_1 K \cdot (I-E) + \delta_2 N_g + \delta_3 F_L^j + U_t \tag{3.94}$$

Where all the variables and the parameters are defined as follows:

$a_1 = \ln A$,

$\lambda_1 < 0$ to insure negatively sloped Marshallian demand curve,

P_t^j = real price per unit of jth crop in period t,

$\sum_{i=2}^{n} \lambda_i \gtreqless 0$ for all λ_i's depending upon the interrelationships between r=1, 2 .... n goods,

P_t^{0i} = real price per unit of other related crops in period t,

$\lambda_{n+1} > 0$ under the assumption that jth crop in normal good in the range of $\bar{Y}_t$.

$\bar{Y}_t$ = limited real income to the household in period t, K = a policy subjective coefficient that takes values between 0 and 1. Or $0 < K \leq 1$, and

I-E = imports-exports of jth crop in period t. The value $K \cdot (I-E)$ is an approxy for P^*_{pL} and I^*.

In other words, if Egypt could adjust her price and consumption policies, such that the requirements of jth crop are reduced by K, then, this will help Egypt to achieve a reasonable degree of self-sufficiency by the year 2000. This approximation could be done in several ways; furthermore, the approximation takes care of the desired self-sufficiency diet changes. The adjustment of price and consumption policies in Egypt is very important because of the dramatic shifts in the aggregate demand in the last three decades. Even under high population growth rate, the requirements of the jth crop could be reduced by radically changing the current price, subsidy and consumption policies. The following are examples of possible adjustments:

(a) The Egyptian society could adjust its tastes to diverse kinds of the same item. For example, the society could adjust to a mixed wheat bread rather than white wheat bread, frozen meat, milk, or other foods rather than fresh ones. Besides the tastes change, the demand for food, oil, sugar, etc., during some months of the year should be reduced.

(b) The Egyptian government, on the other hand, could direct the subsidies provided to the consumers, i.e., the higher, middle, and lower income classes should be differentiated in terms of the price of the same item. Or alternatively, the government should reconsider the issues of the income distribution with no subsidies at all, i.e., the way in which the government helps the poor should be reconsidered in accordance with changing the current cost of living.

(c) Even the middle and lower classes should only get subsidies for the necessary diet with eventually changing the tastes to eliminate the phenomenon of "keeping up with the Joneses."

(d) Finally, the price adjustment should include all the marketing charges, retail profits, etc.

Through adjustments (a)-(c), the requirements of the jth crop will be reduced by K and this will help Egypt to maintain a reasonable degree of self-sufficiency.

F_L^j, N_g and U_t are defined before. The reduced form of (3.94) could be obtained by substituting (3.93) in (3.94),

$$\ln C_t^{*j} = a_1 + \lambda_1 \ln P_t^j + \sum_{i=2}^{n} \lambda_i \ln P_t^{0i} - \sum_{r=1}^{n} \lambda_r \ln \bar{Y}_t$$

$$- \delta_1 K \cdot (I-E) + \delta_2 N_g + \delta_3 F_L^j + U_t$$

$$= \gamma_1' + \gamma_2' \ln P_t^j + \gamma_{0i}' \ln P_t^{0i} - \gamma_3' \ln \bar{Y}_t$$

$$- \delta_1 K(I-E) + \delta_2 N_g + \delta_3 F_L^j + U_t \qquad (3.95)$$

Where:

$\gamma_1' = a_1$

$\gamma_2' = \lambda_1$

$\gamma_{0i}' = \sum_{i=2}^{n} \lambda_i$

$\gamma_3' = -\sum_{r=1}^{n} \lambda_r = \lambda_{n+1}$, and the rest or the variables are defined before.

Equation (3.95) is over identified and is estimable. Before fitting (3.95), however, one final approximation about F_L^j should be made. This approximation depends upon the data availability and it will be discussed later in this study.

Estimation Procedures

So far, the structural model was the main concern. The reduced forms and the variables in the model have been identified and defined. The estimation procedures of this model will be based upon a single equation type model. In dealing with the time series data, several issues have to be considered. These issues are:

(1) The possibility that the exogenous variables are collinear, i.e., the existence of the multicollinearity.

(2) Due to the nature of the time series data, it is highly likely that the error terms are correlated with one another, i.e., the existence of the autocorrelation.

(3) If (1) and (2) or both exist, the error variance will be heterogeneous, not homogeneous, and this will lead to a heteroskedastic distribution for the stochastic term.

(4) The possibility that one or more than one independent variables are measured with error.

In dealing with these issues and others, this study will develop the following estimation procedures.

To configurate the rates of growth over time, study will follow the following procedure:

Let $Y_i = f(X_i)$ for $i=1 \ldots. n$ (3.96)

$$= a \pm \beta X_i + U_i \tag{3.97}$$

Where:

Y_i = the study's variable. For all i.

X_i = time. For all i.

Then,

$$\dot{\hat{Y}}_i = \frac{\partial \hat{Y}_i}{\partial X_i} \cdot \frac{1}{Y_i} = \pm \frac{\hat{\beta}^1}{Y_i} \tag{3.98}$$

Where:

$\dot{\hat{Y}}_i$ = estimated time rate of growth in Y_i. And,

$\hat{\beta}$ = the least-squares estimate.

As for estimating the functions in the model, the study will start by determining a rough mathematical form for the function. The determination of the form is either imposed by the economic theory or could be inferred from a scatter plot of the data. The number of the variables in each single equation will be chosen upon the stepwise maximum R^2 improvement technique. The technique was developed by James Goodnight and explained in the 1979 SAS manual.

Consider the case where the functional form of the equations could be written as:

$$Y = X\beta + U \tag{3.99}$$

$$= \text{fixed part} + \text{random part}$$

---

[1]This estimator developed upon Branson's (4) definition. Further, the properties of $\dot{\hat{Y}}_i$ will be studied after studying the distribution of $\hat{\beta}$.

Where:

Y is a column vector of N observations on the dependent variable;

X is an N x (M + 1) vector of observations on M independent variables and a column of ones;

β is an (M + 1) x 1 column vector of coefficients;

U is an (N x 1) vector of errors.

Assume that:

$$E[U_t] = 0 \quad \text{for all } t \tag{3.100}$$

$$E[U_t^2] = \sigma^2 \quad \text{for all } t < \infty \tag{3.101}$$

$$E[U_t\ U_s] = 0 \quad \text{for } s \neq t \tag{3.102}$$

$$E[X_{it}\ U_t] = 0 \quad \text{for all } i \tag{3.103}$$

Further, assume that all X_i's are constants measured without error. By this assumption, X_i's are fixed, no linear relation will exist between the independent variables or the multicollinearity is absent.

The Ordinary Least-Squares (OLS) estimate of β in (3.99) is given by:

$$\hat{\beta} = (X'X)^{-1}\ X'y \tag{3.104}$$

provided that (X'X) exists and is a nonsingular matrix. The estimator in (3.104) is Unbiased, as well as is the Best Linear Estimator (BLUE), i.e., has minimum variance among all other linear estimators;[1] furthermore, Ladd and Martin (27) and Intriligator (21) stated that if in addition to assumptions (3.100)- (3.103), the U_t's are assumed to be

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[1] These results are commonly known as the Gauss-Markov theorem. The details of the Theorem are explained in (21) and (22).

normally distributed,[1] the OLS estimator possesses the Maximum Likelihood (MLE) properties of sufficiency and consistency and are normally distributed, i.e., the distribution of $\hat{\beta}$ is:

$$\hat{\beta} \sim N(\beta, (X'X)^{-1} \sigma^2 I) \tag{3.106}$$

Given the distribution of $\hat{\beta}$ in (3.106), the study could utilize the statistical theory for testing all or some $\hat{\beta}_i$'s.[2] Further, 100 $(1-\alpha)$% confidence intervals and predicted values for the year 2000 could be inferred.

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[1] U_t's are assumed to have a density function as:

$$f(U_t) = \begin{cases} \dfrac{1}{\sqrt{2\pi\ \sigma^2 I}} \ \text{exp.} \ \dfrac{-1}{2\sigma^2 I} \cdot U_t^2 & \text{for } -\infty < U_t < \infty \\ 0 & \text{otherwise.} \end{cases} \tag{3.105}$$

[2] There are several ways to perform this test. The general form of the test is:

$$F = \frac{(\hat{\beta}_s - \beta_{os})' \ A_s^{-1} (\hat{\beta}_s - \beta_{os})/K_s}{s^2} \sim F_{N-K}^{Ks} \tag{3.107}$$

Where:

β_{os} are specified under the null hypotheses.

A_s^{-1} are the portion of $(X'X)^{-1}$ that matches $\hat{\beta}_s$.

And $s^2 = \frac{1}{N-K} (Y'Y - \hat{\beta}' X' Y)$

For $K = 1$, the test gives results equal these given by t^2.

Now since the distribution of $\hat{\beta}$ is known, this could help in inferring the distribution of $\hat{\dot{Y}}$ in Equation (3.98). But before inferring the distribution of $\hat{\dot{Y}}$, the distribution of Y should be determined. There are several ways to infer the distribution of any variable. Some of these ways are very naive and some of them are very sophisticated. Larson (28) and Freund and Walpole (2) explained all of these ways. For instance, one could infer such a distribution from: (1) The knowledge known about the distribution of some other variables, (2) The distribution of the single observation in the population could also help one to infer the distribution of variables in the sample. For example, what is based on normal is normal, (3) Under certain limiting conditions the Moment Generating Functions (Mgf) could be used. This is due to the fact that Mgf has one to one correspondence with the probability distributions (densities) when the former exists. And finally, (4) One can use (1) and the simple expectations. There are, however, other ways some of them are easier than (1) - (4) and some others are much more difficult. For simplicity, consider Equation (3.97). In this equation, the distribution of U_t, as specified in (3.105), and the knowledge about X_i could help in inferring the distribution of Y_i. Let assumptions (3.100) - (3.103) and (105) hold, then,

$$E(Y_i) = E(\alpha \pm \beta X_i + U_i) = E(\alpha) \pm E(\beta X_i) + E(U_i)$$

by the properties of the expectations.

$$= \alpha \pm \beta X_i \qquad (3.108)$$

And

$$V(Y_i) = V(\alpha \pm \beta X_i + U_i) = V(U_i) = \sigma^2 \tag{3.109}$$

provided that U_i, α and X_i are pairwise independent, i.e., the covariance terms are = 0. From (3.108) - (3.109)

$$Y_i \sim (\alpha \pm \beta X_i, \sigma^2) \tag{3.110}$$

Further, the distribution of Y_i could be inferred from the assumptions about U_i since Y_i is a linear function of U_i. Therefore, Y_i would have a normal distribution. Then,

$$Y_i \sim N(\alpha \pm \beta X_i, \sigma^2) \tag{3.111}$$

Furthermore, under assumptions (3.100) - (3.103) and (3.105), $\hat{\beta}$ has the following distribution:

$$\hat{\beta} \sim N(\beta, \frac{\sigma^2}{\sum_{i=1}^{n} (X_i - \bar{X})^2}) \tag{3.112}$$

$\hat{\beta}$ in (3.112), on the other hand, exhibits all the maximum likelihood estimator's properties specified before. One more property of the MLE is called the invariance property.[1] Then, from (3.111), (3.112), and the invariance property of MLE, the distribution and the property of $\dot{Y}_i$ could be inferred as follows:

$$\hat{\dot{Y}}_i = \pm \frac{\hat{\beta}}{Y_i} = \pm \hat{\beta} \cdot Y_i^{-1} \tag{3.113}$$

It follows that $\hat{\dot{Y}}$ is a MLE of $\dot{Y}_i$. Further, $\hat{\dot{Y}}_i$ is normally distributed, since it is a function of normal. It also follows that $\hat{\dot{Y}}_i$ exhibit all

[1]Freund and Walpole (12) stated this property as: "If $\hat{\Theta}$ is a maximum likelihood estimator of Θ and the function given by $g(\Theta)$ is continuous, then $g(\hat{\Theta})$ is also a maximum likelihood estimator of $g(\Theta)$. This holds true for any Θ in the parameter space Ω."

the MLE properties and need not be unbiased.[1] And the percentage rate of growth in Y evaluated at the mean value is:

$$\hat{\dot{Y}} = \frac{\hat{\beta}}{\bar{Y}} \cdot 100 \tag{3.114}$$

Therefore, this study's estimation of the time rate of growth exhibits desirable, statistical properties.

Due to the nature of the time series data, some of the assumption stated before may likely be unfulfilled. Good model specifications, however, help in the fulfillment of some of these assumptions, and hence, help to avoid problems (1) - (4) on page 58 of this dissertation. In other words, if the model is specified upon the economic theory and the data provide sufficient enough information, then problems (1) - (4) will be avoided or at least the estimations will be reasonable.

Under the assumption that Xs are nonstochastic and no linear dependence exists in the X matrix, i.e., the matrix of the exogenous variables satisfies the rank condition,[2] then, the multicolinearity will be absent. Intriligator (21) and Johnston (22) emphasized that under the case of perfect colinearity, i.e., $|X'X| = 0$, the estimation of the parameters will be impossible. Even under less than perfect collinearity, i.e., $|X'X| \doteq 0$, the OLS estimators will lose some desirable properties.

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[1] The expectation and the variability for lower degree polynomials are not straightforward. This study will not elaborate on these operations and will leave them to future studies in this area.

[2] The rank condition as specified by Intriligator (21) is $\rho(X) = K$ for a (n x K) matrix of explanatory variables.

The existence of multicollinearity will increase as the number of variables in the regression equation increases, as stated by Tweeten (47), especially if many dummy variables are included in the equation. Intriligator (21) and Tweeten (47), among others, examined some sets of alternatives to deal with multicollinearity. For dealing with perfect multicollinearity, Intriligator suggests the following solutions:

(1) Eliminate those variables which can be expressed as linear combinations of the other explanatory variables.

(2) Estimate the linear combination of the coefficients rather than single coefficients. Notably, under this alternative, it is difficult to determine the separable effects of the explanatory variables. If, on the other hand, the multicollinearity is viewed as a deficient sample information problem, i.e., if the sample data do not provide "rich" enough information to estimate the parameters, Intriligator suggests other approaches such as:

   (a) Collect more data. Notably, the data being collected should be different from that already available and exhibit multicollinearity.

   (b) Scale down the model to match the data available. This could be done by changing the specification by dropping some of the explanatory variables (as in the case of perfect multicollinearity) or to average or to aggregate certain groups of variables.

(c) Live with the multicollinearity, especially if (a) - (b) are difficult to do. Similar ways of dealing with the multicollinearity are suggested by Tweeten (47). Furthermore, both Intriligator and Tweeten indicate several consequences that could happen in the presence of the multicollinearity such as:

(i) R^2 may increase or decrease with higher intercorrelation coefficients r_{12}, r_{13}, etc. But, the regression coefficient will be unstable when high intercorrelations are present.

(ii) F and t tests are high and low, respectively, which may lead to falsely rejecting or accepting a true null hypothesis.

(iii) Even if (i) and (ii) could happen, the multicollinearity is not a serious problem if the primary purpose is forecasting, i.e., one can usually obtain good forecasts despite the presence of multicollinearity, since the same relationships among the explanatory variables usually exist in the forecast period. If, however, the purpose is structural analysis, specifically that of disentangling separate influences of explanatory variables, then multicollinearity is a very serious problem that must be addressed. Based upon the previous discussion, the multicollinearity is not expected to be present in this study's model. This is because:

First, the variables are chosen upon a well-defined economic theory. Second, the number of variables in each reduced form is reasonable. Furthermore, the related variables have been combined in one explanatory variable as the study has shown. And, third, the purpose of the model is to forecast the supplies and the requirements by the year 2000. Therefore, even in the presence of the multicollinearity, the estimation will be good.

As for the serial correlation (autocorrelation), the stochastic disturbance terms are not independent of one another, i.e., assumption (3.102) is unfulfilled. Or, the elements off the principal diagonal of the covariance matrix, $E(U_t U_s)$, are not all equal to zero. Intriligator (21), Ladd (26), Johnston (22, 23), and Orcutt and Winokur (35) handled this problem in much detail. The major issues in all of these studies are:

(1) If the autocorrelation is present, then, how will $\hat{\beta}$ be affected?

(2) If the autocorrelation is present, then, how badly biased will the F and t tests be?

(3) If the autocorrelation is present, then, how close to the reality will the forecasted value be?

Intriligator attributed the problem of the autocorrelation to the components of U_t's. Or, it is mainly a misspecification problem, particularly the exclusion of relevant variables from the model. The presence of the autocorrelation, however, will cause the t and F tests to be biased. Assume that the first order autocorrelation is present, i.e.,

iet $U_t = \rho\, U_{t-1} + e_t$ (3.115)

Where:

$|\rho| < 1$ and, U_{t-1} and e_t are independent, i.e.,

$$\mathrm{Cov}(U_{t-1}, e_t) = 0 \tag{3.116}$$

For all $t \geq 2$. Further,

$$e_t \sim \mathrm{NID}(0, \sigma^2) \tag{3.117}$$

Johnston (23) has shown that under these conditions, the variability of $\hat{\beta}$ will be

$$V(\hat{\beta}) = \frac{\sigma^2}{\sum_{i=1}^{n} x_i^2} \left(1 + 2\rho \frac{\sum_{i=1}^{n-1} x_i x_{i-1}}{\sum_{i=1}^{n} x_i^2} + 2\rho^2 \frac{\sum_{i=1}^{n-2} x_i x_{i+2}}{\sum_{i=1}^{n} x_i^2} \right. \tag{3.118}$$

$$\left. + 2\rho^{n-1} \frac{x_1 x_n}{\sum_{i=1}^{n} x_i^2}\right)$$

If $\rho = 0$, then (3.118) reduces to the variability of $\hat{\beta}$ in (3.112). This implies that both the least-squares estimator and the prediction will be badly biased in the presence of autocorrelation.

The Durbin-Watson (DW) test for autocorrelation will be used in this stage of the model. Since X is nonstochastic by assumption and no lagged dependent variable will be used as explanatory variable.[1] Furthermore, under the assumptions (3.116) - (3.117), Equation (3.115) could be viewed as a simple regression problem. If one adds the assumption that U^2_{t-1} is fixed, then:

$$\hat{\rho} = \frac{\sum_{t=2}^{n} U_{t-1} U_t}{\sum_{t=2}^{n} U^2_{t-1}} \tag{3.119}$$

Where:

$\hat{\rho}$ = estimated serial correlation coefficient.

Further, under assumptions (3.116) - (3.117) and U^2_{t-1} is fixed, then, $\hat{\rho}$ is an unbiased estimator of ρ. But, due to the fact that U_t's may not be observable, then the study could utilize βOLS in the following manner:

$$\hat{U}_t = Y_t - X_t \hat{\beta}\text{OLS} \tag{3.120}$$

Then compute,

$$\hat{\hat{\rho}} = \frac{\sum_{t=2}^{n} \hat{U}_t \hat{U}_{t-1}}{\sum_{t=2}^{n} \hat{U}^2_{t-1}}, \text{ never be} > 1 \tag{3.121}$$

In order to get a reasonable estimate of β in the presence of the autocorrelation, Fuller[2] proposes the following way:

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[1]Orcutt and Winokur (35) and Johnston (22) examined the issue of using lagged dependent variables under the first order autoregressive scheme. This study will use lagged dependent variables to create new variables, but will not directly use the lagged dependent variables.

[2]Wayne A. Fuller. "Statistics 538 Class Notes." Department of Statistics, Iowa State University.

(1) Compute $\hat{\hat{\rho}}$ as in (3.120) - (3.121). Notably, $\hat{\hat{\rho}}$ never exceeds 1, while $\hat{\rho}$ may exceed 1.

(2) Transform the data set, such that:

$$\hat{T}Y = \hat{T} \times \beta + \hat{T}U \tag{3.122}$$

$$W = Z\beta + V \tag{3.123}$$

Then,

$$\hat{\beta} = (Z'Z)^{-1} Z'W \tag{3.124}$$

Where:

$Z = \hat{T}X$,

$V = \hat{T}U$. And,

$$\hat{T} = \begin{bmatrix} \sqrt{1-\hat{\hat{\rho}}} & 0\;0\;0 & \cdots & 0 & \cdots & 0 \\ -\hat{\hat{\rho}} & 1\;0\;0\;0 & \cdots & 0 & \cdots & 0 \\ 0 & .\;1\;\;0\;\;0 & & 0 & \cdots & 0 \\ & \vdots & & \vdots & & \vdots \\ 0 & \vdots & & \vdots & & \vdots \\ \vdots & \vdots & & \vdots & & \vdots \\ 0 & 0 & & -\hat{\hat{\rho}} & & 1 \end{bmatrix} \tag{3.125}$$

The statistics in (3.124) is GLS estimate of β. On the other hand, $\hat{\beta}$ is BLUE β provided that U_t is not known. By this simple two-step estimate, the least-squares estimate of the parameters could be obtained.

There are many other methods to deal with the estimation in the presence of the autocorrelation. Ladd (26) and Ladd and Martin (27) proposed the modified version of the Gauss-Newton nonlinear regression procedure. This procedure was developed by Fuller and Martin and called the Autoregressive Least-Squares (ALS). This procedure is an iterative procedure for obtaining simultaneous estimate of β and ρ.

The choice of which way to deal with autocorrelation depends mainly on the computational ease, i.e., this study has no preference in using either way; whichever is handy in the computer manual will be used.

There is still one more problem which is the heteroskedasticity. Intriligator (21) explained this phenomenon as the case in which:

$$\begin{aligned} &\text{var}(U_i) \neq \text{var}(U_{i'}) \quad \text{for } i \neq i', \text{ or} \\ &\text{var}(U_i) = \infty \text{ for some } i \end{aligned} \tag{3.126}$$

Alternatively, the elements along the principal diagonal of $E(U_t U_t')$ either are not equal or are infinite. This case, however, is ruled out by assumption (3.101). If the case in (3.126) exists, the least-squares estimates will not be efficient and the tests of significance will be invalid. This study, however, will assume that the error variance is constant over the sample or the variance is homoskedastic.

For estimating each function, the study will try different degree polynomial models (depending upon the nature of the data). The best fit, however, will be chosen upon maximum $\bar{R}^2$, where:

$$\begin{aligned} \bar{R}^2 &= 1 - \frac{(n-1)}{n-k-1}(1-R^2) \\ &= \text{adjusted } R^2 \end{aligned} \tag{3.127}$$

Where k is the number of regressors, and (k+1) is subtracted from n because a constant term in addition of these k regressors will be estimated.

The validity of the model, specified before, could be tested by comparing the forthcoming results to the actual values. U^2 - coefficient will be used in this stage, where:

$$U^2 = \frac{\sum_{t=1}^{n} (A_t - P_t)^2 \frac{1}{n}}{\sum_{t=1}^{n} (A_t - A_{t-1})^2 \frac{1}{n}} \quad \text{for all } t \tag{3.128}$$

Where:

A_t = actual value in year t, and

P_t = predicted value in year t.

CHAPTER IV. THE STRUCTURE OF THE AGRICULTURAL SECTOR IN EGYPT

This part of the study is mainly concerned with the basic structure of the agricultural sector in Egypt. As this study has shown in Chapter II, there are some structural changes due to following several production policies in the last three decades. In order for this study to propose its long-run self-sufficiency policy, the current structure of the agricultural sector in Egypt should be studied. Notably, this part of the study is the first analytical part. Further, the forthcoming results may or may not support the previous studies in Chapter II. In other words, the review of literature will be examined in this chapter.

According to the classical economists, the factors of production could be classified into: land, labor, management, and capital. This classification shows that these four factors cooperate in any production processes. As in the case of Egypt, several considerations should also be taken into account besides the previous classification. This study will analyze this classification and the considerations in the following parts of this chapter thereof.

The Land

The land is, by and large, the major factor of production. All other resources work on the land. The land in general is a homogeneous, immobile factor. Further, the short-run supply of land resources is fixed. The cultivated area of the land resource, however, is subject to the society's decisions, i.e., the society's decisions could work in the direction of increasing or decreasing the current supply of cultivated farmland.

There has been several ways of classifying the land resource in Egypt. Emarah (9) handled some of these ways in detail. In summary, there are, according to the physical classification of the Ministry of Agriculture (33), six land classes. Table 4.1 shows the area of each class and the percentage of these areas. Table 4.1 shows that except for land classes 5 and 6, which are invalid for cultivation, about 50 percent of the farmland needs different improvement treatments. This fact reflects the significance of this study's proposed self-sufficiency policies to Egypt.

The Ministry of Agriculture (32) classified the land resource, according to the land's productive efficiency, into five classes. They are:

<u>The first productive area</u> includes farmland with the maximum productive efficiency, i.e., the farmland with 5.00 - 4.30 efficiency units. The area of this class is about 2.10 million feddan which represents about 37.24 percent of the total area.

<u>The second productive area</u> includes the farmland with degree of efficiency between 4.20 - 3.50 efficiency units. The area of this class is about 2.03 million feddan which represents 36.05 percent of the total area.

<u>The third productive area</u> includes the farmland with efficiency degree 3.40 - 2.70 efficiency units. The area in this class is

Table 4.1. The physical classification of the Egyptian farmland[a]

Land class \ Area	Area in feddan[b]	Percentage of the area relative to the total area
Class 1	359,617	4.91
Class 2	2,631,313	35.89
Class 3	2,238,865	30.54
Class 4	556,750	7.59
Class 5	882,820	12.04
Class 6	662,640	9.04
Total area	7,332,005	100.00

[a]Source: Computed from Emarah (9).

[b]Feddan = 0.42 hectare.

about 1.107 million feddan which represents 19.61 percent of the total area.

<u>The fourth productive area</u> includes the farmland with efficiency degree 2.60 - 1.90 efficiency units. The area in this class is about 0.221 million feddan which represents 3.92 percent of the total area.

<u>The fifth productive area</u> includes the farmland with degree of efficiency between 1.08 - 1.00 efficiency units. The area in this class is about 0.179 million feddan which represents 3.18 percent of the total area.

The results of this classification show that the agricultural farmland in Egypt decreased from 5.97 million feddan to 5.64 million feddan in the period 1966-1970 as compared to 1971-1975. The annual decrease in the area is about 66,000 feddan. These results confirm the results of El-Nagar and Aita (8b) as stated in the review of the literature of this dissertation. Later on in this part, this study will compare this rate with the annual addition to the current supply of farmland through the horizontal land programs.

In comparison with 1966-1970 classification, the classification in 1971-1975 reflects the significance of the vertical land policy programs in Egypt. Table 4.2 shows this comparison. The increase in the efficiency and the decrease in the area reflect the importance of this study's paradoxical self-sufficiency policy.

Table 4.2. The results of the economic classification in the period 1961-1970 as compared to the period 1971-1975[a]

Productive area	1966-1970		1971-1975	
	Area in feddan	Percentage from total	Area in feddan	Percentage from total
First	2,169,370	36.31	2,101082	37.24
Second	1,436,037	24.04	2,033,965	36.05
Third	1,354,162	22.67	1,106,511	19.61
Fourth	875,469	14.65	221,002	3.92
Fifth	138,923	2.33	179,286	3.18

[a]Source: Ministry of Agriculture (32).

Emarah (9) used the Least Significance Difference (LSD) and came to the same conclusions.

As for the farm size in Egypt, it is characterized by small sized farms. Table 4.3 shows a comparison between the size of the ownership before and after the agrarian reform laws. As stated in Chapter II of this dissertations, some economists, soil experts, etc., call for consolidating the small farms into an economical size. The major issue from this study's point of view is not the small size but the efficiency. Therefore, it seems reasonable to direct the private and public investment for improving and increasing the current supply of farmland. This is because of the fact that there are no gains to society from consolidating poor farmland.

As for the effectiveness of the horizontal and vertical land policy programs, the experience of Egypt has shown that both policy alternatives are necessary. As stated before, vertical programs are this study's policy instrument. At the same time, the horizontal land policy programs are vital to Egypt. This is because of the facts that (1) reduction in the rate of productivity growth, and (2) expansion of housing and industrialization use land at the expense of the agricultural use. Or, in other words, (1) and (2) imply the reduction in the quality due to the intensive use of the farmland and the reduction in the quantity due to high demand for other uses.

The government of Egypt has successfully considered these programs. But, there is still much room for both the public and the government to function in the direction of increasing and improving the current

Table 4.3. Distribution of the land ownership in 1965 as compared to 1952[a]

Size of ownership	1952 Number of owners in 1000	1952 Area in 1000 feddan	1952 Percentage of owners	1952 Percentage of area	1965 Number of owners in 1000	1965 Area in 1000 feddan	1965 Percentage of owners	1965 Percentage of area
Less than 5 feddan	2,642	2,122	94.30	35.40	3,033	3,693	94.50	57.10
5-9.99 feddan	79	526	2.80	8.80	78	614	2.40	9.50
10-19.99 feddan	47	638	1.70	10.70	61	527	1.90	8.20
20-49.99 feddan	22	654	0.80	10.90	29	815	0.90	12.60
50-99.99 feddan	6	430	0.20	7.20	6	392	0.20	6.10
100-199.99[b] feddan	3	437	0.10	7.30	4	421	0.10	6.50
200 feddan and more	2	1,177	0.10	19.70	-	-	-	-
Total	2,801	5,984	100.00	100.00	3,211	6,462	100.00	100.00

[a]Source: Ministry of Agriculture (32).

[b]In 1965, it is 100 feddan only.

supply of farmland before the year 2000. The total reclaimed area during the period 1952-1974 is 908.50 thousand feddan at an annual rate of 39.50 thousand feddan. This rate implies two main conclusions: (1) Supply of farmland decreases at a rate of 26.50 thousand feddan, and (2) Area lost due to the expansion of housing and industries is different in quality from the area added due to the reclamation. This conclusion can be substantiated from the published data from the Ministry of Agriculture (32).

As for the vertical policy programs, they have been very successful in Egypt. The increase in the productivity of the main crops due to the soil improvement programs is provided in Table A.4 in the Appendix. The rate of increase in the productivity per feddan differs among crops and regions. Table A.4 also shows that the improvement in the productivity is consecutive during the land treatment period. The percentage increase in the productivity for wheat, corn, cotton and rice ranges from 0.75 percent to 300 percent. This increase, according to the Ministry of Agriculture (33), is also expected to persist after the land treatment. Also, due to the improvement programs, some crops could be efficiently introduced into the agricultural rotation (Table A.4 in the Appendix).

This study will use the rates of increase in the productivity shown in Table A.4 to estimate the increase in the aggregate supply of all the study's crops. This increase in the aggregate supply is one of this study's main proposed self-sufficiency policies.

Table 4.4. ALS[a] best fit of the time equations of employment and wages in the agricultural sector as compared to all other sectors in Egypt through the period 1972-1977[b]

Explanatory variables	Employment: Agriculture in 1000 individuals	Industry in 1000 individuals	All good sectors in 1000 individuals	All service sectors in 1000 individuals	Total employment
Intercept	4034.62	1038.24	5644.17	3189.71	8852.45
SE[c]	(62.21)	(22.07)	(190.13)	(84.23)	(150.35)
$\approx$ prob.[d]	(0.0001)	(0.0005)	(0.001)	(0.001)	(0.0003)
X_i	108.56	72.40	-127.50	-121.85	-274.76
SE	(40.57)	(24.51)	(211.44)	(93.26)	(166.20)
$\approx$ prob.	(0.08)	(0.098)	(0.61)	(0.321)	(0.24)
X_i^2	-17.70	-18.91	77.94	78.02	165.31
SE	(5.70)	(7.78)	(67.12)	(29.56)	(52.66)
$\approx$ prob.	(0.053)	(0.14)	(0.37)	(0.12)	(0.09)
X_i^3	....	2.02	-8.70	-6.53	-16.22
SE	....	(0.74)	(6.36)	(2.801)	(4.99)
$\approx$ prob.	....	(0.111)	(0.304)	(0.15)	(0.083)
$\bar{R}^2$ [e]	0.72	0.99	0.91	0.99	0.99

[a]ALS stands for autoregressive least-squares.

[b]Source: Computed upon data from (CAPMS) (6).

[c]SE is the standard error of the coefficient.

[d]$\approx$ prob. is the approximate probability.

[e]$\bar{R}^2$ is the adjusted R^2.

Wages				
Agriculture in million pounds	Industry in million pounds	All goods sectors in million pounds	All service sectors in million pounds	Total wages in million pounds
407.53	231.07	811.71	936.50	1750.38
(53.45)	(57.00)	(44.65)	(36.33)	(76.46)
(0.017)	(0.06)	(0.003)	(0.002)	(0.002)
-259.68	75.57	-317.89	-128.73	-448.43
(59.04)	(63.46)	(49.28)	(40.32)	(84.49)
(0.05)	(0.36)	(0.02)	(0.09)	(0.03)
109.59	-23.74	137.14	73.79	211.34
(18.70)	(20.15)	(15.60)	(12.79)	(26.76)
(0.03)	(0.36)	(0.013)	(0.03)	(0.02)
-10.96	3.13	-12.57	-5.90	-18.50
(1.77)	(1.91)	(1.48)	(1.21)	(2.54)
(0.03)	(0.24)	(0.014)	(0.04)	(0.02)
0.99	0.98	0.99	0.99	0.99

Labor

As stated before in this dissertation, the Egyptian population in the agricultural sector is around 50 percent. Further, the service of labor in the production process is abundant such that most of the small farms are labor intensive.

Table 4.4 - 4.5 compare the employment and the labor share in the agricultural sector to all other sectors.[1] The results of Table 4.5 show that the employment in the agricultural sectors is decreasing at

Table 4.5. Time rates of growth[a] in employment and wages in the agricultural sector as compared to all other sectors in Egypt, 1972-1977[b]

Sector	Agriculture	Industry	All good sectors	All service sectors	Total
	percentage				
Employment	-0.37	2.09	1.01	4.46	2.33
Wages	14.92	11.04	14.12	12.06	12.91

[a]Time rate of growth = $(\hat{\beta} \cdot \bar{Y}^{-1})100$. Equation (3.114)

[b]Source: Computed from (CAPMS) (6) and ALS estimates.

an annual rate of -0.37 percent, while the labor shares are increasing at a rate of 14.92 percent per annum. The movement of the agricultural labor to nonfarm occupations is desirous because of high labor intensity. But, such a movement should carefully be carried out in order to insure

[1]The rates of growth are computed from all significant coefficient polynomial forms, but they are not necessarily computed from the Autoregressive Least-Squares (ALS) best fit.

the feasibility of a well-trained labor force in agriculture. The increase in the labor shares in the agricultural sector, on the other hand, implies that the agricultural workers are making good returns out of their work.

In comparison with all other sectors, the rate of growth in wages in agriculture is higher than all other sectors. But this result does not imply that the agricultural workers are better, in terms of the income per worker, than nonfarm workers. This is because many other sources of income should be considered before making this judgement. In general, what is important to this study is that the agricultural wages are increasing at a reasonable rate. Finally, as stated in the review of literature of this dissertation, the government should seriously consider the problem of excess labor resources in the agricultural sector, as well as increase the investment in rural industry to absorb the excess rural labor.

Management

The management plays a critical role in directing and allocating the resources in any economic activity. Because of this role, many economists believe that improving the efficiency of the management will lead to increasing the total output by about 33 percent.

As indicated before, most of the farms are small-sized farms. Further, the sizes of these farms are different. Because of these facts, the small-holding farmers usually manage their own farms. The cooperatives, on the other hand, help these small-holding farmers through formulating the agricultural rotations, as well as providing them with advice, training programs, information, etc. On the contrary, in large farms, the owners or their behalfs practice the management of these farms.

As for the number of the cooperatives and the number of the members in Egypt, the most recent statistics, i.e., up to 1979 publications, are shown in Table 4.6. The number of cooperatives has increased about three times, while the number of members has increased about six times as compared to the base year. The data from the same reference, i.e., Ministry of Agriculture (32), have shown that the monetary power of the cooperatives has increased from 661,000 pounds in 1952 to 8,124,000 pounds in 1973.

Table 4.6. Number of cooperatives and number of members of these cooperatives in Egypt[a]

Year	Number of cooperatives	Index number 1952=100	Number of members	Index number 1952=100
1952	1,727	100.00	498,652	100.00
1969	5,009	290.04	2,920,983	585.78
1970	5,049	292.36	2,830,345	567.60
1971	5,055	292.70	3,017,963	605.22
1972	5,073	293.75	3,134,346	628.56
1973	5,075	293.86	3,241,368	650.03

[a]Source: Ministry of Agriculture (32).

Since the cooperatives play a major role in the decision making processes, the government of Egypt should consider all the cooperative programs. As indicated in Chapter II of this dissertation, the cooperatives are one of the major supporting institutions in Egypt. Therefore, based on the policy action (c) of this study's proposed self-sufficiency policies on pages 19 and 20 of this dissertation, there are several considerations such as:

(1) The subsidies provided by the cooperatives should seriously be considered. In other words, the government must choose one of the following alternatives:

(a) Deregulate the market price of the inputs, or

(b) Provide the farmers with their exact needs of the inputs.

(2) As this study will show, all price policies must be adopted either in a non or free market framework. This holds true for all crops.

(3) The way the resources are managed, through the set agricultural rotation, must radically be changed in the direction of the farmers' preference among all the crops in the same rotation. In other words, the crop rotation should start from the farm level. Further, if the government wants to increase the acreage of one crop, then direct payment will be considered.

(4) The government, by one way or another, should supervise the subsidized inputs, i.e., the farmers must seriously be fined if the subsidized inputs are resold in the black market.

In summary, the subsidies on the side of the producers should be directed, i.e., as indicated before, the issue of subsidy for whom and for what should be reconsidered. Further, the agricultural rotation must be set upon sophisticated studies for all the resource uses. These studies should include (1) the profitability of all crops, (2) the nation's needs, (3) the comparative advantages, as well as (4) the quality of the farmland.

Finally, the quality of the Egyptian workers and managers has proven to be superior. They are successfully helping all the Arab countries in their development. This study believes that the government of Egypt should find a way to make the best use of these human resources first, and then let the rest go anywhere else. Egypt has invested a lot in her people and these people should repay Egypt.

Capital

As stated before, the agricultural sector is in need of more capital. The short and intermediate-run loans are especially limited. Furthermore, the way in which the loans are allocated and used is still behind the efficiency criterion, i.e., where the value of marginal productivity is equal to the price.

Credit is the most critical source for financing the agricultural sector in Egypt. But, before examining the current policies concerning the capital use, the word capital needs to be clarified. The small farmers usually own some farm animals to help them in agricultural processes. The middle owners may own, in addition, some farm machinery. An interested reader can find the animal and machinery owned in all holding sizes in the fourth agricultural survey in Egypt. Because of the difficulty in calculating an equivalence to all sources of capital, this study will concentrate on the investment in agriculture in relation to the national income originating in the agricultural sector, and on the short and intermediate-run loans. Later on in this dissertation, the short and intermediate-run loans will be used as an approximation for the capital available for the production of jth crop.

In comparison with all other economic activities, Tables 4.7 and 4.8 show the allocations of the gross fixed investment, as well as the national income originating in the agricultural and nonagricultural sectors in Egypt. The figures show that the agricultural sector is a major source of the Egyptian national income. But, most surprising is that the share of the agricultural sector in the gross fixed investment is smaller than the industrial sector. Meanwhile, the agricultural sector originates much more income than the industrial sector does.

These results must be seriously considered by the Egyptian government in addition to considering the expansion of industrial and housing land uses. From this study's point of view, the Egyptian society should concentrate on the major goal which is the food production. This is because of: (1) Long-run comparative advantages existing in the agricultural industry, and (2) Industrial products are available in larger supply in the international market. If (1) and (2) are correct, then the flow of investment and land use policies should be changed in the direction of developing the agricultural sector. This

Table 4.7. Gross fixed investment according to the economic activity[a]

Sectors	Year 1972	1973	1974	1975	1976	1977
Agriculture						
Investment in million pounds	55.10	57.60	54.20	94.60	98.40	138.50
Index number	100.00	104.54	98.37	171.69	178.58	251.36
Percentage of gross investment	13.61	12.47	8.47	7.70	7.11	7.83
Industry						
Investment in million pounds	152.90	154.30	189.90	268.70	352.10	512.40
Index number	100.00	100.92	124.20	175.74	230.28	335.12
Percentage of gross investment	37.75	33.40	29.66	21.88	25.42	28.96
Total good						
Investment in million pounds	239.30	247.20	328.80	561.10	771.70	1,005.00
Index number	100.00	103.30	137.40	234.48	322.48	419.98
Percentage of gross investment	59.09	53.51	51.36	45.70	55.72	56.80
Total service sectors						
Investment in million pounds	165.70	214.80	311.40	666.80	613.20	764.40
Index number	100.00	129.63	187.93	402.41	370.07	461.32
Percentage of gross investment	40.91	46.49	48.64	54.30	44.28	43.20

[a]Source: Computed upon data from (CAPMS) (6).

Table 4.7 (continued)

Sectors	Year					
	1972	1973	1974	1975	1976	1977
<u>Grand total</u>						
Investment in million pounds	405.00	462.00	640.20	1227.90	1384.90	1769.40
Index number	100.00	104.07	158.07	303.19	341.95	436.89

Table 4.8. National income[a] per economic activity[b]

Sectors	1972	1973	1974	1975	1976	1977
	Year					
Agriculture						
National income in million pounds	933.60	1062.50	1280.00	1468.50	1744.00	1787.00
Index number	100.00	113.81	137.10	157.29	186.80	191.41
Percentage of gross national income	31.57	33.03	31.14	30.73	30.14	27.56
Industry						
National income in million pounds	589.30	635.00	732.50	849.50	986.00	1113.00
Index number	100.00	107.76	124.30	144.15	167.32	188.87
Percentage of gross national income	19.93	19.73	17.82	17.78	17.04	17.17
Total good						
National income in million pounds	1689.90	1849.80	2306.40	2753.80	3379.00	3737.00
Index number	100.00	109.46	136.48	162.96	199.95	221.08
Percentage of gross national income	57.15	57.50	56.10	57.63	58.39	57.63
Total service						
National income in million pounds	1267.10	1367.20	1804.60	2025.00	2408.00	2747.00
Index number	100.00	107.90	142.42	159.81	190.04	216.79
Percentage of gross national income	42.85	42.50	43.90	42.38	41.61	42.37

[a]Source: Computed upon data from (CAPMS) (6).

[b]Evaluated at factor costs.

Table 4.8 (continued)

Sectors	Year 1972	1973	1974	1975	1976	1977
Grand total						
National income in million pounds	2957.00	3217.00	4111.00	4778.80	5787.00	6483.00
Index number	100.00	108.79	139.03	161.61	195.71	219.24

normative judgement should be recognized if the objective of the Egyptian society is producing more food.

Not only is balanced growth in all sectors necessary in Egypt, but also a much more flexible capital supply is required. Table 4.9 shows that the short-run loans, i.e., the loans required for financing the production and marketing processes for the major crops are increasing at a rate of 3.44 percent annually, while the intermediate loans, i.e., the loans required for mechanization, animal production, etc., are decreasing at a rate of -6.36 percent annually. As a result, the total loans and the total loans per feddan are increasing at a rate of 3.24 percent and 3.70 percent, respectively.

So far, this study has examined some major issues concerning the structure of the agricultural sector in Egypt. The main conclusions are:

(1) The vertical and horizontal land programs are vital to Egypt. This is because of the high demands and high intensive use levels.

(2) The problems of excess labor and the quality of the farm laborers and managers should be seriously considered.

(3) The cooperative policies, as well as the supply side subsidies should be radically adopted and controlled in accordance with the farmers' needs and the current agricultural rotation.

(4) The flow of the investment and the capital to the agricultural sector should be increased and directed, and finally

Table 4.9. ALS[a] best fit of the time equations of short, intermediate, and total loans available for the Egyptian agricultural sector[b]

Explanatory variables	Short-run loans in million Egyptian pounds	Intermediate-run loans in million Egyptian pounds	Total loans in million Egyptian pounds	Total loans in Egyptian pounds per feddan
Intercept	24.09	0.77	24.79	4.37
SE[c]	(7.30)	(0.74)	(6.97)	(1.25)
$\dot{\sim}$ probability[d]	(0.007)	(0.32)	(0.005)	(0.005)
X_i	17.42	0.74	18.22	2.87
SE	(3.83)	(0.39)	(3.65)	(0.66)
$\dot{\sim}$ probability	(0.001)	(0.08)	(0.0004)	(0.001)
X_i^2	-1.89	-0.10	-2.004	-0.31
SE	(0.55)	(0.06)	(0.52)	(0.09)
$\dot{\sim}$ probability	(0.005)	(0.09)	(0.003)	(0.007)
X_i^3	0.07	0.004	0.07	0.01
SE	(0.02)	(0.002)	(0.02)	(0.004)
$\dot{\sim}$ probability	(0.01)	(0.15)	(0.007)	(0.02)
$\bar{R}^2$[e]	0.82	0.49	0.83	0.85
Estimation period	1961-1975	1961-75	1961-1975	1961-1975
Rate of growth	3.44	-6.36	3.24	3.70

[a]ALS stands for Autoregressive Least-Squares.

[b]Source: Computed upon data from Ministry of Agriculture (32).

[c]SE is the standard error of the coefficient.

[d]$\dot{\sim}$ stands for word "approximate."

[e]$\bar{R}^2$ is the adjusted R^2.

(5) The government of Egypt should reconsider the problem of balanced growth in all sectors. The figures available to the researchers, so far, suggest that the agricultural sector should grow at the expense of all other sectors, but not vice versa.

The conclusions (1) - (5) could be considered as minimum requirements for any long-run self-sufficiency policy. These conclusions are clear for the time being more than they ever have been. In order to configurate the interrelationships within the agricultural sector, this study will analyze the crop rotations, the price structures, and the cost structures.

Crop Rotations

In this part of this chapter, this study will analyze the current agricultural rotation. The main concern, however, will be for the major agricultural crops.

Wheat

Wheat is one of the major grain crops in Egypt. Furthermore, the wheat supply in Egypt is far behind the wheat demand. In comparison with 26 other nations, Egypt ranks 14th (Table 4.10). The results of Table 4.10 suggest that Egypt could be self-sufficient in wheat production under the following possible ways:

(1) Egypt could increase the productivity per feddan by following this study's proposed self-sufficiency policy, i.e., the increase in the productivity is possible through the vertical

Table 4.10. Rank of Egypt among the major wheat producing countries according to the productivity per feddan, 1975-1977[a]

Country	Average of 1975-1977		
	Productivity in ardeb[b] per feddan	Rank in productivity	Area in 1000 feddan
Netherlands	14.57	1	289
Denmark	14.02	2	273
Sweden	12.56	3	850
Germany, West	12.23	4	3,800
United Kingdom	12.19	5	2,649
Belgium	11.46	6	472
France	11.09	7	9,738
Germany, East	11.00	8	1,730
Czechoslovakia	10.82	9	2,925
Austria	10.76	10	670
Hungary	10.40	11	3,084
Bulgaria	10.38	12	1,914
Mexico	10.01	13	1,904
Egypt	9.48	14	1,332
Yugoslavia	9.06	15	3,922
Poland	8.27	16	4,370
Finland	7.59	17	449
Romania	7.25	18	5,557
Italy	7.16	19	7,834
Greece	6.33	20	2,205
Albania	5.76	21	420
United States	5.74	22	66,257
Canada	5.45	23	24,480
Turkey	4.83	24	22,147
Spain	4.41	25	6,438
Argentina	4.37	26	12,400

[a]Source: Ministry of Agriculture (32).

[b]Ardeb = 150 kilograms.

land policy programs. This point will become clear later in this chapter, and

(2) Since Egypt could increase the productive efficiency for the current supply of farmland, then, through changing the current agricultural rotation, Egypt could produce more wheat. This point will also be clear after studying the other crops in the agricultural rotation later on in this chapter.

The major concern in this part of this chapter is to examine the crop structure. Therefore, this study will analyze the major variables in each crop in this part. Table 4.11 shows the average of the major variables through the study period, as well as the rates of growth in these variables. The results of Table 4.11 confirms the results of Table 4.10. This is because of the fact that the area is decreasing at an annual rate of -0.59 percent, meanwhile the productivity, the production, and the requirement per capita are increasing at a rate of 1.92 percent, 3.45 percent and 2.51 percent per annum, respectively. These results suggest that besides the land improvement programs, the Eqyptian government should set the agricultural rotation in accordance with the comparative advantages and basic needs of the society as this study will show.

Beans

Beans are the next important winter crop in this study. The seeds of beans could be consumed in different ways. For all purposes and among most of the income classes, beans are a major part of the diet.

Table 4.11. Time rates of growth for the study's major crops for various periods[a]

Crop / Variable	Wheat: Average of the study period	Wheat: Percentage rate of growth	Beans: Average of the study period	Beans: Percentage rate of growth
Area in 1000 feddan	1334.42	-0.59	304.00	-3.22
Area's index number	90.53	0.09	83.33	-3.20
Yield[b]	8.09	1.92	0.92	1.41
Yield's index number	124.05	1.91	119.40	1.41
Production[c]	10806.74	3.45	284.47	-1.79
Production's index number	112.37	3.43	98.47	NS[d]
Per capita production[e]	50.10	1.00	8.36	-4.16
Imports[f]	16834.40	6.95	-	-
Exports[g]	-	-	-	-
Total requirements[h]	27829.20	5.43	289.31	NS
Per capita requirements[i]	121.83	2.51	8.80	NS

[a]Source: Computed from ALS estimate and Equation (3.114). For the time period, see Table A.5 in the Appendix.

[b]Yield is in ardeb per feddan. This is for wheat and corn. As for rice, beans, and sugarcane, the yield is in ton per feddan. Finally, for cotton, the yield is in kentar per feddan.

[c]Production is in 1000 ardeb for wheat and corn, and in 1000 tons for beans, rice, and sugarcane. As for cotton, the production is in 1000 kentar.

[d]NS = no significant coefficients are obtained.

[e]Per capita production is in kilograms per individual for all crops.

[f]Imports is in 1000 ardeb for wheat and corn, and 1000 tons for beans.

[g]Exports is in 1000 tons for rice.

[h]Total requirements, the units are same as those for production.

[i]Per capita requirements are in kilograms per individual.

Table 4.11 (continued)

Crop / Variable	Corn: Average of the study period	Corn: Percentage rate of growth	Rice: Average of the study period	Rice: Percentage rate of growth
Area in 1000 feddan	1641.67	2.88	986.37	2.02
Area's index number	95.13	2.85	138.11	2.03
Yield	10.77	1.26	2.20	0.091
Yield's index number	143.00	1.26	98.26	NS
Production	17682.47	2.82	2170.79	2.11
Production's index number	136.00	2.82	135.53	2.08
Per capita production	69.02	NS	46.12	0.07
Imports	1901.27	14.64	-	-
Exports	-	-	361.40	-21.83
Total requirements	19582.20	4.11	1206.47	4.11
Per capita requirements	76.07	1.56	35.32	1.83
	Sugarcane		Cotton	
Area in 1000 feddan	172.63	4.63	1588.79	-2.02
Area's index number	154.11	4.62	90.26	-2.00
Yield	37.40	-0.80	5.74	1.36
Yield index number	96.58	-0.78	110.58	1.22
Production	6387.05	3.79	9141.58	-0.26
Production index number	147.58	3.81	100.05	-0.26
Per capita production	194.26	1.51	-	-
Imports	-	-	-	-
Exports	-	-	-	-
Total requirements	6454.53	3.89	-	-
Per capita requirements	-	1.61	-	-

Table 4.11 (continued)

Crop / Variable	Vegetables: Winter – Average of the study period	Vegetables: Winter – Rate of growth	Vegetables: Summer – Average of the study period	Vegetables: Summer – Rate of growth
Area in 1000 feddan	169.21	3.14	189.37	3.26
Area's index number	268.63	3.14	350.63	3.26
Yield	-	-	-	-
Yield index number	-	-	-	-
Production	-	-	-	-
Production index number	-	-	-	-
Per capita production	-	-	-	-
Imports	-	-	-	-
Exports	-	-	-	-
Total requirements	-	-	-	-
Per capita requirements	-	-	-	-

	Berseem: Average of the study period	Berseem: Rate of growth
Area in 1000 feddan	2662.00	0.97
Area's index number	121.00	0.97
Yield	-	-
Yield index number	-	-
Production	-	-
Production index number	-	-
Per capita production	-	-
Imports	-	-
Exports	-	-
Total requirements	-	-
Per capita requirements	-	-

Table 4.12 shows the same results as Table 4.10, i.e., among 14 major bean producing countries, Egypt is the third in terms of the productive efficiency. Furthermore, Table 4.11 shows that the area and per capita production are decreasing at an annual rate of -3.22 percent and -4.16 percent, respectively, while the yield is increasing at a rate of 1.41 percent. These conclusions may explain why Egypt has been recently importing beans.

Table 4.12. Rank of Egypt among the major bean producing countries according to the productivity per feddan, 1975-1977[a]

Country	Average of 1975-1977		
	Productivity[b] in ardeb per feddan	Rank in productivity	Area in 1000 feddan
United Kingdom	7.14	1	94
Germany, West	6.86	2	30
Egypt	6.14	3	266
France	5.43	4	50
Turkey	4.34	5	72
Italy	3.29	6	531
Ethiopia	3.25	7	643
China	3.05	8	9,314
Spain	2.65	9	252
Morocco	2.41	10	477
Tunisia	2.40	11	150
Mexico	2.19	12	120
Portugal	1.79	13	102
Brazil	1.25	14	455

[a]Source: Ministry of Agriculture (32).

[b]Ardeb = 155 kilogram.

Wheat and beans are the two major winter crops in this study. But, for a policymaker to infer a positive judgement, the other major crops (in terms of the acreage) should be studied. For this study's purposes, the other major crops will be called "shifters." The word shifters stands for crops not included in this study that compete with this study's crops for the area available. The importance of studying these crops is due to the fact that, as stated many times before, the farmland available to the Egyptian society is limited. The winter shifters in this study are the berseem and the winter vegetables, while the summer shifters are the cotton and summer vegetables. In studying the price structures, other shifters will be used.

Berseem

Berseem, or alfalfa, is a major animal feed crop in Egypt. No other uses for berseem are significant. For this study's proposed self-sufficiency policy, a great impact falls on berseem. This is because of the major trade-off so involved. In other words, given the current rotation, this study directs a critical question to the agricultural policymakers in Egypt. Is it of great significance to produce wheat, beans, or berseem, given the area cultivated? This serious trade-off between feeding the Egyptian animals and the Egyptian people will be considered in detail in this study.

Table 4.11 shows that, on the average, the area of wheat and beans is about 62 percent of the area cultivated with berseem. Furthermore, the area cultivated with wheat and beans is decreasing at a rate of

-0.59 percent and -3.22 percent per annum. Meanwhile, the area cultivated with berseem is increasing at a rate of 0.97 percent. These results confirm Chapter II of this dissertation, and completely contradict this study's proposed policy. It seems to the researcher that the animal scientists in Egypt should find other varieties of animals. This is because of the clear fact to the researcher that no other place in the world uses approximately 47 percent of its area for feeding animals. This study's positive judgement about this point will be stated by the end of this study.

Winter Vegetables

Table 4.11 shows that the area cultivated by all winter vegetables is increasing at a rate of 3.14 percent. The results of Table 4.11 also suggest that the area of winter vegetables is not of great competition to the area cultivated with wheat and beans. Further, the increase in the area of winter vegetables is much more desirable than the increase of the area of berseem.

So far, this study has analyzed the major winter crops. In the next part, this study will analyze the major summer crops.

Corn

Corn, or maize, is another major grain crop in Egypt. The Egyptian aggregate supply of corn is lagging behind the aggregate demand for all uses. In comparison with 17 other corn producing nations, Egypt ranks 12th (Table 4.13). The results of Table 4.13 suggest the same conclusions stated before about wheat production. Furthermore, this study

Table 4.13. Rank of Egypt among the major corn producing countries according to productivity per feddan, 1975-1977[a]

Country	Average of 1975-1977		
	Productivity[b] in ardeb	Rank in productivity	Area in 1000 feddan
Austria	19.66	1	373
Italy	18.49	2	2,197
United States	16.64	3	67,038
Canada	16.56	4	1,645
Hungary	13.63	5	3,221
France	13.50	6	3,952
Czechoslovakia	12.46	7	376
Bulgaria	12.29	8	1,629
Greece	12.13	9	303
Yugoslavia	12.06	10	5,599
Spain	11.43	11	1,088
Egypt	11.13	12	1,829
Romania	9.23	13	7,971
USSR	9.10	14	7,391
China	8.95	15	26,290
Argentina	7.90	16	6,647
Turkey	6.13	17	1,441

[a]Source: Ministry of Agriculture (32).

[b]Ardeb = 140 kilogram.

believes that Egypt could have a comparative advantage in corn production under this study's proposed self-sufficiency policy as this study will show. Unlike the case for the wheat, the Egyptian corn area is increasing at an annual rate of 2.88 percent during the study period. The results of Table 4.11 also show that even the production is growing at a rate of 2.82 percent per annum. The imports, total requirements, and the per capita requirements are growing at an annual rate of 14.64 percent, 4.11 percent, and 1.56 percent, respectively. The high importation rate and low area, productivity and production growth rates imply again the importance of this study's proposed self-sufficiency policy to Egypt. Meanwhile, these results suggest serious questions to the agricultural rotation policymakers in Egypt.

Rice

Rice is one of the major diet components for all income classes. Table 4.14 shows that Egypt ranks third among 25 rice producing countries, in terms of the productive efficiency. But unlike the other crops studied so far, Egypt is still a rice exporting country, as shown in Table 4.11. Egypt, on the average, produces 46.12 kilograms of rice per person, while each person consumes only 35.32 kilograms. Further (Table 4.11), the exports of rice decrease at a per annum rate of -21.83 percent. At the same time, the per capita production, the total requirements, and the per capita requirements grow at an annual rate of 0.07 percent, 4.11 percent, and 1.83 percent, respectively. These results suggest that the rice substitutes other goods in the diet. This tends to reduce the importations at an annual rate of -21.83 percent.. Along with the necessary changes in the agricultural rotation, this study's call for diet changes may help Egypt to keep its long-run comparative advantage in rice production and exportation. Finally, achieving a high degree of self-sufficiency in rice production will help

Table 4.14. Rank of Egypt among the major rice producing countries according to the productivity per feddan, 1975-1977[a]

Country	Average of 1975-1977 Productivity in tons per feddan	Rank in productivity	Area in 1000 feddan
Japan	2.501	1	6,585
South Korea	2.293	2	1,967
Egypt	2.207	3	1,057
United States	2.141	4	2,423
Italy	2.053	5	431
Peru	1.864	6	301
Colombia	1.751	7	856
USSR	1.663	8	1,246
China	1.481	9	87,628
Iran	1.414	10	6,096
Venezuela	1.347	11	282
Ecuador	1.171	12	302
Indonesia	1.142	13	20,045
Mexico	1.037	14	467
Guyana	0.997	15	280
Pakistan	0.987	16	4,184
Sri Lanka	0.960	17	1,429
Nepal	0.949	18	3,001
Afghanistan	0.896	19	500
North Vietnam	0.894	20	12,701
Cuba	0.894	21	480
Bangladesh	0.781	22	23,932
Philippines	0.770	23	8,550
Thailand	0.763	24	19,199
Burma	0.761	25	12,256

[a]Source: Ministry of Agriculture (32).

Egypt to avoid the shortages in the world market supplies of wheat and corn. All of these facts direct the Egyptian government toward the main solutions to the food crisis.

Sugarcane

Sugarcane and its final and by-products have a lot of uses known to every Egyptian. Besides sugar, the sugarcane juice is a widely preferred summer drink. In terms of the cultivated area, sugarcane is not a major crop in Egypt (Table 4.11). But in terms of importance, sugarcane is one of the most important crops in Egypt.

In terms of productive efficiency, Egypt ranks second among 28 major producing countries (Table 4.15). On the contrary, Table 4.11 shows that the cultivated area and production are increasing at an annual rate of 4.63 percent and 3.79 percent, respectively, while productivity is decreasing at a rate of -0.80 percent per annum during the study period. This implies that the Ministry of Agriculture in Egypt has to consider the sugarcane production policy in order to keep the long-run comparative advantage that Egypt has had. These results could be inferred from comparing Tables 4.11 and 4.15. The results of Table 4.11 also imply per capita production, in terms of sugarcane total, is less behind the per capita requirements. Worth noting is that Egypt was an exporting country for sugarcane. This study has had some difficulties in analyzing per capita production, per capita requirements, and foreign trade for sugarcane. But, the results in Table 4.11 still confirm the reality. Interested future research in this area may calculate the rates of growth for these variables when a much clearer data set is available.

Table 4.15. Rank of Egypt among the major sugarcane producing countries according to productivity per feddan, 1975-1977[a]

Country	Average of 1975-1977: Productivity in tons per feddan	Rank in productivity	Area in 1000 feddan
Peru	66.296	1	134
Egypt	34.893	2	237
United States	34.755	3	731
Australia	34.460	4	666
South Africa	33.766	5	551
Colombia	33.690	6	621
Guyana	32.934	7	113
Indonesia	32.584	8	438
Venezuela	29.421	9	192
China	28,765	10	1,564
Ecuador	28.337	11	236
Mexico	28.091	12	1,154
Mauritius	27.484	13	214
Puerto Rico	27.274	14	115
Dominican	26.351	15	397
Jamaica	24.031	16	145
India	21.613	17	6,766
Thailand	21.238	18	906
Brazil	21.038	19	5,025
Argentina	20.562	20	776
Fiji	20.442	21	111
Philippines	18.924	22	1,229
Bangladesh	18.739	23	343
Cuba	18.459	24	2,963

[a]Source: Ministry of Agriculture (32).

Table 4.15 (continued)

Country	Average of 1975-1977		
	Productivity in tons per feddan	Rank in productivity	Area in 1000 feddan
Haiti	15.648	25	178
Pakistan	14.750	26	1,714
Burma	14.330	27	105
Honduras	12.429	28	123

Cotton

Egyptian cotton was and is still the most famous kind of cotton in the world. Egyptian cotton, along its history, was a major summer crop in Egypt. The Egyptian agricultural rotation and foreign trade have centered around cotton for a long time. Cotton, so far, is an agricultural export product. Further, the cooking oil of cottonseed is still the most preferable among all other alternatives for Egyptians.

Given the importance of cotton to Egypt, the Egyptian society faces other difficult trade-offs, i.e., as the case of berseem. These trade-offs could be summarized as follows:

(1) Given the limited, extensively used farmland, the Egyptian society could sacrifice cotton for more corn and rice.

(2) The Egyptian policymakers face another difficult trade-off between the future gains and losses from changing the current agricultural rotation.

(3) As stated before, according to Askari and Cummings (2), the Eqyptian farmers are price nonresponsive in regards to cotton. This may imply that the trade-off is extended up to the farm level.

In order to analyze these trade-offs, this study will consider cotton as a major summer shifter. In terms of the productive efficiency, Egypt ranks 8th among 40 major producing countries. In the period 1975-1977, the average productivity per feddan was 6.03 kentar,[1] while the

[1]Metric kentar = 157.50 kilogram.

average area was 1,349 thousand feddan during this period. The productivity per feddan is lower than the productivity per feddan in USSR, Greece, Syria, Turkey, and higher than the productivity per feddan in Spain, Peru, Iran, United States, China, etc.

Table 4.11 shows the average area during the study period, i.e., 1960-1978, is about 1588.79 thousand feddan. Further, both the area and the production are decreasing at an annual rate of -2.02 percent and -0.26 percent, respectively. These results imply that the trade-offs discussed before are solved in the direction of producing more corn and rice. These results also confirm the results stated before about the corn and rice areas (Table 4.11).

Summer Vegetables

As in the case of winter vegetables, the cultivated area is increasing at an annual rate of 3.26 percent. The increase in the area cultivated with summer vegetables does not contradict the objectives of this study's policies.

So far, the major conclusions are:

(1) Egypt does have a comparative advantage in the production of beans, rice, and sugarcane. Further, under this study's proposed policies, Egypt can have a comparative advantage in wheat and corn production (Tables 4.10 - 5.15 and Table A.4 in the Appendix).

(2) The crop system in Egypt should radically be changed in the direction of producing more wheat, beans, corn, rice, and sugarcane at the expense of berseem and cotton production.

(3) As stated before, the Egyptian government should direct the flow of investment in society toward farmland, i.e., the vertical and horizontal land programs are now more vital to Egypt than they ever have been.

In the next part of this chapter, this study will analyze the price and cost structures for the major crops.

Price Structures

The price structures determine the allocation of the resources in a society. The efficiency of this allocation, however, depends upon the efficiency and sufficiency of the market information. As stated before, Egypt suffers both the efficiency and sufficiency of the market information. It should be clear that the price stability is a major requirement for any self-sufficiency policy in Egypt. It is vital that the Egyptian policymakers recognize this issue. Even the desired crop system should be based upon the minimum relative price variability.

Table 4.16 shows the nominal and the relative price rate of growth for the major crops. The nominal prices for the crops are increasing at a reasonable rate. The annual rates of growth in the nominal prices range from 4.77 percent for wheat to 19.20 percent for sugarcane. The real prices for wheat and rice decrease at an annual rate of -0.47 percent and -2.74 percent, respectively. On the contrary, the real price of beans, corn, and sugarcane are increasing at a rate of 4.02 percent, 2.53 percent, and 7.38 percent per annum, respectively. The relative crop prices, on the other hand, show either nonsignificant results or

Table 4.16. Time rates of growth of the price of major crops for various periods[a]

Wheat		Beans		Corn	
Variables	Rate of growth (percentage)	Variables	Rate of growth (percentage)	Variables	Rate of growth (percentage)
Nominal price of final output P/T	4.77	Nominal price of final output P/T	9.87	Nominal price of final output P/T	7.68
Real price of final output P/T[b]	-0.47	Real price of final output P/T	4.02	Real price of final output P/T	2.53
Price of wheat/ berseem P/T	NS[c]	Price of beans/ wheat P/T	5.40	Price of corn/ cotton P/T	1.10
Price of wheat/ barley P/T	NS	Price of beans/ berseem P/T	NS	Price of corn/ rice P/T	NS
Price of wheat/ beans P/T	-4.40	Price of beans/ barley P/T	3.92	Price of corn/ sugarcane P/T	-4.39
Price of wheat/ winter tomatoes P/T	-15.10	Price of beans/ winter tomatoes P/T	NS	Price of corn/ summer potatoes P/T	-5.20

[a]Source: Computed from ALS estimates and Equation (3.114). For the time periods, see Table A.6 in the Appendix.

[b]P/T stands for Egyptian pound per ton.

[c]NS stands for the case where the coefficients of the first three polynomial degrees are non-significant.

Table 4.16 (continued)

Rice		Sugarcane	
Variables	Rate of growth (percentage)	Variables	Rate of growth (percentage)
Nominal price of final output P/T	7.59	Nominal price of final output P/T	19.20
Real price of final output P/T	-2.74	Real price of final output P/T	7.38
Price of rice/ corn P/T	NS	Price of sugarcane/ corn P/T	4.50
Price of rice/ cotton P/T	NS	Price of sugarcane/ cotton P/T	NS
Price of rice/ sugarcane P/T	-4.50	Price of sugarcane/ rice P/T	NS
Price of rice/ summer potatoes P/T	-5.79	Price of sugarcane/ summer potatoes P/T	NS

negative interrelationships. This holds true except for beans-wheat, beans-barley, corn-cotton, and sugarcane-corn prices. These results demonstrate that the prices of the crops in the same rotation do not adjust simultaneously. This may lead to many problems such as: misallocation of the resources, rural poverty, net loss to some producers, and net gains to some others. If this case persists until the year 2000, it will be very difficult for Egypt to maintain a reasonable degree of self-sufficiency. Further implications will be clear after studying the cost structures.

Cost Structures

The importance of studying the variable costs of the major crops is to answer a critical question. This question is: How much does the price increase relative to the variable cost? In comparison between Tables 4.16 and 4.17, one can infer that except for the nominal and real variable costs for sugarcane, the nominal and real variable costs for all crops increase at higher rates than the nominal and real prices do. Economically speaking, these results imply that except for the current, mandatory crop rotation, the Egyptian farmers will leave the farming industry. These results also confirm the reality for many Egyptians. These results also clear the issue of how Egypt achieves self-sufficiency.

To summarize, this chapter sheds some light on future implemented policies. For Egypt to be self-sufficient, the following adjustments are needed:

Table 4.17. Time rates of growth of the variable costs of major crops for various time periods[a]

Costs / Crop	Nominal (percentage)	Real (percentage)
Wheat	10.57	2.93
Beans	12.16	4.80
Corn	10.80	3.21
Rice	7.69	1.96
Sugarcane	12.04	5.49

[a]Source: Computed from ALS estimates and Equation (3.114). For the time periods, see Table A.7 in the Appendix.

(1) The vertical and horizontal land programs are vital to Egypt.

(2) The current crop system should be adjusted in the direction of the comparative advantages that Egypt has in food production. Since the Egyptian productivity per feddan is higher than many major producing and exporting countries, it does not make sense to import wheat, corn, beans, and sugarcane. But, what makes sense to this researcher is to reduce the area cultivated with berseem and cotton.

(3) The flow of investment among goods and service sectors should be adjusted in accordance to the amount of national income originating from that sector. Egypt has always been an agricultural country and she has long-run comparative advantages in the farming industry.

(4) The rates of growth in the requirements per individual should match the rate of growth in the production per individual.

(5) The government of Egypt should seriously reconsider the following:

(a) The efficiency of the cooperative system and the input subsidizations,

(b) The price interrelationships and the income distribution,

(c) The classical issue: subsidy for what and whom, and finally

(d) The price-variable cost ratios for all the crops in the agricultural rotation, i.e., the rates of growth in all the prices and variable costs.

In the next chapter, the importance of these adjustments to Egypt will become clear.

CHAPTER V. POTENTIAL SELF-SUFFICIENCY OF THE MAIN AGRICULTURAL PRODUCTS

In this chapter, this study will analyze both the supply and demand sides for the main agricultural products. The farmers' response, as well as the projected consumers' demand for the main crops, will also be analyzed. As stated before, the estimation will be under this study's proposed policies.

Basically, the main concern in this chapter is the year 2000. In Chapter IV, this study was seeking a positive judgement based upon normative statements about the Egyptian economy. The basic structures, as well as the basic problems are now clear. In this chapter, this study will present the solutions.

To forecast the year 2000, several questions need to be answered. These questions are:

(1) How accurate are the forecasted values?

(2) Are the variances of the actual and forecasted values the same?

(3) How accurately does the model forecast?

To answer these questions, this study will state some assumptions. Further, many different statistical techniques will be used. For instance, one can assume the actual and forecasted values have the same variance since they have the same probability distribution. If this is the case, one can combine the actual and forecasted values in one set of data. This assumption is very reasonable. This is simply because the forecasted values are an initial function of the past values. On the other hand, one can get the functional relationship from the actual data and then forecast the endogenous variables from a set of the exogenous variables. In this case, there is no need for one to assume the homogeneity of the variance. This study will try both ways. This study will also use different forecasting techniques and will calculate the value of U^2 in Equation (3.128) to insure the accuracy of the forecast.

Before studying the functions of the model, this study will analyze the agricultural rotation and the degree of self-sufficiency given the rotation. Table 5.1 shows the production, consumption, and degree of self-sufficiency for the major products in 1977 as compared to 1970. The table is self-explanatory. The reduction of the degree of self-sufficiency over time for wheat, corn, rice, beans, and sugarcane reflect the importance and significance of this study's policies and conclusions. As stated before, the private and public sectors have to consider the trade-offs the society faces. The reduction in the degree of self-sufficiency and the increase in the rate of growth in per capita requirements are serious problems. If one takes into consideration the population growth rate and the worldwide inflation rate, these problems will turn out to be danger signs of dissatisfaction in the Egyptian economy.

Once again, the solutions for the problems stated above are easy. This study has proposed some of these solutions in Chapter IV of this dissertation. These conclusions presented in Chapter IV confirm the reality and the published figures about Egypt. The proposed crop structure for 1979 shows the wheat, beans, rice, and sugarcane cultivated

Table 5.1. Production, consumption, and percentage of self-sufficiency of the major agricultural products in Egypt[a]

Crop	1970 Production in 1000 tons	1970 Consumption in 1000 tons	1970 Percentage of self-sufficiency	1977 Production in 1000 tons	1977 Consumption in 1000 tons	1977 Percentage of self-sufficiency
Wheat	1,516	3,809	39.80	1,697	5,100	33.90
Beans	278	278	100.00	270	330	81.80
Corn	2,389	2,465	96.90	2,724	3,325	81.90
Rice	1,738	1,211	143.50	1,515	1,380	109.80
Sugarcane	591	500	118.20	625	850	73.50
Vegetables	3,582	3,537	101.20	6,684	6,484	103.00
Fruits	1,407	1,346	104.50	1,902	1,732	109.80
Milk	1,613	1,677	96.10	1,783	2,285	78.00
Meat	287	299	95.90	320	385	83.10
Chicken meat	98	98	100.00	121	130	93.00
Fish	91	93	97.80	140	170	82.40

[a]Source: Ministry of Agriculture (32).

areas have increased while the corn cultivated area has decreased. At the same time, the cotton area has increased as compared to year 1978. The area cultivated by berseem has also increased as compared to the base year 1978. Worth noting is that the actual published figures of the areas in 1979 are not available to the researcher. The results of 1979s proposed crop system partially contradict this study's main conclusions so far. But, the increase in the imports and the reduction in the degree of self-sufficiency substantiate this study's main conclusions.

In the next part of this chapter, this study will concentrate on the statistical results of fitting the reduced forms of this study's model.

Econometric Results

This part will show the statistical results of the farmers' response, the supply and requirements for wheat, beans, corn, rice, and sugarcane.

Farmers' Response

To study the farmers' response for the major crops, one has to consider the relative profitabilities of all the crops. Most of the work done so far concentrates on the relative prices. But as stated before, it seems reasonable to study the relative profitabilities. This is because of the limited supply of land resources. The farmers' preference among all the available alternatives will be mainly determined in accordance to the net gains. This assumption could be tested in several ways. But, this is not of great importance to this study. This study is concerned with the area's response to the relative profitability of jth and kth crops. To estimate a nxn matrix for the farmers' preferences, this study estimates Equation (3.66) for the major crops and the major competitor crops. The meaning of the word competitor is the crop which competes with any of the study's major crops in terms of area. These competitors in the study are called "shifters." Then, after calculating Equation (3.66), this study divides the profitability of jth crop over the profitability of kth crop in order to obtain the relative profitabilities for all crops (Table 5.2). Then, on the average, a nxn matrix for the ratios of profitability of all crops is obtained (Table 5.3). The values in Table 5.3 are the average of 1971-1979.

This study assumes that every firm in Egypt is a rational, profit maximizing firm. The farmers formulate their decision by weighing all the possible alternatives according to their profitabilities. For instance, the wheat farmer compares the profitability per feddan of wheat to the profitability per feddan of berseem, beans, barley, and winter tomatoes, and then makes his decision. If this is the case, this study assumes that the farmers are sophisticated enough to compare the rows and columns of Table 5.3 before making their cultivation decision. This assumption raises several questions such as:

(1) How about the mandatory crop system?

(2) Is it reasonable to assume that the farmers in Egypt are sophisticated?

Table 5.2. Relative profitability of the major agricultural crops, 1971-1979[a]

	1971	1972	1973	1974	1975	1976	1977	1978	1979
<u>Notation starts with wheat</u>									
Wheat/berseem	0.42	0.25	0.29	0.35	0.36	0.20	0.24	0.31	0.23
Wheat/barley	1.52	1.65	1.36	1.14	1.12	0.86	1.27	1.47	1.72
Wheat/beans	1.27	0.67	1.37	0.85	0.59	0.49	0.96	0.85	0.76
Wheat/winter tomatoes	0.25	0.12	0.14	0.14	0.11	0.07	0.13	0.21	0.17
<u>Notation starts with beans</u>									
Beans/berseem	0.33	0.37	0.21	0.41	0.60	0.40	0.25	0.36	0.31
Beans/wheat	0.79	1.49	0.73	1.17	1.68	2.05	1.05	1.17	1.32
Beans/barley	1.20	2.46	0.99	1.34	1.88	1.76	1.33	1.72	2.27
Beans/winter tomatoes	0.20	0.18	0.11	0.17	0.19	0.15	0.13	0.24	0.22
<u>Notation starts with rice</u>									
Rice/corn	0.75	0.57	0.48	0.56	0.86	1.14	0.75	1.52	2.43
Rice/cotton	0.55	0.29	0.50	0.47	0.99	0.42	0.91	0.72	0.41
Rice/sugarcane	1.00	0.37	0.30	0.17	0.20	0.20	0.46	0.52	0.44
Rice/summer potatoes	0.23	0.10	0.16	0.12	0.12	0.08	0.21	0.25	0.13
<u>Notation starts with corn</u>									
Corn/rice	1.34	1.75	2.07	1.77	1.16	0.88	1.34	0.66	0.41
Corn/cotton	0.74	0.51	1.03	0.84	1.14	0.37	1.21	0.47	0.17

[a] Source: Computed upon data from (9, 32, 51, 52).

Table 5.2 (continued)

	1971	1972	1973	1974	1975	1976	1977	1978	1979
corn (continued)									
Corn/sugarcane	1.35	0.65	0.63	0.30	0.23	0.18	0.61	0.34	0.18
Corn/summer potatoes	0.31	0.17	0.34	0.21	0.14	0.07	0.28	0.16	0.06
Notation starts with sugarcane									
Sugarcane/rice	1.00	2.71	3.31	5.89	5.12	4.99	2.20	1.93	2.29
Sugarcane/corn	0.74	1.55	1.60	3.32	4.42	5.69	1.64	2.94	5.56
Sugarcane/cotton	0.55	0.80	1.65	2.79	5.05	2.09	1.99	1.39	0.92
Sugarcane/summer potatoes	0.23	0.27	0.54	0.71	0.63	0.40	0.46	0.48	0.31

Table 5.3. The relative profitability matrix[a]

Crop / Crop	Wheat	Berseem	Beans	Barley	Winter tomatoes	Corn	Rice	Cotton	Sugar-cane	Summer potatoes
Wheat	1	0.29	0.87	1.35	0.15	NC[b]	NC	NC	NC	NC
Berseem		1	2.78	4.82	0.51	NC	NC	NC	NC	NC
Beans			1	1.66	0.18	NC	NC	NC	NC	NC
Barley				1	0.11	NC	NC	NC	NC	NC
Winter tomatoes					1	NC	NC	NC	NC	NC
Corn	NC	NC	NC	NC	NC	1	1.26	0.72	0.50	0.19
Rice	NC	NC	NC	NC	NC	0.80	1	0.58	0.41	0.16
Cotton			NC	NC	NC			1	0.52	0.28
Sugar-cane									1	0.45
Summer potatoes	NC	Nonsymmetric[c]							2.22	1

[a]Source: Computed from Table 5.2.

[b]NC stands for not comparable. This is because both crops are in different rotation. Further, all values are average of 1971-1979.

[c]$a_{ij} \neq a_{ji}$.

(3) What are the effects of the cooperative system and the subsidy provided on weighing the alternatives?

(4) How about the farmers who produce for their own consumption?

To answer these questions, one has to consider the results of Chapter IV, as well as Tables 5.1 - 5.3. The Egyptian agricultural economy is a small farm sized type of economy. The farmers, on the other hand, have had a long-run experience in the farming industry. Furthermore, Equation (3.66) is calculated by taking into account the supervision of the cooperatives and the subsidizations. Moreover, as far as the reseacher knows, some farmers violate the imposed crop rotation. Therefore, it seems reasonable to say that Tables 5.2 - 5.3 are the bases for any sophisticated crop system and for any self-sufficiency policy.

Given the resources and given that a reasonable degree of self-sufficiency is desirous, it seems unfair to ask farmers to produce wheat, beans, barley, corn, rice, and sugarcane (Table 5.3). If this case persists, Egypt should forget about its long-run comparative advantage in the farming industry and specialize in producing berseem, vegetables, and fruits. If, on the contrary, the Egyptian seriously wants to produce more food, the direction of the resource allocation should be radically changed. These results confirm the policy alternative (c) of our proposed self-sufficiency policy on page 19 of this dissertation. Furthermore, the reallocation of these resources should be based upon the relative crop profitabilities, not the prices. The prices are a poor allocative criteria over time. In other words, Table 5.3 is the best base for allocating the resources in Egypt for self-sufficiency in food production.

Under the assumption that the relative crop profitabilities influence the farmers' response, Equation (3.77) has been estimated for all the study's major crops. The results of maximum R^2 stepwise procedure tends to fit the form:

$$A_t^j = \alpha_0 \pm \sum_j^r \beta_j \, \pi_{t-1}^{j,k,L,m,r} \pm \beta_{j+1} X_t + U_t \qquad (5.1)$$

Where:

A_t^j = the cultivated area of jth crop in period t.

$\pi_{t-1}^{j,k,L,m,r}$ = profitability of jth crop relative to the profitability of the other major competitive crops as k,L,m, and r.

X_t = time to represent the technology.

The stepwise results are shown in Tables 5.4 - 5.8. This study has also tested for autocorrelation for all the equations. The Durbin-Watson (DW) test was not significant for all the equations.

This study has set R^2 or $\bar{R}^2$ as the criterion for selecting the best fit (Equation (3.127)). This criterion is based upon studying the contribution of each variable in explaining the total variation. But, there are many other statistical and economic aspects for one to consider in selecting the best form such as:

(1) The significance of the overall F ratio,

(2) The significance of each coefficient in the equation,

(3) The significance of the autoregressive parameter, and

Table 5.4. Wheat area's response to the relative profitabilities of the other major winter crops, stepwise results, 1971-1978[a]

Explanatory variables	Best one variable model	Best two variable model	Best three variable model	Best four variable model	Best five variable model
Intercept	1271.71	1081.80	1056.60	904.24	507.91
SE[b]	--	--	--	--	--
$P_r > F$[c]	--	--	--	--	--
$\pi_{t-1}^{j,k}$[d]	--	527.03	890.83	1082.90	1614.52
SE	--	(441.69)	(629.99)	(532.02)	(374.84)
$P_r > F$	--	(0.29)	(0.23)	(0.14)	(0.05)
$\pi_{t-1}^{j,L}$[e]	--	--	--	--	245.56
SE	--	--	--	--	(95.16)
$P_r > F$	--	--	--	--	(0.12)
$\pi_{t-1}^{j,m}$[f]	--	--	--	189.44	218.95

[a]Source: Computed from data from Ministry of Agriculture (32).

[b]SE is the standard error of the coefficient.

[c]$P_r > F$ is the probability of the calculated F greater than the tabulated F.

[d]$\pi_{t-1}^{j,k}$ is the relative profitability of jth and kth crops in period t-1. Where j is the wheat and k is berseem.

[e]$\pi_{t-1}^{j,L}$ is the relative profitability of jth and Lth crops in period t-1. Where L is barley.

[f]$\pi_{t-1}^{j,m}$ is the relative profitability of jth and mth crops in period t-1. Where m is beans.

Table 5.4 (continued)

Explanatory variables	Best one variable model	Best two variable model	Best three variable model	Best four variable model	Best five variable model
SE	--	--	--	(111.72)	(66.75)
$P_r > F$	--	--	--	(0.19)	(0.08)
$\pi_{t-1}^{j,r\,g}$	--	--	-617.76	-1366.45	-2513.92
SE	--	--	(738.82)	(752.73)	(627.71)
$P_r > F$	--	--	(0.45)	(0.17)	(0.06)
X_t	11.45	18.23	19.45	27.63	40.61
SE	(12.18)	(13.07)	(13.56)	(12.18)	(8.76)
$P_r > F$	(0.38)	(0.22)	(0.23)	(0.11)	(0.04)
R^2	0.13	0.32	0.42	0.71	0.93

[g] $\pi_{t-1}^{j,r}$ is the relative profitability of jth and rth crops in period t-1. Where r is winter tomatoes.

Table 5.5. Beans area's response to the relative profitabilities of the other major winter crops, stepwise results, 1971-1978[a]

Explanatory variables	Best one variable model	Best two variable model	Best three variable model	Best four variable model	Best five variable model
Intercept	305.71	281.18	303.71	265.74	262.25
SE[b]	--	--	--	--	--
$P_r > F$[c]	--	--	--	--	--
$\pi_{t-1}^{j,k}$[d]	--	--	--	--	-172.50
SE	--	--	--	--	(174.91)
$P_r > F$	--	--	--	--	(0.43)
$\pi_{t-1}^{j,L}$[e]	--	24.48	48.01	62.82	102.94
SE	--	(27.00)	(40.11)	(41.78)	(58.46)
$P_r > F$	--	(0.41)	(0.30)	(0.23)	(0.22)
$\pi_{t-1}^{j,m}$[f]	--	--	-29.94	-52.21	-65.09

[a]Source: Computed upon data from Ministry of Agriculture (32).

[b]SE is the standard error of the coefficient.

[c]$P_r > F$ is the probability of the calculated F greater than the tabulated F.

[d]$\pi_{t-1}^{j,k}$ is the relative profitability of jth and kth crops in period t-1. Where j is beans and k is berseem.

[e]$\pi_{t-1}^{j,L}$ is the relative profitability of jth and Lth crops in period t-1. Where L is wheat.

[f]$\pi_{t-1}^{j,m}$ is the relative profitability of jth and mth crops in period t-1. Where m is barley.

Table 5.5 (continued)

Explanatory variable	Best one variable model	Best two variable model	Best three variable model	Best four variable model	Best five variable model
SE	--	--	(36.61)	(41.58)	(43.77)
$P_r > F$	--	--	(0.46)	(0.30)	(0.28)
$\pi^{j,r}_{t-1}$ [g]	--	--		354.14	618.59
SE	--	--	--	(331.48)	(427.54)
$P_r > F$	--	--	--	(0.36)	(0.29)
X_t	-9.21	-10.65	-11.73	-13.10	-15.10
SE	(4.63)	(4.96)	(5.30)	(5.36)	(5.75)
$P_r > F$	(0.09)	(0.08)	(0.09)	(0.09)	(0.12)
R^2	0.40	0.48	0.56	0.68	0.78

[g] $\pi^{j,r}_{t-1}$ is the relative profitability of jth and rth crops in period t-1. Where r is winter tomatoes.

Table 5.6. Corn area's response to the relative profitabilities of the other major summer crops, stepwise results, 1971-1978[a]

Explanatory variables	Best one variable model	Best two variable model	Best three variable model	Best four variable model	Best five variable model
Intercept	1580.14	1774.07	1607.15	1555.79	1551.23
SE[b]	--	--	--	--	--
$P_r > F$[c]	--	--	--	--	--
$\pi_{t-1}^{j,k}$[d]	--	--	--	26.99	29.38
SE	--	--	--	(34.19)	(75.77)
$P_r > F$	--	--	--	(0.49)	(0.74)
$\pi_{t-1}^{j,L}$[e]	--	187.80	177.50	160.34	161.28
SE	--	(69.61)	(27.44)	(36.12)	(50.66)
$P_r > F$	--	(0.04)	(0.003)	(0.02)	(0.09)
$\pi_{t-1}^{j,m}$[f]	--	-278.91	-167.38	-155.34	-151.42

[a]Source: Computed upon data from Ministry of Agriculture (32).

[b]SE is the standard error of the coefficient.

[c]$P_r > F$ is the probability of the calculated F greater than the tabulated F.

[d]$\pi_{t-1}^{j,k}$ is the relative profitability of jth and kth crops in period t-1. Where j is corn and k is rice.

[e]$\pi_{t-1}^{j,L}$ is the relative profitability of jth and Lth crops in period t-1. Where L is cotton.

[f]$\pi_{t-1}^{j,m}$ is the relative profitability of jth and mth crops in period t-1. Where m is sugarcane.

Table 5.6 (continued)

Explanatory variables	Best one variable model	Best two variable model	Best three variable model	Best four variable model	Best five variable model
SE	--	(58.88)	(31.23)	(36.19)	(112.50)
$P_r > F$	--	(0.005)	(0.006)	(0.02)	(0.31)
$\pi_{t-1}^{j,r\,g}$	--	--	--	--	-16.91
SE	--	--	--	--	(445.93)
$P_r > F$	--	--	--	--	(0.97)
X_t	42.77	--	25.61	30.37	30.81
SE	(11.97)	--	(4.81)	(7.87)	(15.12)
$P_r > F$	(0.01)	--	(0.006)	(0.03)	(0.18)
R^2	0.68	0.85	0.98	0.98	0.98

${}^{g}\pi_{t-1}^{j,r}$ is the relative profitability of jth and rth crops in period t-1. There r is summer potatoes.

Table 5.7. Rice area's response to the relative profitabilities of the other major summer crops, stepwise results, 1971-1978[a]

Explanatory variables	Best one variable model	Best two variable model	Best three variable model	Best four variable model	Best five variable model
Intercept	1012.12	984.35	975.43	961.27	961.60
SE[b]	--	--	--	--	--
$P_r < F$[c]	--	--	--	--	--
$\pi^{j,k}_{t-1}$[d]	--	35.73	135.60	110.22	130.85
SE	--	(40.00)	(54.47)	(56.26)	(83.14)
$P_r > F$	--	(0.41)	(0.07)	(0.15)	(0.26)
$\pi^{j,L}_{t-1}$[e]	--		121.29	85.27	87.63
SE	--		(64.25)	(68.50)	(80.78)
$P_r > F$	--		(0.13)	(0.30)	(0.39)
$\pi^{j,m}_{t-1}$[f]	115.55	110.97	--	--	-62.71

[a]Source: Computed upon data from Ministry of Agriculture (32).

[b]SE is the standard error of the coefficient.

[c]$P_r > F$ is the probability of the calculated F greater than the tabulated F.

[d]$\pi^{j,k}_{t-1}$ is the relative profitability of jth and kth crops in period t-1. Where j is rice and k is corn.

[e]$\pi^{j,L}_{t-1}$ is the relative profitability of jth and Lth crops in period t-1. Where L is cotton.

[f]$\pi^{j,m}_{t-1}$ is the relative profitability of jth and mth crops in period t-1. Where m is sugarcane.

Table 5.7 (continued)

Explanatory variables	Best one variable model	Best two variable model	Best three variable model	Best four variable model	Best five variable model
SE	(49.90)	(51.02)	--	--	(152.96)
$P_r > F$	(0.06)	(0.08)	--	--	(0.72)
$\pi_{t-1}^{j,r\,g}$	--	--	--	271.55	472.90
SE	--	--	--	(230.19)	(560.87)
$P_r > F$	--	--	--	(0.32)	(0.49)
X_t	--	--	-22.83	-19.73	-25.42
SE	--	--	(8.85)	(8.85)	(17.34)
$P_r > F$	--	--	(0.06)	(0.11)	(0.28)
R^2	0.47	0.55	0.68	0.78	0.80

${}^{g}\pi_{t-1}^{j,r}$ is the relative profitability of jth and rth crops in period t-1. Where r is summer potatoes.

Table 5.8. Sugarcane area's response to the relative profitabilities of the other major summer crops, stepwise results, 1971-1978[a]

Explanatory variables	Best one variable model	Best two variable model	Best three variable model	Best four variable model	Best five variable model
Intercept	186.36	183.18	188.93	190.82	191.51
SE[b]	--	--	--	--	--
$P_r > F$[c]	--	--	--	--	--
$\pi_{t-1}^{j,k}$[d]	--	--	-3.17	-5.49	-4.81
SE	--	--	(2.28)	(1.99)	(4.30)
$P_r > F$	--	--	(0.24)	(0.07)	(0.38)
$\pi_{t-1}^{j,L}$[e]	--	2.71	5.80	6.00	5.41
SE	--	(1.73)	(2.72)	(1.99)	(3.93)
$P_r > F$	--	(0.18)	(0.10)	(0.06)	(0.30)
$\pi_{t-1}^{j,m}$[f]	--	--	--	3.89	4.17

[a]Source: Computed from data from Ministry of Agriculture (32).

[b]SE is the standard error of the coefficient.

[c]$P_r > F$ is the probability of the calculated F greater than the tabulated F.

[d]$\pi_{t-1}^{j,k}$ is the relative profitability of jth and kth crops in period t-1. Where j is sugarcane and k is rice.

[e]$\pi_{t-1}^{j,L}$ is the relative profitability of jth and Lth crops in period t-1. Where L is corn.

[f]$\pi_{t-1}^{j,m}$ is the relative profitability of jth and mth crops in period t-1. Where m is cotton.

Table 5.8 (continued)

Explanatory variables	Best one variable model	Best two variable model	Best three variable model	Best four variable model	Best five variable model
SE	--	--	--	(1.84)	(2.66)
$P_r > F$	--	--	--	(0.12)	(0.26)
$\pi_{t-1}^{j,r\,g}$	--	--	--	--	-6.72
SE	--	--	--	--	(35.20)
$P_r > F$	--	--	--	--	(0.87)
X_t	9.14	8.20	7.44	6.88	7.15
SE	(1.14)	(1.19)	(1.22)	(0.93)	(1.79)
$P_r > F$	(0.0002)	(0.001)	(0.004)	(0.005)	(0.06)
R^2	0.91	0.94	0.96	0.99	0.99

[g]$\pi_{t-1}^{j,r}$ is the relative profitability of jth and rth crops in period t-1. Where r is summer potatoes.

(4) The sign of the coefficients, as well as the estimated elasticities.

In this stage of the estimation, it is very hard, upon the available information, to get all the promising results. For instance, according to maximum R^2 criterion, the five variable model is the best fit (Tables 5.4 - 5.8). But, in order to conserve over the degrees of freedom, as well as (1) - (4) above, some other results of the stepwise procedure could be used. Future studies in this area may concentrate on causes of the shortcoming results. The contributions of this study in this stage are the theoretical model, as well as some results based on the available information. From Table 5.4, wheat results are not good. These models, however, explain how the farmers formulate the precultivation decision. The results show that wheat could be substituted for the other conventional crops such as: berseem, barley, and beans, i.e., if the government of Egypt wants to encourage wheat production, a direct, also if allowed, higher price, payment to the farmers to increase the profit will increase the area and hence the production given the technology. The winter tomatoes, however, show a complementary relationship with wheat. From Table 5.3, one can infer that, on the average, a feddan of winter tomatoes is 6.67 times as profitable as a feddan of wheat. This fact is known to every Egyptian. The vegetables and fruits are much more profitable than the conventional crops such as wheat, beans, rice, cotton, etc. Further, the Egyptian farmers would like, if they could, to produce vegetables and fruits, as long as the climate and soil conditions help them to do so. The reality also substantiates that even the value of land producing vegetables and fruits is higher than the land producing wheat, corn, etc. This may justify the farmers' attitude toward winter tomatoes. Further, one can fit Equation (5.1) for the conventional crops only. The main conclusions will still be correct, i.e., if the government of Egypt wants to encourage wheat production, a direct payment is necessary. Due to the low explanatory power of the model, no further inference will be made. More inference will be made from the estimated supply functions.

As for beans, the fit is not satisfactorily good except for high R^2. This study cannot use the results in Table 5.5. This is because of the high significant level, as well as the sign of the coefficients are not reasonable. The inference about beans will be made from the estimated supply functions. Worth noting is that beans could be substituted for wheat and winter tomatoes. This result confirms the wheat results stated before.

As for corn, the five variable model is the best fit, according to R^2 criterion but two variable model gives good results in terms of R^2, the power of the model, as well as the significance level of the coefficients. The results of Table 5.6 show that in general, the government of Egypt could encourage the production of corn by increasing the profitability of a feddan of corn relative to the profitability of a feddan of other conventional crops such as rice and cotton. As for sugarcane and summer potatoes, the results show complementary relationships with corn. Both sugarcane and summer potatoes are still desirous.

The results of the rice area's response are presented in Table 5.7. These results show that rice can substitute for other conventional crops, such as corn and cotton. Sugarcane shows a complementary relationship with rice. But the most surprising result is that rice shows a substitutability relationship with summer potatoes. The reality and importance of rice as a major diet component may support this evidence.

As for sugarcane, Table 5.8 could be interpreted in relation to Tables 5.6 - 5.7. For an increase in the profit per feddan of sugarcane, the farmers still prefer to produce rice. On the contrary, for the same increase in the profit per feddan of sugarcane, the farmers will substitute sugarcane for corn and cotton. Summer potatoes are preferable to sugarcane, even if the government increases the profit of sugarcane producers.

Finally, the technology as represented by time in this study's modified Nerlove model shows either negative or positive effects on the area (Tables 5.4 - 5.8). In small farm size type of economy and under intensive land use, it is actually hard to interpret the sign. But, if one carefully interprets Tables 5.4 - 5.8 in connection with Table 4.11, then one can infer that the results for beans, corn, and sugarcane are consistent. As for wheat and rice, the results are inconsistent.

In the next part of this chapter, this study will concentrate on the supply side estimation and prediction. The estimated equations together with the coefficient of determination (R^2), the standard error of the coefficients (SE), the approximate (:) probability, the level of significance ($P_r > |t|$), the Durbin-Watson (DW) statistic, and the estimated elasticity (E_{t-1}) are presented. The results of the Autoregressive Least-Squares (ALS) and the Ordinary Least-Squares (OLS) will also be reported.

Supply Side

In this part, the major issues center around this study's proposed self-sufficiency policy. This part will also provide a test for the first hypothesis stated on page 21 of this dissertation. As stated before at the beginning of this chapter, each function is estimated twice by two different techniques. These techniques are:

(1) Simple two-stage procedure. In this case each exogenous and endogenous variable is predicted separately from the time. Then, the endogenous variable is regressed on a set of exogenous variables.

(2) Estimate the functional forms of the model and then one could forecast the endogenous variable from a set of exogenous variables such as prices and costs.

Once again the efficiency of both ways will not be examined in this study. This point will be left for future studies.

Wheat

This study has estimated Equation (3.83) for wheat. This study has tried to estimate this equation under many assumptions to get reasonable results. Worth noting is that the predicted values used in the simple two-stage procedure are accurate. Equation (3.128), as well as other statistical forecast procedures have been tried. The predicted values created from ALS estimates lie between the upper and lower limits of other statistical procedures such as time series forecast procedure. So, in general, there is no doubt about the predicted values used.

The best fit possible for Equation (3.83) by using the simple two-stage procedure is:

$$
\begin{array}{llllll}
 & A_t^j = 1842.37 & + 10.72\ P_{ft-1}^j & - 10.22\ V_t^j & - 46.34\ \bar{C}_t^j & \\
\text{SE} & (232.43) & (4.42) & (6.12) & (16.70) & \\
\text{probability} & (0.0001) & (0.02) & (0.11) & (0.01) & (5.2) \\
 & -6.88\ X_t & & & & \\
\text{SE} & (5.57) & & & & \\
\text{probability} & (0.23) & & & &
\end{array}
$$

$R^2 = 0.44$ DW = NS $E_{t-1}^j = 0.28$

This equation shows that Durbin-Watson (DW) is not significant (NS), therefore, the same equation has been estimated again to obtain the OLS estimates of the parameters. The best fit is:

$$
\begin{array}{lllll}
 & A_t^j = 1826.96 & + 10.45\ P_{ft-1}^j & - 9.67\ V_t^j & \\
\text{SE} & (334.56) & (4.44) & (6.06) & \\
P_r > |t| & (0.0001) & (0.03) & (0.12) & (5.3) \\
 & -45.44\ \bar{C}_t^j & - 7.12\ X_t & & \\
\text{SE} & (16.82) & (5.52) & & \\
P_r > |t| & (0.01) & (0.21) & &
\end{array}
$$

$R^2 = 0.44$ $E_{t-1}^j = 0.27$

The estimation, in its present form, shows that R^2 is low, the loans per feddan $\bar{C}_t^j$ have a negative effect on the area and the estimated coefficients are mostly significant at level 0.05. Furthermore, the estimated supply elasticity E_{t-1}^j is about 0.27. In comparison with Table A.3 in the Appendix, this result is moderate. To overcome some of these problems, this study has tried to estimate several other forms under a set of conditions. Some of these forms show unreasonable signs of the coefficients. Before interpreting the sign of $\bar{C}_t^j$, the other estimated forms will be presented as follows: Under the assumption that $K_2 = K_3 = 0$ in Equation (3.83), this study obtained the following results:

ALS:

$$
\begin{array}{lllll}
 & A_t^j = 1044.96 & + \; 7.87 \; P_{ft-1}^j & - \; 1.10 \; X_t & \\
\text{SE} & (156.38) & (4.31) & (0.95) & \quad (5.4) \\
\text{: probability} & (0.0001) & (0.08) & (0.26) &
\end{array}
$$

$R^2 = 0.37$ DW = NS $E_{t-1}^j = 0.20$

OLS:

$$
\begin{array}{lllll}
 & A_t^j = 1013.10 & + \; 8.70 \; P_{ft-1}^j & - \; 0.88 \; X_t & \\
\text{SE} & (157.62) & (4.33) & (1.05) & \quad (5.5) \\
P_r > |t| & (0.0001) & (0.05) & (0.41) &
\end{array}
$$

$R^2 = 0.30$ $E_{t-1}^j = 0.23$

Under the assumption that the price of wheat relative to the price of berseem per ton influence the farmers's cultivation decision, i.e., substituting P^j_{ft-1} by $P^{j,K}_{ft-1}$ in Equation (3.83). Where j is wheat and K is berseem, this study obtained the following results:

ALS:

$$A^j_t = 1865.003 - 5.03\ P^{j,K}_{ft-1} - 3.05\ V^j_t$$

SE (349.85) (5.46) (5.60)

: probability (0.0001) (0.37) (0.59)

$$-27.62\ \bar{C}^j_t - 10.35\ X_t \tag{5.6}$$

SE (19.90) (5.44)

: probability (0.18) (0.07)

$R^2 = 0.41$ DW = S $E^j_{t-1} = -0.03$

Where S stands for significance at level 0.05.

Given the capital and the variable cost, i.e., $K_2 = K_3 = 0$, the resulting model is:

ALS:

$$A^j_t = 1453.16 - 9.38\ P^{j,K}_{ft-1} - 5.37\ X_t$$

SE (51.08) (3.83) (1.31)

: probability (0.0001) (0.02) (0.0003)

(5.7)

$R^2 = 0.47$ DW = S $E^{j,K}_{t-1} = -\ 0.06$

Theoretically speaking, the economic theory suggests that the higher the variable cost/price ratio the lower the area. If one assumes that the farmers base their decision on the variable cost of production in year t relative to price in year t-1, then, the resulting model is:

ALS:

$$A_t^j = 2416.57 - 488.86 \frac{V_t^j}{P_{ft-1}^j} - 54.98 \bar{C}_t^j - 4.94 X_t \tag{5.8}$$

SE	(272.57)	(160.89)	(14.95)	(5.31)
$\approx$ probability	(0.0001)	(0.0005)	(0.001)	(0.36)

$R^2 = 0.48$ DW = NS $E_{t-1}^j = -0.43$

If one set other assumptions, one will get different sets of the estimated functions. For instance, this study also obtained the following results:

ALS:

$$A_t^j = 1350.98 + 106.88R - 13.36 P_{ft-1}^{j,K} - 3.63 X_t \tag{5.9}$$

SE	(102.16)	(100.25)	(5.95)	(1.97)
$\approx$ probability	(0.0001)	(0.30)	(0.03)	(0.08)

$R^2 = 0.44$ DW = NS $E_{t-1}^r = 0.08$

$E_{t-1}^{j,K} = -0.08$

Where $R = \dfrac{P_{ft-1}^j}{V_t^j}$

ALS:

$$A_t^j = 1915.40 - 583.45 \frac{V_t^j}{P_{ft-1}^j} - 18.53 P_{ft-1}^{j,K} + 10.14 X_t \tag{5.10}$$

SE	(162.14)	(184.97)	(5.13)	(4.91)
$\approx$ probability	(0.0001)	(0.004)	(0.001)	(0.05)

$R^2 = 0.51$ DW = NS $E_{t-1}^j = -0.52$

$E_{t-1}^{j,K} = -0.11$

ALS:

$$A_t^j = 1456.49 - 9.44\ P_{ft-1}^{j,K} - 0.11\ V_t^j - 5.29\ X_t$$

SE (149.72) (4.76) (4.68) (3.42)

: probability (0.0001) (0.06) (0.98) (0.13) (5.11)

$R^2 = 0.47$ DW = NS $E_{t-1}^{j,K} = -0.06$

OLS:

$$A_t^j = 1023.94 + 9.12\ P_{ft-1}^j - 1.5\ V_t^j + 0.17\ X_t$$

SE (168.83) (4.86) (5.69) (5.30)

$P_r > |t|$ (0.0001) (0.07) (0.84) (0.98) (5.12)

$R^2 = 0.30$ $E_{t-1}^j = 0.24$

$$A_t^j = 1986.78 - 689.50\ \frac{V_t^j}{P_{ft-1}^j} - 19.31\ P_{ft-1}^{j,K}$$

SE (172.49) (196.58) (5.45)

$P_r > |t|$ (0.0001) (0.002) (0.001) (5.13)

$$+ 13.28\ X_t$$

SE (5.21)

$P_r > |t|$ (0.02)

$R^2 = 0.47$ $E_{t-1}^j = -0.61$

$E_{t-1}^{j,K} = -0.11$

As for forecasting the area from a given set of exogenous variables, this study obtained an estimation for the reduced form as:

ALS:

$$A_t^j = 2690.24 + 10.17\ P_{ft-1}^j - 18.56\ V_t^j - 96.41\ \bar{C}_t^j$$

SE (537.34) (5.84) (8.12) (29.01)

: probability (0.002) (0.13) (0.06) (0.01) (5.14)

$$-2.50\ X_t$$

SE (6.49)

: probability (0.71)

$R^2 = 0.67$ DW = NS $E^j_{t-1} = 0.27$

OLS:

$$A^j_t = 2303.56 + 12.48\ P^j_{ft-1} - 17.61\ V^j_t - 76.79\ \bar{C}^j_t + 2.92\ X_t \qquad (5.15)$$

SE	(538.62)	(6.70)	(9.75)	(28.29)	(9.21)
$P_r > \|t\|$	(0.004)	(0.11)	(0.11)	(0.03)	(0.76)

$R^2 = 0.60$ $E^j_{t-1} = 0.33$

These results show the elasticity of supply does not change much as compared to the simple two-stage procedure explained before. Furthermore, not much is gained from this procedure other than a higher R^2 as compared to the simple two-stage procedure. Under the same set of conditions stated before, the only good fit obtained is:

ALS:

$$A^j_t = 3321.63 + 11.79\ P^{j,K}_{ft-1} - 15.22\ V^j_t - 132.06\ \bar{C}^j_t - 11.30\ X_t \qquad (5.16)$$

SE	(692.53)	(9.99)	(7.95)	(46.30)	(6.53)
∸ probability	(0.002)	(0.28)	(0.10)	(0.03)	(0.13)

$R^2 = 0.63$ DW = NS $E^{j,K}_{t-1} = 0.10$

OLS:

$$A^j_t = 2756.19 + 12.61\ P^{j,K}_{ft-1} - 9.95\ V^j_t - 101.16\ \bar{C}^j_t - 7.26\ X_t \qquad (5.17)$$

SE	(659.42)	(11.61)	(9.93)	(43.70)	(9.86)
$P_r > \|t\|$	(0.004)	(0.31)	(0.35)	(0.05)	(0.49)

$R^2 = 0.48$ $E^{j,K}_{t-1} = 0.11$

From all of these trials, as well as the results of the stepwise maximum R^2, this study cannot obtain an interpretation for all the questions raised before. But, in general, one can infer the effects of the supply side shifter S^*_{Lt} from Table A.4 in the Appendix, as well as the estimated $\hat{K}i$'s in the reduced forms (Equation (3.83)). Or alternatively, one can use the projected values for A^j_t, the productivity per feddan and the estimated improvement in the productivity per feddan in Table A.4 in the Appendix. These issues will be clear later on in this chapter. But, the main conclusions so far are the results of estimating the reduced forms under this study's proposed policy, and their economic implications. As stated before, the estimated supply elasticity for wheat is moderate as compared to the elasticity estimated by Askari and Cummings (2). Further, using $\bar{C}^j_t$, the limited short and intermediate-run loans, as an approximation for the capital per feddan of wheat, does not show promising results. The only interpretation available to the researcher is that both the area and the real $\bar{C}^j_t$ are decreasing at a rate of -0.59 percent and -2.50 percent annually. The insufficiency of the total credit per feddan and the reduction in the area cultivated with wheat may justify the negative sign obtained for $\hat{K}_3$. Other interpretations are possible. Yet, the estimation and the interpretation mentioned before are the best available to the researcher.

Beans

Unlike wheat, the results for beans are good in terms of R^2. The same way is used in estimating both wheat and beans' supply functions. By using the simple two-stage procedure, i.e., forecasting all the variables, and then estimating the functions, the ALS's result is:

$$A_t^j = -210.85 + 0.103\ P_{ft-1}^j + 9.08\ V_t^j + 27.99\ \bar{C}_t^j$$

SE (74.99) (0.59) (1.88) (4.40)

: probability (0.009) (0.86) (0.0001) (0.0001) (5.18)

$$-\ 9.85\ X_t$$

SE (1.33)

: probability (0.0001)

$R^2 = 0.996$ DW = S $E_{t-1}^j = 0.05$

The results are good except for nonsignificant price coefficient and positive variable cost coefficient. Inspection of the data shows that the beans' area is decreasing, while both the real price and the real variable costs are increasing. These facts make the interpretation hard. Therefore, this study has tried other fits under the same set of conditions stated for wheat. If one assumes that $K_2 = K_3 = 0$, the simple Nerlove result is:

ALS:

$$A_t^j = 275.80 + 1.42\ P_{ft-1}^j - 12.95\ X_t$$

SE (26.97) (0.60) (1.45)

: probability (0.0001) (0.03) (0.0001) (5.19)

$R^2 = 0.98$ DW = NS $E_{t-1}^j = 0.69$

The results are good except for the elasticity of supply E_{t-1}^j. The interpretation for high elasticity is not known. This is because of the fact that year 2000 is still far away. It may be correct that the Egyptian farmers will be very responsive to the bean prices. The other possibility available to the study is to deflate the real price

P^j_{ft-1} by the real variable cost and estimate K_1. The ALS results are good. The best fit is:

$$
\begin{array}{lccccc}
 & A^j_t = 200.18 & + \; 7.18 \; \dfrac{P^j_{ft-1}}{V^j_t} & + \; 8.29 \; \bar{C}^j_t & - \; 6.76 \; X_t & \\
\text{SE} & (113.88) & (26.35) & (6.08) & (2.04) & \\
\text{: probability} & (0.09) & (0.78) & (0.18) & (0.003) & (5.20) \\
R^2 = 0.98 & & \text{DW = NS} & E^j_{t-1} = 0.11 & &
\end{array}
$$

The signs in the function are correct. Further, the estimated elasticity is very close to the Askari and Cummings (2) results (Table A.3 in the Appendix). But, $\hat{K}_1$ and $\hat{K}_3$ are not significant. Several other forms have been estimated under different assumptions. The ALS results are:

$$
\begin{array}{lcccc}
 & A^j_t = 316.99 & + \; 7.88 \; \dfrac{P^j_{ft-1}}{V^j_t} & - \; 9.49 \; X_t & \\
\text{SE} & (73.65) & (27.02) & (0.35) & \\
\text{: probability} & (0.0002) & (0.77) & (0.0001) & (5.21) \\
R^2 = 0.98 & & \text{DW = NS} & E^j_{t-1} = 0.12 &
\end{array}
$$

$$
\begin{array}{lcccccc}
 & A^j_t = -178.90 & + \; 56.76 \; P^{j,K}_{ft-1} & + \; 6.50 \; V^j_t & + \; 24.14 \; \bar{C}^j_t & \\
\text{SE} & (77.92) & (20.77) & (1.51) & (4.41) & \\
\text{: probability} & (0.03) & (0.01) & (0.0002) & (0.0001) & (5.22) \\
 & - \; 12.62 \; X_t & & & & \\
\text{SE} & (1.59) & & & & \\
\text{: probability} & (0.0001) & & & & \\
R^2 = 0.994 & & \text{DW = S} & E^{j,K}_{t-1} = 0.82 & &
\end{array}
$$

Where j = beans, and
k = wheat.

$$A_t^j = 353.77 - 41.59 \frac{V_t^j}{P_{ft-1}^j} - 9.51 \; X_t$$

SE (69.56) (187.97) (0.35)

⁚ probability (0.0001) (0.83) (0.0001) (5.23)

$R^2 = 0.97$ DW = NS $E_{t-1}^j = -0.09$

$$A_t^j = 231.08 - 30.53 \frac{V_t^j}{P_{ft-1}^j} + 8.29 \; \bar{C}_t^j - 6.78 \; X_t$$

SE (110.63) (183.08) (6.09) (2.04)

⁚ probability (0.05) (0.87) (0.18) (0.002) (5.24)

$R^2 = 0.98$ DW = NS $E_{t-1}^j = -0.07$

$$A_t^j = 231.08 - 30.53 \frac{V_t^j}{P_{ft-1}^j} + 8.29 \; \bar{C}_t^j - 6.78 \; X_t$$

SE (110.63) (183.08) (6.09) (2.04)

⁚ probability (0.05) (0.87) (0.18) (0.002) (5.25)

$R^2 = 0.98$ DW = NS $E_{t-1}^j = -0.07$

$$A_t^j = 221.88 + 95.27 \; P_{ft-1}^{j,K} - 16.87 \; X_t$$

SE (31.55) (25.54) (1.98)

⁚ probability (0.0001) (0.001) (0.0001) (5.26)

$R^2 = 0.98$ DW = NS $E_{t-1}^{j,K} = 1.37$

Many other farms have been obtained, but not much gain in terms of solving the major problem. This study has tried to estimate Equation (3.83) from actual data. The endogenous variable A_t^j could then be predicted from a set of exogenous variables. The ALS fit in this case is:

	$A_t^j = -\ 221.81$	$-\ 0.28\ P_{ft-1}^j$	$+\ 10.41\ V_t^j$	$+\ 28.54\ C_t^j$	
SE	(174.16)	(1.37)	(4.58)	(10.23)	
t probability	(0.25)	(0.84)	(0.06)	(0.03)	(5.27)
	$-\ 10.03\ X_t$				
SE	(3.11)				
t probability	(0.02)				

$R^2 = 0.86$ DW = S $E_{t-1}^j = -0.06$

Aside from the significance of the coefficients, the supply elasticity E_{t-1}^j, as well as the variable cost V_t^j do not show good results. As the case for simple two-stage procedures, this study tried to estimate Equation (3.83) under a set of assumptions. The ALS fit for the simple Nerlove model, i.e., $K_2 = K_3 = 0$ is:

	$A_t^j = 270.57$	$+\ 1.26\ P_{ft-1}^j$	$-\ 10.45\ X_t$	
SE	(48.60)	(1.09)	(3.72)	
t probability	(0.001)	(0.28)	(0.23)	(5.28)

$R^2 = 0.59$ DW = NS $E_{t-1}^j = 0.26$

The only problem with this form is the significance of the coefficient. Under several other assumptions, like those stated for wheat, the study obtained the following ALS results:

	$A_t^j = 201.77$	$+\ 82.02\ P_{ft-1}^{j,K}$	$+\ 1.53\ V_t^j$	$-\ 15.36\ X_t$	
SE	(71.01)	(57.03)	(4.38)	(5.54)	
t probability	(0.03)	(0.19)	(0.74)	(0.03)	(5.29)

$R^2 = 0.60$ DW = NS $E_{t-1}^{j,K} = 0.49$

Where j = beans, and
k = wheat

$$A_t^j = 277.00 + 16.79 \frac{P_{ft-1}^j}{V_t^j} - 6.76 \; X_t$$

SE (145.51) (52.02) (2.62)

∴ probability (0.09) (0.76) (0.03) (5.30)

$R^2 = 0.50$ DW = NS $E_{t-1}^j = 0.16$

$$A_t^j = 200.26 + 15.10 \frac{P_{ft-1}^j}{V_t^j} + 5.81 \; \bar{C}_t^j - 5.18 \; X_t$$

SE (225.32) (54.44) (12.15) (4.32)

∴ probability (0.40) (0.79) (0.65) (0.27) (5.31)

$R^2 = 0.52$ DW = NS $E_{t-1}^j = 0.14$

$$A_t^j = 209.51 + 94.54 \; P_{ft-1}^{j,K} - 14.58 \; X_t$$

SE (59.35) (47.31) (4.56)

∴ probability (0.008) (0.08) (0.013) (5.32)

$R^2 = 0.60$ DW = NS $E_{t-1}^{j,K} = 0.57$

$$A_t^j = 359.12 - 98.34 \frac{V_t^j}{P_{ft-1}^j} - 6.80 \; X_t$$

SE (130.62) (359.10) (2.62)

∴ probability (0.03) (0.79) (0.03) (5.33)

$R^2 = 0.50$ DW = NS $E_{t-1}^j = -0.13$

Several other forms, as well as the stepwise results have been obtained. But, not much gain is provided by these forms. For some cases, the study tried to estimate the parameters by using OLS. This is because the autoregressive parameter (ρ) is not significantly different from zero. Some of these results are:

$$A_t^j = 264.91 + 1.35\ P_{ft-1}^j - 10.44\ X_t \tag{5.34}$$

SE (56.16) (1.22) (4.16)

$P_r > |t|$ (0.002) (0.30) (0.04)

$R^2 = 0.49$ $E_{t-1}^j = 0.28$

$$A_t^j = -10.03 + 40.21\ \frac{P_{ft-1}^j}{V_t^j} + 14.86\ \bar{C}_t^j \tag{5.35}$$

SE (166.06) (58.22) (8.73)

$P_r > |t|$ (0.95) (0.51) (0.13)

$R^2 = 0.35$ $E_{t-1}^j = 0.38$

$$A_t^j = -39.78 + 86.74\ P_{ft-1}^{j,K} + 3.72\ V_t^j + 14.57\ C_t^j - 14.35\ X_t \tag{5.36}$$

SE (191.03) (54.17) (4.42) (10.74) (5.26)

$P_r > |t|$ (0.84) (0.16) (0.43) (0.22) (0.03)

$R^2 = 0.70$ $E_{t-1}^{j,K} = 0.52$

$$A_t^j = 387.05 - 178.08\ \frac{V_t^j}{P_{ft-1}^j} - 6.53\ X_t \tag{5.37}$$

SE (138.54) (382.86) (3.04)

$P_r > |t|$ (0.02) (0.65) (0.06)

$R^2 = 0.43$ $E_{t-1}^j = -\ 0.24$

In summary, except for the reverse sign for the variable costs and the significance of the $\hat{K}_i$'s, the estimated elasticities and R^2 are good. If one considers the trade-off the researchers face among the possible criteria, one will realize that the models above are the best possible, given the data. As in the case of wheat, one can calculate A^{*j}_{2000} and Q^{*j}_{2000} from Table A.4 in the Appendix and the estimated $\hat{K}_i$'s, or alternatively use A^{*j}_t, the productivity and the results of Table A.4 in the Appendix. The supply side forecasts will be presented later on.

Corn

The same procedures and assumptions used in analyzing wheat and beans are used in analyzing corn. The ALS estimation of the reduced form by using the two-step procedure is:

$$
\begin{array}{llllll}
 & A^j_t = 1959.64 & + 6.36\ P^j_{ft-1} & - 7.56\ V^j_t & - 33.01\ \bar{C}^j_t & \\
\text{SE} & (213.75) & (2.05) & (4.15) & (10.59) & \\
\text{: probability} & (0.0001) & (0.004) & (0.08) & (0.004) & (5.38) \\
 & + 17.16\ X_t & & & & \\
\text{SE} & (6.19) & & & & \\
\text{: probability} & (0.01) & & & &
\end{array}
$$

$R^2 = 0.92$ DW = S $E^j_{t-1} = 0.15$

These results are very good. If one considers that the corn area grows at a rate of 2.88 percent annually, and the real capital $\bar{C}^j_t$ decreases at a rate of -2.50 percent annually, one will realize the superiority of these results. Along with this model, the data have been used to fit many other forms. The ALS results of these forms are:

$$A_t^j = 1303.42 + 6.06 \; P_{ft-1}^j + 19.80 \; X_t$$

SE (74.04) (2.21) (2.61)

$\therefore$ probability (0.0001) (0.01) (0.0001) (5.39)

$R^2 = 0.90$ DW = S $E_{t-1}^j = 0.15$

$$A_t^j = 1975.44 + 473.82 \; P_{ft-1}^{j,K} - 7.50 \; V_t^j - 30.00 \; C^j{}_t$$

SE (236.96) (214.05) (4.58) (11.60)

$\therefore$ probability (0.0001) (0.04) (0.11) (0.02) (5.40)

$$+ 22.51 \; X_t$$

SE (5.96)

$\therefore$ probability (0.001)

$R^2 = 0.92$ DW = S $E_{t-1}^{j,K} = 0.08$

Where j = corn, k = cotton.

$$A_t^j = 1464.22 + 430.26 \; P_{ft-1}^{j,K} - 3.87 \; V_t^j + 28.34 \; X_t$$

SE (163.06) (242.50) (4.99) (5.91)

$\therefore$ probability (0.0001) (0.09) (0.44) (0.0001) (5.41)

$R^2 = 0.92$ DW = S $E_t^{j,K} = 0.07$

Even though the results mentioned before are excellent, this study has tried to estimate the reduced form, i.e., Equation (3.83) from the published data set. This will help in projecting the endogenous variable A_t^j from a set of exogenous variables such as price, cost, and capital. The selected ALS results are:

$$A_t^j = 2000.55 + 6.43 \; P_{ft-1}^j - 3.31 \; V_t^j - 51.14 \; \bar{C}_t^j$$

SE (491.46) (4.58) (7.54) (24.96)

∴ probability (0.005) (0.20) (0.67) (0.08) (5.42)

$$+ 24.90 \; X_t$$

SE (11.18)

∴ probability (0.06)

$R^2 = 0.91$ DW = NS $E_{t-1}^j = 0.14$

And, the simple Nerlove's result is:

$$A_t^j = 1233.50 + 5.64 \; P_{ft-1}^j + 33.56 \; X_t$$

SE (142.47) (4.58) (9.01)

∴ probability (0.0001) (0.25) (0.005) (5.43)

$R^2 = 0.79$ DW = NS $E_{t-1}^j = 0.12$

Substituting $P_{ft-1}^{j,K}$ for P_{ft-1}^j, the result is:

$$A_t^j = 1913.43 + 873.30 \; P_{ft-1}^{j,K} - 0.20 \; V_t^j - 54.45 \; \bar{C}_t^j$$

SE (512.002) (502.59) (7.25) (24.75)

∴ probability (0.007) (0.13) (0.98) (0.06) (5.44)

$$+ 24.70 \; X_t$$

SE (9.15)

∴ probability (0.03)

$R^2 = 0.93$ DW = NS $E_{t-1}^{j,K} = 0.16$

Where j= corn, and
k = cotton.

The OLS estimations for the same specifications are:

$$A_t^j = 2029.79 + 6.42 \ P_{ft-1}^j - 3.13 \ V_t^j - 53.62 \ \bar{C}_t^j$$

SE (502.36) (4.63) (7.48) (25.51)

$P_r > |t|$ (0.005) (0.21) (0.69) (0.07) (5.45)

$$+ 24.36 \ X_t$$

SE (10.84)

$P_r > |t|$ (0.06)

$R^2 = 0.91$ $E_{t-1}^j = 0.14$

$$A_t^j = 1195.67 + 6.54 \ P_{ft-1}^j + 34.11 \ X_t$$

SE (161.41) (5.26) (8.05)

$P_r > |t|$ (0.0001) (0.25) (0.002) (5.46)

$R^2 = 0.85$ $E_{t-1}^j = 0.14$

$$A_t^j = 1889.16 + 848.12 \ P_{ft-1}^{j,K} - 0.53 \ V_t^j - 51.51 \ \bar{C}_t^j$$

SE (500.60) (498.54) (7.40) (24.30)

$P_r > |t|$ (0.007) (0.13) (0.95) (0.07) (5.47)

$$+ 25.61 \ X_t$$

SE (9.62)

$P_r > |t|$ (0.03)

$R^2 = 0.92$ $E_{t-1}^{j,K} = 0.16$

As stated before, these results are good. Further, the forcasted supply side variables will be shown later on in this part.

Rice

The same procedure used before has been used to analyze rice. The simple two-stage procedure used before in wheat, beans, and corn is used. The ALS results are:

$$A_t^j = 1160.41 + 12.21 \; P_{ft-1}^j - 2.54 \; V_t^j - 29.03 \; \bar{C}_t^j$$

SE (313.33) (7.73) (6.11) (15.65)

⁚ probability (0.001) (0.13) (0.68) (0.07) (5.48)

$$+ 1.44 \; X_t$$

SE (6.46)

⁚ probability (0.83)

$R^2 = 0.83$ DW = S $E_{t-1}^j = 0.37$

$$A_t^j = 864.98 + 4.82 \; P_{ft-1}^j + 12.91 \; X_t$$

SE (166.24) (5.74) (4.07)

⁚ probability (0.0001) (0.41) (0.003) (5.49)

$R^2 = 0.63$ DW = S $E_{t-1}^j = 0.15$

In the first equation, i.e., Equation (5.48), the sign for the capital $\bar{C}_t^j$ is negative. The reduction in the rate of growth in real $\bar{C}_t^j$ and the increase in the area may justify this negative sign. The simple Nerlove, i.e., Equation (5.49) where $K_2 = K_3 = 0$, gives good results except for nonsignificant real price coefficient. This study has tried several other models. But, the results are not good.

To forecast the area A_t^j given the set of exogenous variables, the data have been used to fit the reduced form, i.e., Equation (3.83), the ALS results are:

$$A_t^j = 908.83 + 7.66 \; P_{ft-1}^j - 0.10 \; V_t^j + 3.96 \; \bar{C}_t^j$$

SE (429.004) (8.38) (7.34) (23.64)

⁚ probability (0.07) (0.39) (0.99) (0.88) (5.50)

$$- 14.83 \; X_t$$

SE (6.31)

: probability (0.05)

$R^2 = 0.69$ DW = NS $E^j_{t-1} = 0.22$

$$A^j_t = 968.61 + 7.31 \; P^j_{ft-1} - 15.85 \; X_t$$

SE (120.01) (4.02) (3.36)

: probability (0.0001) (0.10) (0.001) (5.51)

$R^2 = 0.71$ DW = NS $E^j_{t-1} = 0.21$.

The signs of the first equation, i.e., Equation (5.50), are good. But the coefficients are mostly nonsignificant. The second equation, i.e., Equation (5.51) or simple Nerlove, gives much better results than the first. The rice farmers are responsive to the rice prices. These results confirm reality. The estimated elasticities have good implications to the policymakers. In formulating the production and marketing policies, the price of the final output has to be considered.

The OLS results are not good. The only reasonable form is:

$$A^j_t = 978.63 + 6.72 \; P^j_{ft-1} - 14.84 \; X_t$$

SE (153.33) (5.15) (4.41)

$P_r > |t|$ (0.0001) (0.23) (0.008) (5.52)

$R^2 = 0.56$ $E^j_{t-1} = 0.19$

The forecasted values of the supply side variables will be presented later on in this part.

Sugarcane

In a similar fashion to the procedure used in the other crops, the ALS results of the simple two-stage procedure are:

$$\begin{array}{llllll}
 & A_t^j = 85.19 & + 0.10 \; P_{ft-1}^j & + 0.49 \; V_t^j & + 3.47 \; \bar{C}_t^j & \\
\text{SE} & (24.07) & (2.84) & (0.20) & (1.47) & \\
\dot{\sim}\ \text{probability} & (0.001) & (0.97) & (0.02) & (0.03) & (5.53) \\
 & + 7.20 \; X_t & & & & \\
 & (0.55) & & & & \\
 & (0.0001) & & & &
\end{array}$$

$R^2 = 0.998$ $\quad$ DW = NS $\quad$ $E_{t-1}^j = 0.002$

This function shows that R^2 is very high and the coefficient of the real price is nonsignificant. Further, the sign of the V_t^j coefficient is reversed. The evidence shows that the real price, the real variable cost, and area are increasing (Tables 4.11, 4.16, and 4.17). This evidence may justify the positive sign for $\hat{K}_2$, i.e., V_t^j coefficient. Other models have been fitted. But, the only reasonable model is the simple Nerlove. Where $K_2 = K_3 = 0$ gives the following results:

$$\begin{array}{lllll}
 & A_t^j = 152.14 & + 2.55 \; P_{ft-1}^j & + 7.26 \; X_t & \\
\text{SE} & (4.71) & (2.01) & (0.59) & (5.54) \\
\dot{\sim}\ \text{probability} & (0.0001) & (0.21) & (0.0001) &
\end{array}$$

$R^2 = 0.996$ $\quad$ DW = NS $\quad$ $E_{t-1}^j = 0.06$

These results suggest that the past year's price is a determinate factor to the area in year t. Substituting $P_{ft-1}^{j,K}$ for P_{ft-1}^j, where j is sugarcane and K is corn, does not change the results much, i.e., V_t^j coefficient is still positive. The ALS estimates in this case are:

$$\begin{array}{llllll} & A_t^j = & 52.26 & + 189.71\ P_{ft-1}^{j,K} & + 0.24\ V_t^j & \\ \text{SE} & & (20.89) & (49.64) & (0.12) & \\ \text{: probability} & & (0.02) & (0.001) & (0.06) & \\ & & + 5.62\ \bar{C}_t^j & + 7.94\ X_t & & \\ \text{SE} & & (1.28) & (0.43) & & \\ \text{: probability} & & (0.0001) & (0.0001) & & \end{array} \qquad (5.55)$$

$R^2 = 0.999$ DW = NS $E_{t-1}^{j,K} = 0.10$

$$\begin{array}{llllll} & A_t^j = & 141.72 & + 117.07\ P_{ft-1}^{j,K} & + 0.16\ V_t^j & \\ \text{SE} & & (6.57) & (60.43) & (0.17) & \\ \text{: probability} & & (0.0001) & (0.06) & (0.37) & \\ & & + 6.81\ X_t & & & \\ \text{SE} & & (0.54) & & & \\ \text{: probability} & & (0.0001) & & & \end{array} \qquad (5.56)$$

$R^2 = 0.997$ DW = NS $E_{t-1}^{j,K} = 0.06$

The fits as presented above are good except for the sign of $\hat{K}_2$ and $\hat{K}_3$. The estimated elasticities are reasonable. Because of the fact that DW is nonsignificant, this study has estimated the parameters by the OLS procedure. The results are:

$$\begin{array}{llllll} & A_t^j = & 80.44 & + 0.48\ P_{ft-1}^j & + 0.47\ V_t^j & + 3.79\ \bar{C}_t^j \\ \text{SE} & & (24.51) & (2.82) & (0.20) & (1.51) \\ P_r > |t| & & (0.003) & (0.87) & (0.02) & (0.02) \end{array} \qquad (5.57)$$

$$+ 7.24 \quad X_t$$

SE (0.54)

$P_r > |t|$ (0.0001)

$R^2 = 0.998$ $\qquad E^j_{t-1} = 0.01$

$$A^j_t = 151.06 + 3.30\ P^j_{ft-1} + 7.03\ X_t$$

SE (4.22) (1.85) (0.54)

$P_r > |t|$ (0.0001) (0.09) (0.0001) $\qquad$ (5.58)

$R^2 = 0.997$ $\qquad E^j_{t-1} = 0.08$

$$A^j_t = 74.46 + 161.91\ P^{j,K}_{ft-1} + 0.24\ V^j_t$$

SE (20.95) (54.04) (0.14)

$P_r > |t|$ (0.001) (0.006) (0.10) $\qquad$ (5.59)

$$+ 4.22\ \bar{C}^j_t + 7.63\ X_t$$

SE (1.27) (0.48)

$P_r > |t|$ (0.002) (0.0001)

$R^2 = 0.999$ $\qquad E^{j,K}_{t-1} = 0.09$

The results as presented before are good. The simple Nerlove gives moderate results as compared to the other models. Further, the results of simple Nerlove, i.e., $K_2 = K_3 = 0$, are good. This is because of the significance level of the coefficients, high R^2 and reasonable estimated elasticity.

As in the case of all other crops, the endogenous variables A^j_t can be projected from the exogenous variables. To do so, three models have been fitted. The ALS's results are:

$$
\begin{array}{lllll}
 & A_t^j = 95.12 & -\ 1.50\ P_{ft-1}^j & +\ 0.53\ V_t^j & \\
\text{SE} & (52.09) & (5.99) & (0.44) & \\
\ddot{\sim}\ \text{probability} & (0.12) & (0.81) & (0.27) & \quad (5.60) \\
 & +\ 2.263\ \bar{C}_t^j & +\ 7.93\ X_t & & \\
\text{SE} & (3.24) & (1.30) & & \\
\ddot{\sim}\ \text{probability} & (0.45) & (0.001) & &
\end{array}
$$

$R^2 = 0.97$ DW = NS $E_{t-1}^j = -\ 0.03$

The simple Nerlove where $K_2 = K_3 = 0$ gives the following results:

$$
\begin{array}{lllll}
 & A_t^j = 147.16 & +\ 2.19\ P_{ft-1}^j & +\ 8.42\ X_t & \quad (5.61) \\
\text{SE} & (8.58) & (3.42) & (1.31) & \\
\ddot{\sim}\ \text{probability} & (0.0001) & (0.54) & (0.0002) &
\end{array}
$$

$R^2 = 0.95$ DW = NS $E_{t-1}^j = 0.04$

Also, by substituting $P_{ft-1}^{j,K}$ for P_{ft-1}^j in Equation (3.83) the following results are obtained.

$$
\begin{array}{lllll}
 & A_t^j = 73.58 & +\ 179.15\ P_{ft-1}^{j,K} & +\ 0.17\ V_t^j & \\
\text{SE} & (46.79) & (123.18) & (0.32) & \\
\ddot{\sim}\ \text{probability} & (0.17) & (0.20) & (0.63) & \quad (5.62) \\
 & +\ 4.24\ \bar{C}_t^j & +\ 8.33\ X_t & & \\
\text{SE} & (2.87) & (1.05) & & \\
\ddot{\sim}\ \text{probability} & (0.19) & (0.0002) & &
\end{array}
$$

$R^2 = 0.982$ DW = NS $E_{t-1}^{j,k} = 0.09$

$$
\begin{array}{lllll}
 & A_t^j = 140.00 & +\ 132.86\ P_{ft-1}^{j,K} & +\ 0.06\ V_t^j & \\
\text{SE} & (11.52) & (118.91) & (0.33) & \quad (5.63) \\
\ddot{\sim}\ \text{probability} & (0.0001) & (0.30) & (0.87) &
\end{array}
$$

$$+ 8.06 \quad X_t$$

SE (1.27)

: probability (0.0004)

$R^2 = 0.97$ DW = NS $E^{j,K}_{t-1} = 0.07$

Due to the fact that DW is nonsignificant, i.e., ρ is not significantly different from zero. This study has also tried an OLS procedure. The results are:

$$A^j_t = 95.53 - 1.51 \quad P^j_{ft-1} + 0.53 \quad V^j_t + 2.60 \quad \bar{C}^j_t$$

SE (51.96) (5.98) (0.44) (3.23)

$P_r > |t|$ (0.12) (0.81) (0.28) (0.45) (5.64)

$$+ 7.93 \quad X_t$$

SE (1.31)

$P_r > |t|$ (0.001)

$R^2 = 0.97$ $E^j_{t-1} = -0.03$

The simple Nerlove's result is:

$$A^j_t = 147.18 + 2.41 \quad P^j_{ft-1} + 8.30 \quad X_t$$

SE (7.61) (3.19) (1.24)

$P_r > |t|$ (0.0001) (0.47) (0.0002) (5.65)

$R^2 = 0.96$ $E^j_{t-1} = 0.05$

Substituting $P^{j,K}_{ft-1}$ for P^j_{ft-1}, the result is:

$$A_t^j = 89.41 + 158.20 \; P_{ft-1}^{j,K} + 0.16 \; V_t^j$$

SE (45.33) (121.45) (0.34)

$P_r > |t|$ (0.10) (0.24) (0.65) (5.66)

$$+ 3.21 \; \bar{C}_t^j + 8.24 \; X_t$$

SE (2.76) (1.18)

$P_r > |t|$ (0.29) (0.0004)

$R^2 = 0.98$ $E_{t-1}^{j,K} = 0.08$

Even though the significance level for price coefficient is high and V_t^j is still positive, the estimated elasticities are good. The elasticity of supply as estimated by simple Nerlove, i.e., $K_2 = K_3 = 0$, is moderate.

The results of this study's model are good. One can compare these results to the other studies done on Egypt. Askari and Cummings (2) and Habashy, Fitch, and Rehiwi (14) have presented some other estimated supply elasticities. Their results in a larger extent support this study's results. In some cases the fit was difficult but, in general, this study has done the best. In the next part, the supply side forecast for the year 2000 will be presented.

The Supply Side Forecasts

In this section, the major issue is to forecast the supply side variables for all the crops. The aggregate supply of each crop and the per capita production will be presented. The calculation of the total and per capita production will be done under this study's proposed objectives. As stated before in Chapter IV, there are several policy

policy actions that must be considered if the objective of the Egyptian society is to produce more food. These policy considerations are:

(1) The land improvement programs should be extended to all land classes before the year 2000. These programs are the responsibility of both the public and the government.

(2) The horizontal land programs, i.e., to increase the current supply of farmland, are vital to Egypt. The direction of the flow of investment should be toward (1) and (2).

(3) The current crop rotation should be radically changed toward producing more wheat and beans at the expense of berseem, and more corn, rice, and sugarcane at the expense of cotton. To do so, the agricultural policymakers should seriously consider the following:

   (a) The relative profitabilities of all the crops (Table 5.3),

   (b) The price-variable cost ratios for all the crops, and

   (c) The comparative advantages that Egypt has in producing each crop.

(4) The allocation of the resources and the subsidy should be reconsidered and controlled.

Without these considerations, the aggregate food supply will not achieve the desired shift.

As stated before, one objective of this study's proposed policies is to increase the food supply by X percent. This increase could be done through (1) increasing the productivity per feddan of each crop, and (b) changing the agricultural rotation. Increasing the productivity per feddan is the study's major policy instrument, i.e., S^{*}_{Lt} in Equation (3.7). Table A.4 in the Appendix, as well as the estimated supply coefficients can help one to calculate the increase in the aggregate supply of each crop. Worth noting is that the X increase in the productivity per feddan is available and observable.

For all of the supply side variables, the forecasted values are in Table 5.9. In this table, two forecasted values of some variables are presented. If one considers time as the only exogenous variable, then one can obtain the time-forecasted value. On the other hand, if one considers the time, as well as the other exogenous variables, such as the prices and capital supplies, then one can use the estimated reduced form of the model to get the forecasted values. This study calls these values the model forecast. The second way, i.e., the model forecast, is widely used in econometric studies. But since the year 2000 is far away, both values may have an equal probability of existence.

The area is estimated from the reduced form, i.e., Equation (3.83). The production is estimated by multiplying the area by the value $(P^{j}_{rt} + IM)$, i.e., Equation (3.80). Worth noting is that IM is available for wheat, cotton, corn, and rice only (Table A.4 in Appendix). Table 5.9 is then self-explanatory. On the supply side with the national average of IM = 3.05 ardeb per feddan, the per capita wheat supply will increase by 16.36 kilograms per Egyptian individual. The corn supply will increase by 31.79 kilograms per individual, given that IM = 3.44

Table 5.9. The supply side forecasts for the year 2000[a]

Variable	Wheat	Beans	Corn	Rice	Sugarcane
Area in 1000 feddan					
Time forecast	1327.52	20.44	2332.33	1575.26	421.40
Model forecast[b]	1622.45	23.48	2878.98	799.92	449.21
Difference	294.93	3.04	546.65	-775.34	27.81
Production in 1000 units[c]					
Time forecast	17685.60	26.57	32119.40	3578.61	13973.60
Model forecast	26121.45	30.52	52167.12	2607.74	12636.28
Difference	8435.85	3.95	20047.72	-970.87	-1337.32
Per capita production in Kg./Ind.[d]					
Time forecast	41.82	0.40	76.65	45.30	NC[e]
Model forecast	58.18	0.45	108.44	38.72	NC
Difference	16.36	0.05	31.79	-6.58	NC
Time forecast of the variable cost in pounds per feddan					
Nominal	149.70	133.14	168.04	150.28	404.80
Real	51.27	49.42	61.21	63.83	174.66
Time forecast of price of final output in pounds per ton					
Nominal	97.29	292.15	135.10	114.62	22.30
Real	30.55	122.72	61.74	48.49	11.67

[a]Source: Computed upon data from the Ministry of Agriculture (32).

[b]Model forecast stands for the values forecasted from the reduced form, i.e., Equation (3.83).

[c]The units of measurements are different among the crops. Wheat and corn are measured in 1000 ardeb of these crops. Rice, beans, and sugarcane are measured in 1000 tons.

[d]Kg./Ind. stands for kilogram per individual.

[e]NC stands for values not computed. This is because of data problems.

ardeb per feddan. Notably, that part of the increase is coming from the increase in the area in both cases. But there is an increase in the food supply per individual out of the policy variable S^*_{Lt}. As for rice, the average national increase in the productivity per feddan is 945 kilograms. This increase is about 652.05 kilograms of paddy rice. But due to the strong trade-off on the limited area, the per capita rice production falls 6.58 kilograms behind the time-forecasted value (Table 5.9). If one carefully inspects Table 5.9, one will figure out the consistency of the above results. The area cultivated with corn is about 546.65 thousand feddan higher than the time-forecasted area. Given the limited farmland, the rice cultivated area decreases by 775.34 thousand feddan. Worth noting is that the total cultivated area of both crops in the year 2000 will be 3678.90 thousand feddan. This implies that the trade-off is allowed by other crops such as cotton, or that the cultivated area will increase substantially. For both beans and sugarcane, there will be little change in the cultivated areas by the year 2000. The importation of beans will increase unless the vertical land policies lead to a large increase in the supply of farmland. The same conclusions are extended to sugarcane. But in the case of sugarcane, the results of Table 4.11 show that the annual rate of productivity growth is -0.80 percent. This result justifies the results of Table 5.9. On the other hand, this productivity decline will lead to a further reduction in the degree of self-sufficiency. So far, Egypt has a comparative advantage in producing sugarcane. But, what is important to this study is the rate of productivity growth, not the productivity in a given year. The sugarcane results also reflect the importance of this study's policies.

In summary, the results of supply side, as estimated by the study's model, are good. This study has used many techniques in estimating each single equation. Further, the estimated elasticities and the farmers' response are logical and good. As compared to other studies, the results are good.

Finally, this study's proposed policies will lead to an increase in the per capita food supply. Further, if one assumes that the welfare and the increase in food supply are positively correlated, then one can easily realize that there will be an increase in the welfare of the Egyptian people out of these policies.

The Demand Side

The same technique used in analyzing the supply side will be used in analyzing the demand side. The major issue in this part is how much the quantity internally consumed in Egypt -- in total or per individual -- should be in the year 2000 through the optimum price, subsidy, and consumption policies. Or alternatively, how much will the price of each crop rise, by the year 2000, to keep the consumption at a sufficient level. Further, the demand side forecast will also be presented.

This study is concerned in this part by the consumption of each crop by the Egyptians. To get such data, the researcher had a hard time. If one considers wheat consumption, one should subtract the quantity used such as seeds, the quantity used in industrial purposes, and the quantity lost in the production and marketing processes. In other crops, similar adjustments are needed. To do so, the following procedure has been used:

$$\text{Production} \pm (\text{Imports} - \text{Exports}) = \text{Total Requiements} \tag{5.67}$$

Then,

$$\text{Total Requirements} - (\text{Lost, Seeds, etc.}) = \text{Net Human Consumption} \tag{5.68}$$

The net human consumption can be divided by the total number of Egyptians to get the per capita figures. Worth noting is that in Chapter IV the major concern was to compute the rates of growth in the requirements. But to get reasonable results out of the demand functions, it seems important to do the adjustments in (5.67) and (5.68). To get the desired figures, a percentage of the total requirements should be subtracted to get (5.68). This job was the most difficult. The study used the figures from the Ministry of Agriculture (32) to do the calculations. The forthcoming results are good, except for sugarcane whose figures are much too complex to compute. Future studies should be done on the calculation of sugarcane. Finally, this study is concerned with the demand for farm products. Other future studies may concentrate on the demand for the final output after the intermediate process. A reasonable fit given the set of the prices and income is very hard.

As for estimating Equation (3.95), the determination of k is another difficult job. As stated before, this study is in need of a reasonably consistent (in terms of economic theory) demand function. This function includes a diet adjustment coefficient. The best possible way available to the study is to estimate Equation (3.95) and then make the adjustment based on Table 4.11. In other words, the following are the possible ways to get k: (1) Since the estimated demand functions are satisfying the homogeneity condition, i.e., Equation (3.93), then if the prices increase by X percent given the income, the consumption will change. If this is the case, then one can think about increasing the prices to regulate the consumption. Or alternatively, the government of Egypt considers the income distribution with no subsidies at all. This adjustment makes sense. The fact of observed excessive subsidies and misused subsidized goods has been debated for a long time. The examples are too many to itemize here, and (2) As stated before, this study has come to some serious conclusions based on the available published data. If one considers Table 4.11, one will realize that the growing requirements at X percent annual rate is a dangerous problem. This implies that not only the population is growing, but also the demand per individual is growing from year to year. The growing demand may be due to (a) excessive subsidies, or (b) limited availability of other substitutes and complements, (c) or both. Given this fact, one can think of regulating the consumption through X percent reduction in the quantity. This X percent is the annual rate of per capita requirement growth. In forecasting the demand side, both ways will be considered.

Econometric Results

This study's econometric model has been used to estimate the demand functions and to infer their economic implications. Some of the results are not good. But, this is the best study thus far, given the data.

Wheat

Many different techniques have been used to analyze the total and the per capita demands. This study has estimated γ''s in Equation (3.95) with two shifters. These shifters are population and time. The stepwise results are presented in Table 5.10. The economic and statistical implications of Table 5.10 are good. This holds true for all the models except for positive price coefficients, i.e., $\hat{\gamma}'_2$. If one considers all the elasticities and all the signs, one can easily infer that population is the dominate factor that influences the aggregate wheat demand. All of the models show that $\hat{\gamma}'_2$, i.e., the own price elasticity for wheat is positive and ranks between 1.70 to 1.88. These results are surprising. If one considers the income elasticity, one can infer that these elasticities rank from 0.96 to 1.26 (Table 5.10). The restriction in Equation (3.93) is not met given the data. In other words, the estimated elasticities are inconsistent. The income elasticity is positive which imply that wheat is a normal good. But the price elasticity, i.e., $\hat{\gamma}'_2$, is positive. To interpret such strange

Table 5.10. The stepwise results for estimating the aggregate demand function for wheat, 1965-1978[a]

Variables	Best one variable model	Best two variable model	Best three variable model	Best four variable model	Best five variable model	Best six variable model
Intercept	6.06	-0.80	-20.53	-21.68	-20.10	-18.84
SE[b]	--	--	--	--	--	--
$P_r > F$[c]	--	--	--	--	--	--
$\ln P_t^{jd}$	--	1.83	1.70	1.88	1.86	1.78
SE	--	(0.59)	(0.41)	(0.39)	(0.39)	(0.40)
$P_r > F$	--	(0.01)	(0.002)	(0.001)	(0.001)	(0.003)
$\ln P_t^{01}$[e]	--		--	0.57	0.58	0.64
SE	--		--	(0.33)	(0.33)	(0.34)
$P_r > F$	--		--	(0.12)	(0.12)	(0.10)
$\ln P_t^{02}$[f]	--		--	--	--	0.39
SE	--		--	--	--	(0.39)
$P_r > F$	--		--	--	--	(0.35)
$\ln \bar{Y}_t$[g]	--		--	--	-0.96	-1.26
SE	--		--	--	(1.04)	(1.08)
$P_r > F$	--		--	--	(0.38)	(0.28)
N_g[h]	0.06	0.08	0.79	0.74	0.83	0.79
SE	(0.02)	(0.02)	(0.20)	(0.18)	(0.21)	(0.21)
$P_r > F$	(0.007)	(0.001)	(0.003)	(0.003)	(0.004)	(0.008)

T^i	--	--	-0.57	-0.54	-0.60	-0.57
SE	--	--	(0.16)	(0.14)	(0.16)	(0.16)
$P_r > F$	--	--	(0.005)	(0.005)	(0.005)	(0.01)
R^2	0.47	0.72	0.88	0.91	0.92	0.93

[a]Source: Computed upon data from (6, 32, 52).

[b]SE is the standard error of the coefficient.

[c]$P_r > F$ is the probability of the calculated F greater than the tabulated F.

[d]ln P_t^j stands for log P_t^j. Where P_t^j is the price of final output of wheat in Egyptian pound (ŁE) per ton in year t.

[e]ln P_t^{01} stands for log P_t^{01}. Where P_t^{01} is the price of corn in ŁE per ton in year t.

[f]ln P_t^{02} stands for log P_t^{02}. Where P_t^{02} is the price of rice in ŁE per ton in year t.

[g]ln $\bar{Y}_t$ stands for log $\bar{Y}_t$. Where $\bar{Y}_t$ is the limited disposable income per capita in year t.

[h]Ng stands for the total population in million individuals.

[i]T is the time.

results is very hard. But, this is what the data suggest. In reality, with an increase in the price of other goods, given the high subsidy levels and the limited substitutes, these results may hold true. For instance, if the cross price elasticities $\hat{\gamma}'_{0i}$'s are positive (Table 5.10), this implies that with the high price of corn and rice, wheat consumption will increase. This may be true. The only figures available for comparison are those provided by Abdel-Fadil (2). The results of Abdel-Fadil are also inconsistent. The evidence may support this study's results. But, in general, in a second best type economy, the economic theory may or may not totally work. In any case, the statistical results are good.

Now, after studying the separable factor effects in the aggregate demand, Equation (3.95) is estimated, on the aggregate level, by two statistical procedures, i.e., ALS and OLS. The DW test is not significant in all models. The results of ALS are:

$$
\begin{array}{lllll}
 & \ln C_t^j = -1.95 & + 1.71 \ln P_t^j & + 0.65 \ln P_t^{01} & + 0.64 \ln P_t^{02} \\
\text{SE} & (6.01) & (0.51) & (0.44) & (0.61) \\
\text{: probability} & (0.75) & (0.01) & (0.17) & (0.32) \\
 & - 0.50 \ln \bar{Y}_t & + 0.06\ \text{Ng} & & \\
\text{SE} & (1.50) & (0.04) & & \\
\text{: probability} & (0.75) & (0.23) & & \\
R^2 = 0.78 & & \text{DW} = \text{NS} & &
\end{array}
\tag{5.69}
$$

Under the assumption that δ_2 in equation (3.95) is zero, or the exogenous variables such as prices and income only influence the aggregate demand, the ALS results are:

$$\ln C_t^j = -8.50 + 1.78 \ \ln P_t^j + 0.83 \ \ln P_t^{01}$$

SE (3.72) (0.57) (0.47)

: probability (0.05) (0.01) (0.11)

$$+ 0.73 \ \ln P_t^{02} + 1.08 \ \text{Ln } \bar{Y}_t \qquad (5.70)$$

SE (0.60) (0.95)

: probability (0.26) (0.29)

$R^2 = 0.76$ DW = NS

If one considers the population and the time as two possible shifters in the aggregate demand for wheat, one will get the following ALS results:

$$\ln C_t^j = -19.31 + 1.84 \ \ln P_t^j + 0.66 \ \ln P_t^{01}$$

SE (5.39) (0.41) (0.35)

: probability (0.009) (0.003) (0.01)

$$+ 0.35 \ \ln P_t^{02} - 1.25 \ \ln \bar{Y}_t + 0.80 \ \text{Ng} \qquad (5.71)$$

SE (0.37) (1.07) (0.21)

: probability (0.37) (0.28) (0.006)

$$-0.57 \ T$$

SE (0.15)

: probability (0.007)

$R^2 = 0.94$ DW = NS

The interpretation of Equations (5.69) - (5.71) is not different from what has been stated before. The elasticities, i.e., the coefficients of the prices and income, are close to these obtained before.

In Equation (5.70), the income elasticity is 1.08. This implies that wheat is an inferior good in the range of $\bar{Y}_t$.[1]

Under the same set of assumptions, the OLS's results are:

$$\begin{array}{lllll}
 & \ln C_t^j = & -4.51 + 1.88 & \ln P_t^j + 0.79 & \ln P_t^{01} \\
\text{SE} & & (6.25)\ (0.62) & & (0.53) \\
P_r > |t| & & (0.49)\ (0.02) & & (0.17) \\
 & & +\ 0.63 & \ln P_t^{02} - 0.06 & \ln \bar{Y}_t \\
\text{SE} & & (0.59) & (1.60) & \\
P_r > |t| & & (0.32) & (0.98) & \\
 & & +\ 0.04 & Ng & \\
\text{SE} & & (0.04) & & \\
P_r > |t| & & (0.40) & & \\
R^2 = 0.80 & & & &
\end{array} \qquad (5.73)$$

---

[1] This interpretation is based upon the Slutsky equation, i.e., Silberberg (43) stated the equation as:

$$\frac{\partial X_i^M}{\partial P_j} = \frac{\partial X_i^U}{\partial P_j} - X_j^M \frac{\partial X_i^M}{\partial M} \qquad i, j = 1 \ldots n \qquad (5.72)$$

Where:

X_i^M = the quantity of good i,

P_j = the price of good j,

X_j^M = the quantity of good j, and

M = limited household income.

And Equation (3.93).

$$\ln C_t^j = -8.98 + 1.88 \ln P_t^j + 0.92 \ln P_t^{01}$$
SE (3.61) (0.62) (0.50)

$P_r > |t|$ (0.04) (0.01) (0.10) (5.74)

$$+ 0.64 \ln P_t^{02} + 1.10 \ln \bar{Y}_t$$
SE (0.59) (0.91)

$P_r > |t|$ (0.31) (0.26)

$R^2 = 0.78$

If one assumes that all the Egyptians are independent of one another, then one can get the per capita demand for ith individual, and sum over all the individuals to get the aggregate demand. This study has also used this procedure. The ALS results are:

$$\ln C_t^{ji} = -14.43 + 1.73 \ln P_t^j + 0.71 \ln P_t^{01}$$
SE (3.67) (0.50) (0.42)

: probability (0.003) (0.007) (0.13) (5.75)

$$+ 0.69 \ln P_t^{02} + 0.26 \ln \bar{Y}_t$$
SE (0.58) (0.93)

: probability (0.27) (0.79)

$R^2 = 0.69$ DW = NS

Adding time to represent the taste changes to the specification, the ALS results are:

$$\ln C_t^{ji} = -12.94 + 1.73 \ln P_t^j + 0.69 \ln P_t^{01}$$
SE (6.95) (0.54) (0.46)

: probability (0.10) (0.01) (0.18) (5.76)

$$+ 0.66 P_t^{02} - 0.04 \ln \bar{Y}_t + 0.01 T$$
SE (0.62) (1.51) (0.03)

: probability (0.32) (0.98) (0.80)

$R^2 = 0.69$ DW = NS

The OLS results of the specification in (5.75) are:

$$\ln C_t^{ji} = \underset{(3.53)}{\underset{(0.002)}{-15.19}} + \underset{(0.60)}{\underset{(0.01)}{1.88}} \ln P_t^j + \underset{(0.49)}{\underset{(0.13)}{0.81}} P_t^{01}$$

SE	(3.53)	(0.60)	(0.49)
$P_r > \lvert t \rvert$	(0.002)	(0.01)	(0.13)

$$+ 0.61 \ln P_t^{02} + 0.28 \ln \bar{Y}_t \qquad (5.77)$$

SE	(0.57)	(0.89)
$P_r > \lvert t \rvert$	(0.31)	(0.76)

$R^2 = 0.69$

The estimated forms so far give typical results; the forms (5.69)-(5.77) are the best to this study. The estimated elasticities, i.e., the estimated coefficients $\hat{\gamma}_i'$'s, may explain the Egyptian economy. But more evidence is still needed to judge these elasticities.

Beans

The same procedure used to analyze wheat will be used for beans. Table A.8 in the Appendix shows the stepwise results for beans. The price elasticity of the Marshallian demand function is negative and the income elasticities are positive. But most surprising is the magnitude of the income elasticities. This study has no clear evidence on these magnitudes. The sign of the cross elasticities is even harder to be interpreted. But if one realizes the lagging supply, he can easily believe in existence of the substitutability relationships. But it is hard to say with the increase in price of wheat and corn, whether bean consumption will increase. But since this is a gross elasticity, the sign is theoretically ambiguous (Equation (5.72)). Further, if one considers the sign of the income elasticity, as well as the significance level of all the elasticities, the sign will be either negative or the two goods are independent. In other words, if the net effect in Equation (5.72), i.e., $\partial X_i^u / \partial P_j$ is negative and the income effect is positive, then the resulting cross elasticity should be negative. If, on the contrary, one considers that the coefficients are not significantly different from zero, one may say that beans are independent from wheat and corn. In any case, more evidence is still needed.

The inclusion of the time variable may be the cause of a negative sign for the population effect, i.e., Ng. But, in general, the sign should be positive.

The estimation of Equation (3.95) on the aggregate or per capita basis does not show better results than those provided by stepwise procedure. Because of this, this study will present only the estimation of the reduced forms. The ALS results are:

	$\ln C_t^j =$	-3.68	$- 0.07 \ \ln P_t^j$	$+ 0.18 \ \ln P_t^{01}$	
SE		(13.01)	(0.62)	(0.68)	
t probability		(0.79)	(0.92)	(0.80)	(5.78)
		$- 1.29 \ \ln P_t^{02}$	$+ 3.12 \ \ln \bar{Y}_t$	$- 0.04$ Ng	
SE		(1.28)	(4.34)	(0.13)	
t probability		(0.36)	(0.50)	(0.79)	

$R^2 = 0.52$ DW = NS

The OLS results for the same form are:

	$\ln C_t^j =$	0.66	$- 0.26 \ \ln P_t^j$	$+ 0.27 \ \ln P_t^{01}$	
SE		(14.06)	(0.70)	(0.71)	(5.79)
t probability		(0.96)	(0.72)	(0.38)	

$$- 0.74 \ \ln P_t^{02} + 1.47 \ \ln \bar{Y}_t + 0.02 \ Ng$$

SE (1.42) (4.58) (0.14)

: probability (0.62) (0.76) (0.92)

$R^2 = 0.40$

The signs of the coefficients in (5.79) are about right. But all the coefficients are nonsignificant. If one accepts this high significance level, one will consider (5.79) the best possible even though the form suffers low R^2 and positive cross elasticity for beans and wheat.

As in the case for wheat, the per capita demand function has been estimated. The results are not good. The only reasonable form is:

$$\ln C_t^{ji} = - 7.24 - 0.46 \ \ln P_t^{j} + 0.19 \ \ln P_t^{01} \tag{5.80}$$

SE (4.22) (0.39) (0.68)

: probability (0.13) (0.28) (0.79)

$$- 0.92 \ \ln P_t^{02} + 1.40 \ \ln \bar{Y}_t$$

SE (0.59) (1.00)

: probability (0.16) (0.20)

$R^2 = 0.37$ DW = NS

Finally in Equation (5.80), the income elasticity is negative. (See Equations (3.93) and (3.95).) This result may be true. With increase in per capita income, bean consumption decreases, i.e., beans are an inferior good in the high range of $\bar{Y}_t$.

Corn

On the aggregate basis, the results of stepwise procedure for corn are shown in Table 5.11. The results for corn are good. The price elasticity is around -0.15. The corn tends to substitute for wheat

Table 5.11. The stepwise results for estimating the aggregate demand function for corn, 1965-1978[a]

Variables	Best one variable model	Best two variable model	Best three variable model	Best four variable model	Best five variable model	Best six variable model
Intercept	6.15	-1.22	-2.57	-2.28	-2.88	-2.62
SE[b]	--	--	--	--	--	--
$P_r > F$[c]	--	--	--	--	--	--
$\ln P_t^j$[d]	--	--	--	-0.15	-0.15	-0.14
SE	--	--	--	(0.20)	(0.20)	(0.22)
$P_r > F$	--	--	--	(0.47)	(0.48)	(0.56)
$\ln P_t^{01}$[e]	--	--	0.43	0.39	0.40	0.38
SE	--	--	(0.21)	(0.22)	(0.22)	(0.24)
$P_r > F$	--	--	(0.07)	(0.10)	(0.11)	(0.16)
$\ln P_t^{02}$[f]	--	--	--	--	--	0.08
SE	--	--	--	--	--	(0.25)
$P_r > F$	--	--	--	--	--	(0.76)
$\ln \bar{Y}_t$[g]	--	--	--	--	0.36	0.30
SE	--	--	--	--	(0.64)	(0.71)
$P_r > F$	--	--	--	--	(0.59)	(0.69)
N_g[h]	0.05	0.31	0.30	0.31	0.28	0.27
SE	(0.01)	(0.12)	(0.11)	(0.11)	(0.13)	(0.14)

$P_r > F$	(0.0001)	(0.03)	(0.02)	(0.02)	(0.07)	(0.10)
T[i]	--	-0.21	-0.20	-0.21	-0.19	-0.18
SE	--	(0.10)	(0.08)	(0.09)	(0.10)	(0.11)
$P_r > F$	--	(0.05)	(0.04)	(0.04)	(0.09)	(0.13)
R^2	0.79	0.86	0.90	0.91	0.91	0.91

[a]Source: Computed upon data from (6, 32, 52).

[b]SE is the standard error of the coefficient.

[c]$P_r > F$ is the probability of calculated F greater than the tabulated F.

[d]$\ln P_t^j$ stands for $\log P_t^j$. Where P_t^j is the price of final output of corn in £E per ton in year t.

[e]$\ln P_t^{01}$ stands for $\log P_t^{01}$. Where P_t^{01} is the price of wheat in £E per ton in year t.

[f]$\ln P_t^{02}$ stands for $\log P_t^{02}$. Where P_t^{02} is the price of rice in £E per ton in year t.

[g]$\ln \bar{Y}_t$ stands for $\log \bar{Y}_t$. Where $\bar{Y}_t$ is the limited disposable income per capita in year t.

[h]Ng stands for the total population in million individuals.

[i]T is the time.

and rice. These results may also be true. The population effect is positive, but the income effect tends to be negative.

The reduced form, i.e., Equation (3.95), has been estimated on an aggregate and per capita basis. On the aggregate basis, the ALS results are:

$$
\begin{array}{llllll}
 & \ln C_t^j = & 2.72 & - 0.22 \ln P_t^j & + 0.36 \ln P_t^{01} & \\
\text{SE} & & (2.68) & (0.19) & (0.20) & \\
t \text{ probability} & & (0.34) & (0.28) & (0.12) & \\
 & & + 0.21 \ln P_t^{02} & + 0.57 \ln \bar{Y}_t & + 0.04 \ \text{Ng} & \\
\text{SE} & & (0.28) & (0.67) & (0.02) & \\
t \text{ probability} & & (0.48) & (0.42) & (0.09) & \\
R^2 = 0.83 & & \text{DW} = \text{S} & & &
\end{array}
\tag{5.81}
$$

Comparing Equation (5.81) to the stepwise results, one can infer a little change in the magnitude of the elasticities. The inclusion of time in the equation causes this change. But in general, the results are still fairly good. Through interchanging the variables in the equation, other forms have been obtained. These forms are alternative explanatory forms. They are:

ALS:

$$
\begin{array}{lllll}
 & \ln C_t^j = & -1.60 & - 0.07 \ln P_t^j & + 0.38 \ln P_t^{01} \\
\text{SE} & & (1.82) & (0.24) & (0.26) \\
t \text{ probability} & & (0.40) & (0.77) & (0.18) \\
 & & + 0.24 \ln P_t^{02} & + 1.63 \ln \bar{Y}_t & \\
\text{SE} & & (0.31) & (0.48) & \\
t \text{ probability} & & (0.45) & (0.01) & \\
R^2 = 0.80 & & \text{DW} = \text{NS} & &
\end{array}
\tag{5.82}
$$

$$\ln C_t^j = -2.23 - 0.21 \ \ln P_t^j + 0.35 \ \ln P_t^{01}$$

SE (4.08) (0.19) (0.20)

$\dot{\sim}$ probability (0.60) (0.30) (0.13)

$$+ 0.15 \ \ln P_t^{02} + 0.35 \ \ln \bar{Y}_t + 0.25 \ Ng \qquad (5.83)$$

SE (0.26) (0.66) (0.15)

$\dot{\sim}$ probability (0.59) (0.61) (0.13)

$$- 0.17 \ T$$

SE (0.11)

$\dot{\sim}$ probability (0.18)

$R^2 = 0.88$ DW = NS

The estimated elasticities are the estimated coefficients. The OLS results for Equation (5.82) are not good. As for Equation (5.83), the OLS results are:

$$\ln C_t^j = -2.62 - 0.14 \ \ln P_t^j + 0.38 \ \ln P_t^{01}$$

SE (3.75) (0.22) (0.24)

$P_r > |t|$ (0.51) (0.56) (0.16)

$$+ 0.08 \ln P_t^{02} + 0.30 \ \ln \bar{Y}_t \qquad (5.84)$$

SE (0.25) (0.71)

$P_r > |t|$ (0.76) (0.69)

$$+ 0.27 \ Ng - 0.18 \ T$$

SE (0.14) (0.11)

$P_r > |t|$ (0.10) (0.13)

$R^2 = 0.91$

On a per capita basis, many forms have been tried. The only reasonable ALS results are:

$$\ln C_t^{ji} = -7.78 - 0.19 \ln P_t^j + 0.37 \ln P_t^{01}$$

SE (1.67) (0.18) (0.20)

∴ probability (0.001) (0.31) (0.10)

$$+ 0.23 \ln P_t^{02} + 0.81 \ln \bar{Y}_t \qquad (5.85)$$

SE (0.27) (0.43)

∴ prabability (0.41) (0.09)

$R^2 = 0.59$ DW = S

One could aggregate C_t^{ij} for all i individuals for i = 1, ... 42 million to get the aggregate demand. The estimated elasticities and forms above are the best this study can do.

Rice

The same procedure used for all other crops will be used for rice. Table 5.12 shows the stepwise results for rice. The results are good except for negative population effect. This study believes that including time in the equation may cause reverse signs for some coefficients. For instance, the ALS estimates of the reduced form show that the population has positive effects on the total requirements. The ALS estimates are:

$$\ln C_t^j = 7.77 - 0.63 \ln P_t^j + 0.12 \ln P_t^{01} + 0.08 \ln P_t^{02}$$

SE (4.45) (0.46) (0.37) (0.32)

∴ probability (0.12) (0.20) (0.75) (0.80) (5.86)

$$- 0.44 \ln \bar{Y}_t + 0.08 \ Ng$$

SE (1.11) (0.03)

∴ probability (0.70) (0.04)

$R^2 = 0.70$ DW = NS

Table 5.12. The stepwise results for estimating the aggregate demand function for rice, 1965-1978[a]

Variables	Best one variable model	Best two variable model	Best three variable model	Best four variable model	Best five variable model	Best six variable model
Intercept	6.68	20.37	19.80	19.69	19.28	19.58
SE[b]	--	--	--	--	--	--
$P_r > F$[c]	--	--	--	--	--	--
$\ln P_t^{j}$[d]	--	--	-0.36	-0.33	-0.36	-0.34
SE	--	--	(0.25)	(0.27)	(0.29)	(0.32)
$P_r > F$	--	--	(0.19)	(0.25)	(0.26)	(0.33)
$\ln P_t^{01}$[e]	--	--	--	--	0.13	0.12
SE	--	--	--	--	(0.31)	(0.33)
$P_r > F$	--	--	--	--	(0.69)	(0.72)
$\ln P_t^{02}$[f]	--	--	--	0.13	0.15	0.16
SE	--	--	--	(0.25)	(0.27)	(0.28)
$P_r > F$	--	--	--	(0.61)	(0.58)	(0.60)
$\ln \bar{Y}_t$[g]	--	--	--	--	--	-0.16
SE	--	--	--	--	--	(0.90)
$P_r > F$	--		--	--	--	(0.86)
N_g[h]	--	-0.48	-0.42	-0.44	-0.44	-0.42

SE	--	(0.14)	(0.14)	(0.15)	(0.15)	(0.18)
$P_r > F$	--	(0.005)	(0.01)	(0.02)	(0.02)	(0.05)
T^i	0.05	0.43	0.39	0.39	0.40	0.39
SE	(0.01)	(0.11)	(0.11)	(0.11)	(0.12)	(0.13)
$P_r > F$	(0.0001)	(0.002)	(0.005)	(0.007)	(0.01)	(0.02)
R^2	0.73	0.86	0.90	0.90	0.90	0.90

[a] Source: Computed upon data from (6, 32, 52).

[b] SE is the standard error of the coefficient.

[c] $P_r > F$ is the probability of calculated F greater than the tabulated F.

[d] $\ln P_t^j$ stands for $\log P_t^j$. Where P_t^j is the price of final output of rice in ŁE per ton in year t.

[e] $\ln P_t^{01}$ stands for $\log P_t^{01}$. Where P_t^{01} is the price of wheat in ŁE per ton in year t.

[f] $\ln P_t^{02}$ stands for $\log P_t^{02}$. Where P_t^{02} is the price of corn in ŁE per ton in year t.

[g] $\ln \bar{Y}_t$ stands for $\log \bar{Y}_t$. Where $\bar{Y}_t$ is the limited disposable income per capita in year t.

[h] N_g stands for the total population in million individuals.

[i] T is the time.

Except for the significance level of the coefficients, this fit is good. The rice is a normal good and is substitutable for wheat and corn. Worth noting is that Equation (3.93) says that the sum of the own and all price elasticities is equal negative the income elasticity, i.e., $\sum_{r=1}^{n} \lambda_r = -\lambda_{n+1}$. Or to say $-\sum_{r=1}^{n} \lambda_r = \lambda_{n+1}$ (Equation (3.93)). By this rule, the income elasticity for rice is 0.44. Approximately the same results have been obtained for wheat (Equation (5.69)). The OLS results of the same specification are:

$$
\begin{array}{lllll}
 & \ln C_t^j = 9.77 & - 0.51 \ \ln P_t^j & + 0.06 \ \ln P_t^{01} & \\
\text{SE} & (4.64) & (0.44) & (0.46) & \\
P_r > |t| & (0.07) & (0.28) & (0.91) & (5.87) \\
 & + 0.06 \ \ln P_t^{02} & - 0.99 \ \ln \bar{Y}_t & + 0.09 \ \text{Ng} & \\
\text{SE} & (0.39) & (1.19) & (0.03) & \\
P_r > |t| & (0.89) & (0.43) & (0.02) & \\
R^2 = 0.79 & & & &
\end{array}
$$

This study has tried many other forms, but their results are no better than these specified before. On a per capita basis, this study obtained the following ALS results:

$$
\begin{array}{lllll}
 & \ln C_t^{ji} = 1.03 & - 0.55 \ \ln P_t^j & + 0.14 \ \ln P_t^{01} & \\
\text{SE} & (4.88) & (0.43) & (0.39) & \\
\text{: probability} & (0.84) & (0.24) & (0.73) & (5.88) \\
 & + 0.09 \ \ln P_t^{02} & - 0.81 \ \ln \bar{Y}_t & + 0.05 \ \text{T} & \\
\text{SE} & (0.33) & (1.07) & (0.02) & \\
\text{: probability} & (0.79) & (0.47) & (0.08) & \\
R^2 = 0.51 & & \text{DW} = \text{NS} & &
\end{array}
$$

The Ordinary Least-Squares results, i.e., OLS, for the same specification are:

$$\begin{array}{llllll}
 & \ln C_t^{ji} = 2.48 & - 0.45 \ \ln P_t^j & + 0.10 \ \ln P_t^{01} & & \\
\text{SE} & (4.86) & (0.42) & (0.44) & & \\
P_r > |t| & (0.62) & (0.31) & (0.83) & & (5.89) \\
 & + 0.07 \ \ln P_t^{02} & - 1.16 \ \ln \bar{Y}_t & + 0.05 \ T & & \\
\text{SE} & (0.37) & (1.08) & (0.02) & & \\
P_r > |t| & (0.85) & (0.31) & (0.05) & & \\
R^2 = 0.58 & & & & &
\end{array}$$

The signs are correct, but the income elasticity is high. Even though the coefficients of $\ln \bar{Y}_t$ are not significant in Equations (5.88) - (5.89), the estimated income elasticity in (5.88) is more reliable.

Given the data, the above analysis and interpretation are the best this study can do. In this chapter, several trials have been made to get the best fit. The data are analyzed as accurately as possible. The implications of the supply and demand elasticities for all the crops are serious enough to be considered by the policymakers in Egypt.

Sugarcane

The data on sugarcane are not clear. This study has tried to convert all the final outputs into raw sugarcane and then do the estimation. But, the forthcoming data do not make sense to the researcher. The Ministry of Agriculture (32) does not publish the required figures. The figures published by FAO (10, 11) has been used in doing the preliminary calculations. But, the resulting figures are not accurate. Future studies may concentrate on estimating the demand for sugarcane and its by-products. In early parts of this chapter, this study has analyzed the response. The response analysis and the theoretical model are the contributions of this study. In the next part of this chapter, the demand side forecasts will be presented.

The Demand Side Forecasts

In this part, the forecasted values will be presented. The model forecast will be done in the same way as the supply side forecast, i.e., the forecasted values are estimated from the estimated reduced forms. The time forecasts are just forecasted values from time. Both results will be presented.

Now, the major issue is to determine the k in equation (3.95), i.e., how much should the prices increase or the quantity decrease in order to keep the requirements at a reasonable level. Once again, the Egyptian economy is characterized by (1) heavy subsidy levels, (2) overconsumption of the major food items, (3) very high population growth rate, and (4) unequal income distribution.

Given these facts, it is easy for one to say the government can reconsider the income distribution with no subsidy at all. This study believes that reconsidering the income distribution and deregulating the prices are the solutions to most of the major problems. The economic policymakers should recognize that the marginal utility of a free good is zero, and each Egyptian should only be paid the value of his/her marginal productivity. Without recognizing these basic rules of economics, the researcher believes that the economic recovery is far away.

From before, for one to set an arbitrary k value is a hard job. The results of Table 4.11 and the data from the Ministry of Agriculture (32) about the individual's needs can help one to infer the required X percent reduction in the consumption. This is the only way available to the study to subjectively determine the k in Equation (3.95).

Before determining k, Table 5.13 needs to be explained. This table is similar to Table 5.9. The calculations of the table are based upon the estimated reduced forms, as well as Equations (5.67) and (5.68). The model forecasts are net forecasts, or what is needed for human consumption. On the contrary, the initial time forecasts are the human consumption, in addition to other uses such as: seeds, what is lost, etc. Therefore, this study has adjusted the numbers to calculate the human consumption and the requirements (Equations (5.67) and (5.68)). For instance, in the case of wheat, the difference between the requirement and the consumption figures is 6 percent of the total stock. This 6 percent accounts for the seeds, the wheat lost in production and marketing processes, i.e., 94 percent of the stock of wheat are net for human consumption. The same adjustment has been done for beans, corn, and rice. From Table 5.13, the model forecasts are good as compared to the time forecasts. But as compared to current consumption figures, the model forecasts are considerably high for wheat and corn, low for beans, and just about right for rice. But the model's figures may be correct. The year 2000 is still far away, and the substitutes are very limited.

Table 5.13. The demand side forecasts for the year 2000[a]

Variable	Wheat	Beans	Corn	Rice	Row sugarcane
Total human consumption in 1000 tons					
Time forecast	10149.86	272.86	5403.03	2407.38	--
Model forecast	11246.15	440.10	5575.36	2312.60	--
Difference	1096.29	167.24	172.33	-94.78	--
Per capita consumption in kilogram per individual					
Time forecast	205.23	3.49	112.12	48.30	
Model forecast	206.51	4.104	101.19	43.56	
Difference	1.28	0.61	-10.93	-4.74	--
Total requirements in 1000 tons					
Time forecast	10797.75	368.73	5937.40	2588.58	14237.80
Model forecast	11920.92	554.53	6077.14	2474.48	--
Difference	1123.17	185.80	139.74	-114.10	--
Per capita requirements in kilogram per individual					
Time forecast	218.33	4.71	123.20	51.93	--
Model forecast	218.90	5.17	110.30	46.61	--
Difference	0.57	0.46	-12.90	-5.32	--

[a]Source: Computed upon data from the Ministry of Agriculture (32).

As stated before, Table 4.11 shows a very dangerous sign. This sign is the growth in the per capita requirements over time. This is due to the limited availability of the substitutes and complements. This is the essence of this study's proposed self-sufficiency policy in Chapter II. This study's proposed policy calls for an optimal price and consumption policies such that the total consumption and requirements fall by X percent. The problem is not only the population growth, as many studies believe, but also the needs growth due to limited availability of the substitutes and complements. If one takes into account the misuse of a loaf of bread, sugar, etc., one will at once recognize the importance of this study's proposed policies for Egypt. Once again, this study calls for (1) X percent increase in production, (2) X percent reduction in total consumption, and (3) optimal use of the major food items. In other words, Egypt should not subsidize the goods in order for people to misuse or overuse them. Egypt should subsidize the basic needs of needy consumers. One final note about Table 5.13 is that the model forecasts are calculated from the real variables such as prices and income. The inclusion of the shifters, such as population[1] and time, causes an upward bias in the results. For instance, the estimated wheat consumption, with population as a variable, is 22467.70 thousand tons. But, this figure is an over-

---

[1]As for the population projection, the first degree polynomial form projects the population to be 56.43 million in the year 2000. The second degree projects the population to be 64.150 million in the year 2000. While the third degree polynomial projects the population to be 81.468 million. So, this study considered the average which is 67.349 million.

estimated figure. Still, the current figures in Table 5.13 are accurate.

Given the data on the needs in Table 5.14, as well as the results of Tables 4.11, 5.9, and 5.13, one can determine the k in Equation (3.95). As for wheat, the consumption should fall, either by increasing the prices or regulating the consumption, from 206.51 kilograms to 129.69 kilograms, i.e., k = 0.41 or approximately 41 percent.
If this is the case, Egypt should produce 7057.19 thousand tons of wheat in order to be self-sufficient. From Table 5.9, under the best conditions, Egypt can produce 3918.22 thousand tons in the year 2000. Therefore, under this study's policies, Egypt can at the most be 56 percent self-sufficient in the year 2000. If one compares these results

Table 5.14. Consumption of the major crops in kilogram per individual, 1973-1977[a]

	Wheat	Beans	Corn	Rice	Sugar and honey
1973	96.06	6.60	63.11	37.70	23.30
1974	114.94	5.20	72.52	36.50	22.70
1975	135.01	6.90	75.37	37.00	23.30
1976	125.83	6.00	78.01	36.30	26.00
1977	126.63	5.30	85.94	32.70	25.70
Average	119.63	6.00	74.99	36.04	24.20
Average after war	129.69	6.07	79.77	35.33	25.00

[a]Source: Computed upon data from the Ministry of Agriculture (32).

to Table 5.1, one can infer that this study's policies will lead to a 22 percent increase in self-sufficiency by the year 2000. Further, for Egypt to be self-sufficient, she has to cultivate about 2922.23 thousand feddan of wheat. If, on the contrary, there is a deep taste change which leads to a change in the "loaf of bread components," Egypt will achieve a much higher degree of self-sufficiency in the year 2000.

As for beans, the results of Table 5.13 are below the average. In any case, Egypt needs to extend the beans area to about 426 thousand feddan in the year 2000. This is the only requirement for being self-sufficient in beans. Fortunately, this requirement is supposed to be easy to handle by the makers of crop rotations.

As for corn, this study calls for about a 0.27 percent reduction in the total requirements before the year 2000, i.e., k = 0.27 or 27 percent from the after-war average. Then, the results of Tables 5.9 and 5.13 suggest that Egypt will have no problem in being self-sufficient for corn in the year 2000 under this study's proposed model and policy.

The same conclusions are extended for rice, given this study's proposed policies, on consumption and production sides, Egypt will be just self-sufficient in rice production. If, on the contrary, the supply of land increases by the year 2000, Egypt will stay as a rice exporting country. The estimated k in this case is 0.23 or 23 percent of the after-war average, i.e., the rice exportation is predicted to fall sharply, but Egypt will, at the most, stay self-sufficient in rice in the year 2000.

The price adjustment should work simultaneously to reduce the rate of growth in the requirements by the desired k. The allocation should be seriously controlled, and finally the amount lost in the distribution processes should fall to zero. These are adjustments for the desired stable prosperity and welfare for every Egyptian.

Throughout this long chapter, this study analyzed the responses, the supplies, and the demands. The econometric model set by this study can be used for all other crops. In the next chapter, this study will concentrate on comparing this study's policies to all other possible self-sufficiency policies.

CHAPTER VI. THE ALTERNATIVE SELF-SUFFICIENCY POLICIES

In this chapter the self-sufficiency alternatives will be considered in relation to their costs. In order for one to compare the alternatives, one should calculate Equation (3.114). If, the alternatives result in a positive Net Present Value (NPV), then, one can choose the alternative which makes everybody better off. In Egypt, this specification has often been neglected. If the previous studies use these rules, some undesired side effects of the previous policies would have not occurred.

In order to calculate Equation (3.114), a large body of accurate information is needed. The data on the major variables, such as the current costs and benefits, are not available to the researcher. This study has examined all possible sources to get such data, but the data are not available. Then, the only way is to consider the imputed costs and benefits of alternatives based on some observable evidence. And, this is what this study will do in this chapter. As stated before on pages 31 and 32 of this dissertation, the options available to Egypt are to adopt new policies or to import. For Egypt to import at least wheat, beans, and sugar, several issues have to be considered. These issues are:

(1) The policymakers should consider the availability of the required hard currency,

(2) the worldwide inflation rate, and

(3) the world political stability.

These key points should be taken into account before the year 2000. On the contrary, if Egypt relies on the world market for part of her essential food, Egypt can:

(4) Increase the production of other crops, such as vegetables, fruits, etc., and

(5) Develop the other sectors of the economy at the expense of the agricultural sector.

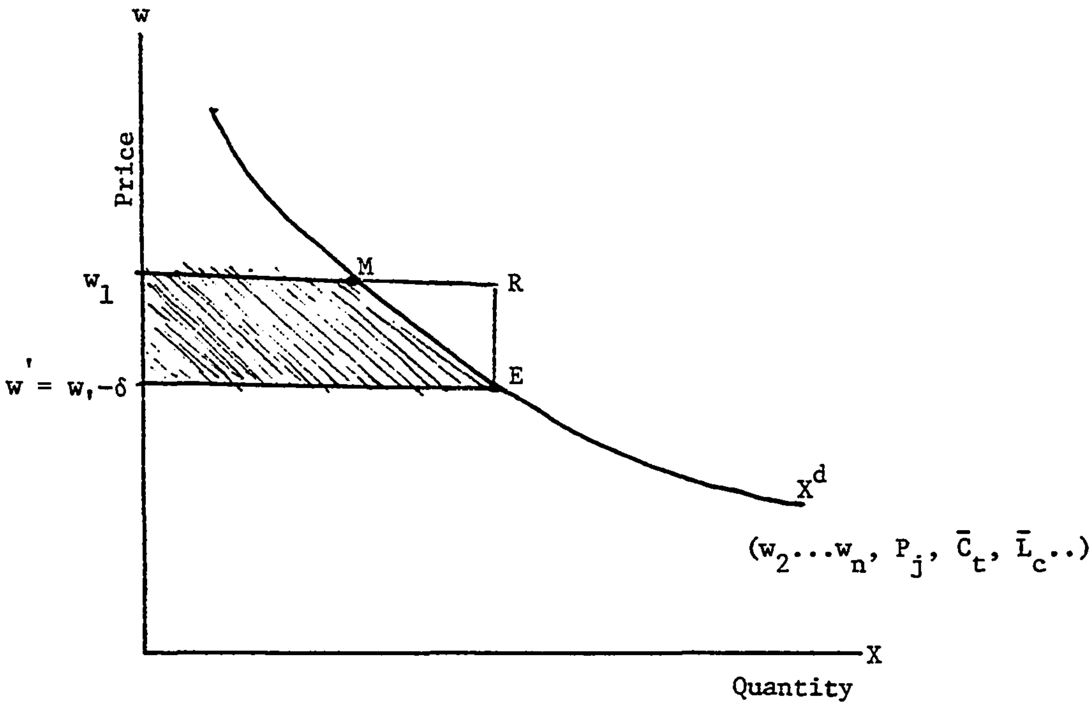
Issues (1) - (3) could be considered as disadvantages, while (4) - (5) are advantages. The economic policymakers should weigh these issues considerably. Furthermore, if the decision is to import, there should be some regulations on the imported items. For instance, Egypt should only import the essential foods. Goods with high income elasticities could be imported in very limited quantities as long as the Egyptian alternatives are available. In other words, this study believes that Egypt should adopt her importation policies based on the income elasticities of the goods in all income classes. Again, if the government wants to help people, it is important to realize who should be helped.

So, in summary, Egypt faces a difficult decision. Nothing is wrong with increasing the size of imports. But, this decision should be made based on an intense study of (1) the expected increase in population and income, (2) the expected world inflation rate, and (3) the income elasticities for goods in all income classes. Without such a study, there will be major side effects of any importation policy. And hence, some people will be better off and some others will be worse off (i.e., Pareto nonoptimal situation).

As for subsidizing the producers and the consumers with no importation, this alternative has been used for a long time. Even a combination of importation and subsidization policies has been tried in Egypt. It is hard to say that these policies are not totally successful, but it is easy to say that they resulted in (1) a misallocation of the resources, (2) unequal income distribution, and (3) mis- and overuse of the subsidized goods. These side effects may justify the major issues such as: What should be imported; what should be subsidized, and finally whom should not be subsidized?

In general, to consider the input subsidization alternative, this study will start with Equations (3.114), (3.87) - (3.88) and Figure 6.1. The government of Egypt pays the value of the input subsidizations in order to shift the aggregate supply upward. Except for the difficulty of getting the required data, the procedure of fitting Equation (3.88) is not different from the procedure used before for fitting Equation (3.95). Figure 6.1 is self-explanatory, with a reduction in the input prices by δ the farmers will utilize more inputs. The government pays an amount equal to δx or $w_1w'MRE$. This will lead to positive net gains to the Egyptian farmers. These gains are equal to $w_1w'ME$ or the result of the integral on page 201. Fortunately, the Ministry of Agriculture (32) publishes these values. Table 6.1 shows the agricultural subsidies through the period 1970-1979.

The results of Table 6.1 show that the input subsidies are increasing over time. With the increase in the general prices after the 1973 war, the subsidies have increased substantially.



The shaded area = The change in the producer's surplus

$$= \int_{w'}^{w_1} X^d(w_i, P_t^j, \delta, \bar{C}_t, \bar{L}_c)\, dw$$

The cost to the government = $w_1 w'MRE$.

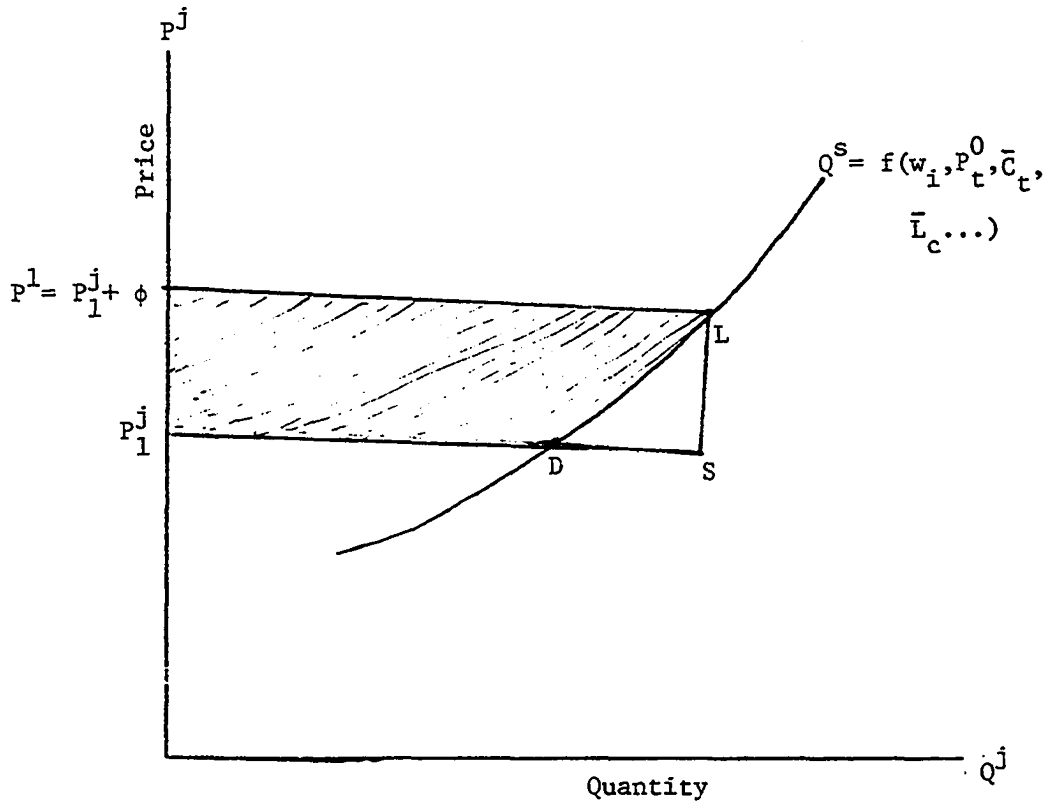
Figure 6.1. Changes in the producer's surplus and costs to the Egyptian government due to the input subsidization policy

Table 6.1. Agricultural subsidy in thousand pounds, 1970-1979[a]

Year	Subsidy	Proportion of the total over the period 1970-1979
1970/1971	427	0.001
1971/1972	13,684	0.03
1973	17,627	0.04
1974	71,827	0.14
1975	110,824	0.22
1976	69,576	0.14
1977	63,960	0.13
1978	65,188	0.13
1979	96,380	0.19
Total 1970-1979	509,493	1.021

[a]Source: The Ministry of Agriculture (32).

The argument may hold true for the price supports, i.e., Equations (3.89) - (3.90), and Figure 6.2. If the government of Egypt supports the farmers by paying Θ_t^j per unit of jth crop produced, then the government has to pay $\Theta_t^j Q_t^j$ for Q_t^j units of jth crop. In both cases, both the consumers and producers will be better off because the producers will realize net gains from increasing their prices. Further, the consumers will realize the increased flow of the major food items. This is true from a pure theoretical point of view. But, the issue is not this simple in Egypt. As stated before, the farms are of small size, i.e., most of the producers are small sized farm producers. The producers may also be the major consumers. Moreover, the population is increasing very rapidly, and the cost of living is also increasing. From



The shaded area = The change in the producer's surplus

$$= \int_{P_1^j}^{P^1} Q^s(w_i,\ P^j,\ P_t^0,\ \bar{C}_t^j,\ \bar{L}_c^j)\,dp.$$

The cost to the government = $P^1 P_1^j LSD$.

Figure 6.2. Changes in the producer's surplus and the costs to the government due to the output price support policy

these facts, the subsidization policy which has been used for a long time does not result in a solution to the major problem. If one takes into account the misuse and the over use of the subsidized goods, one can easily realize what has been said many times in this dissertation about the subsidies. It is much better for the government of Egypt to reconsider the income distribution problem in relation to the productivity of each Egyptian with no subsidies at all, if the government continues subsidizing the consumers and producers. This study calls for an answer to the major question: Who should not be subsidized and what should be subsidized?

If, on the contrary, this study's policies have been used, realized net gains for the consumers and producers will exist. The producers will gain at least the increasing efficiency of their extensively used farmland. The consumers will gain the increased flow of goods. The government will also get indirect gains. If one considers the investment in farmland as compared to subsidizations, one will easily realize the major issue. The investment produces return, but the subsidies may or may not do so. The subsidies may turn into a kind of consumption. Further, if the government proves to be successful in changing the tastes and components of the diet, the government will save part of the money spent on the imports. If the goods are efficiently controlled and allocated, the price variations and income differentials will be adjusted to a desirous level. So, from analysis before, this study's three policy actions in Chapter II may be the best alternative, given the population growth and the limited supply of farmland. There is no clear side effects of this study's policies. But, on the contrary, they should be considered as major national goals in Egypt. In the United States, the most developed country with a huge amount of land resources, the government and the public are concerned with the efficiency of their farmland. As far as the researcher knows about America, millions of dollars are spent annually on the land conservation programs. Other developed nations are even keeping the land for future uses. In Egypt, on the contrary, the land is extensively used and housing and industrial uses extend at the expense of the farmland. These issues are dangerous if Egyptians are concerned with the future food supplies.

Given these facts, it is the responsibility of the public and the government to direct the flow of investment toward expanding and improving the current supply of farmland. This once again should be considered as a national goal. The figures from the Ministry of Agriculture (32), suggest that Egypt is importing soil in the form of fertilizers. From Chapter II of this dissertation, it is also very significant for the policymakers to reconsider the issues of water and mud uses. The conservation programs can cost the Egyptians nothing if they find a way to reconsider God's reward to Egypt, i.e., the Nile. But, on the contrary, reconsidering these issues will save Egyptians millions of dollars spent on importing land, in terms of fertilizers, annually. So, to summarize, there is still much hope, if the Egyptians are serious.

In a similar fashion, taste adoption and changing the diet component are also required in Egypt. As stated before, it is surprising to this study that the substitutes and the complements are limited such that the per capita consumption is increasing. In Chapter V, this study has cleared this issue. The objectives of this study's policy are to reduce the total consumption level of each crop by X percent. This policy action will result in net gains to the consumers, producers, and government. To do so, however, both the public and government should cooperate. It is not hard for people to get used to mixed wheat bread instead of pure wheat bread. If the government tries to direct some diet programs, there will be net gains at a minimum cost.

Finally, the other issues such as: the price stability, the regional allocation, etc., should seriously be considered. The retail profits and the allocation of the goods on the total effective demand must be directed. In other words, this study has revealed the issue of insufficient market information. Egypt had an institution for such information once before. Such organizations must be established and directed. It will be very helpful for the policymakers to set their policies based upon accurate market information. Furthermore, every consumer and producer should know the accurate price figures. This may help in organizing the distribution of the goods. Further, it will lead to eliminating some phenomenon such as "body under the table," "black markets," etc.

As compared to other policy alternatives mentioned before, this study's policies are necessary and cheap. According to the published figure, Egypt is an over-importing and over-subsidizing country. But, this does not lead to a solution of the major problems. Further, the policymakers should consider how far Egypt can go under these conditions. The investment in land resources and taste adoption policies will save Egypt a lot of money. This is the contribution of this study to this point. Future studies may use this study's theoretical model to extend the cost analysis.

Sudan-Egypt Integration

This issue has been debated for a long time. Egypt has the labor and hopefully, in the future, the capital. Sudan, on the other hand, has the fertile land. If one uses the knowledge about the production function in Equation (3.1) and assumes that the land, labor, and capital are cooperative inputs, one can easily infer that both countries will be better off from integration. This study believes that if such integration exists, both countries will be major food producing and exporting countries. The barriers of integration between Egypt and Sudan can easily be broken. This matter is very important and needs to be seriously considered. The basis of the integration in both countries starts with major economic problems, i.e., Sudan suffers low national income as compared to Sudan's needs. It also lacks a well-trained labor force to originate the required income. Egypt lacks the farmland as compared to the Egyptians' needs. Sudan, on the other hand, has the land. Egypt has the well-trained labor force. So, it seems to this study that Egypt and Sudan together can do something positive. The prosperity of both nations hangs on breaking down the existing barriers of integration.

In these six chapters, this study has tried to determine the major problems and the optimal solutions. There are, however, many things left for future studies. There is also still much room for economic recovery and prosperity in Egypt.

CHAPTER VII. SUMMARY AND CONCLUSIONS

Summary

Due to the dramatic shift in the Egyptian aggregate demand for the last three decades, it is of great importance to study self-sufficiency in Egypt. But, to study such a complicated matter, a policymaker should start from the structural changes in Egypt. Because of this fact, this study has analyzed the previous production, consumption, and price policies. Then, this study sets a theoretical and an econometric model to analyze the farmers' response and the consumers' demand. The objectives of setting such models are to infer and to predict as accurately as possible. This study's model is its first contribution in the agricultural policy area. The model starts from the ordinary theory of the firm and the ordinary theory of the consumer. Then, the reduced forms of the model are specified under the restrictions and the conclusions of the model.

Three reduced forms of the model have been obtained. Under the assumption that the Egyptian farmers are relative profit (non) responsive, the first reduced form is:

$$A_t = a_0 + a_1 \pi_{t-1} + a_3 T + u_t$$

Where A_t = actual area under cultivation at time t, π_{t-1} is the relative profitability of jth and kth crops in year t-1, for j,k=1,2...n, T is time to represent the technology, and u_t is the random disturbance term. This form is a modified form of the Nerlove model.

In order to estimate the elasticity of supply and to predict the food supply by the year 2000, the second reduced form of the model is

$$A_t^j = k_0 + k_1 P_{ft-1}^j - k_2 V_t^j + k_3 \bar{C}_t^j + k_4 T + w_t$$

Where A_t^j = area cultivated with jth crop in period t, P_{ft-1}^j is the real price of jth crop in period t-1, V_t^j is the real variable cost of jth crop in period t, C_t^j is short and intermediate-run loans per feddan in period t, T is time to represent the technology, and w_t is the random disturbance term. The estimation time period is different among the crops. In general, the period is from 1965 to 1978. The coefficients of this form, i.e., k_i's include the long-run land improvement coefficient.

The third reduced form, however, is

$$\ln C_t^j = \gamma_0' + \gamma_2' \ln P_t^j + \gamma_{0i}' \ln P_t^{0i} - \gamma_3' \ln \bar{Y}_t$$
$$- \delta_1 k(I-E) + \delta_2 Ng + \delta_3 F_L^j + u_t$$

Where $\ln C_t^j$ is log C_t^j, where C_t^j is the consumption of jth crop in period t, $\ln P_t^j$ is log P_t^j, where P_t^j is the real price of jth crop in period t, $\ln P_t^{0i}$ is log P_t^{0i}, where P_t^{0i} is the real price of other complements and substitutes in period t, $\ln \bar{Y}_t$ is log $\bar{Y}_t$, where $\bar{Y}_t$ is the real limited per capita disposable income in period t, k(I-E) stands for diet change where $0 < k < 1$ and (I-E) is the Import (I) minus Export (E), i.e., k is a policy subjective coefficient, Ng is the population per million, F_L^j is the world market supply of jth crop, and u_t is random disturbance term. This reduced form is obtained under the homogeneity of demand function condition, i.e., the demand function of jth crop is homogeneous of degree zero in all prices and income. This condition can be restated as the sum of own and all price elasticities is equal to negative income elasticity. This is the essence of the Euler therom.

The reduced forms are set upon a well-defined economic theory. The purpose of these forms is to predict the year 2000, therefore, the multicollinearity is expected to be absent. In fitting these forms, the autocorrelation has been tested. This adjustment is required to ensure the accuracy of the estimated elasticity and the prediction.

In studying the structure of the agricultural sector, this study finds that around 50 percent of the Egyptian farmland needs different improvement treatments. Further, the current supply of farmland is decreasing at an annual rate of 26.50 thousand feddan. This is due to the expansion of housing and industrial use land.

The employment in the agricultural sector is decreasing at an annual rate of -0.37 percent, while the labor shares are increasing at a rate of 14.92 percent per annum. The movement of the agricultural labor to nonfarm occupations is desirous because of high labor intensity. But, such a movement should carefully be carried out in order to insure the feasibility of a well-trained labor force in agriculture. This study also finds that Egypt has good management abilities, but the government should find a way to make the best use of these human resources. On the contrary, the study finds that the agricultural sector lacks the capital. The agricultural sector originates more income than does the industrial sector, but the agricultural sector gets less investment.

As for crop rotations, the study finds that Egypt has comparative advantages in producing the major study crops as compared to other major producing countries. In general, there is a strong trade-off, on the limited area, between these crops. The rate of annual growth of the area ranges from -3.22 percent for beans to 4.63 percent for sugarcane. On the contrary, the annual rate of growth in productivity per feddan ranges from -0.80 percent for sugarcane to 1.92 percent for wheat.

As for the cost and price structure for wheat, beans, corn, rice, and sugarcane, the results show that except for the nominal and real variable costs for sugarcane, the nominal and real variable costs for all crops increase at higher rates than the nominal and real prices do.

On the demand side, the total and the per capita requirements are growing annually. The annual rate of growth in the total requirements ranges from 3.89 percent for sugarcane to 5.43 percent for wheat. The annual rate of growth in the per capita requirements ranges from 1.56 percent for corn to 2.51 percent for wheat. These rates imply that the substitutes and the complements are very limited.

The study finds that the farmers are generally responsive to the change in the relative profits, i.e., the profit of jth crop relative to the profit of kth crop, and to the real prices. The supply price elasticity is about 0.27 for wheat, 0.09 for beans, 0.15 for corn, 0.19 for rice, and 0.06 for sugarcane. A wide range of supply elasticities has been obtained. This is because several forms have been fitted for each crop.

The income and price elasticities of demand estimated by this study's model are more difficult to be interpreted than the supply elasticities. The results for wheat are inconsistent, i.e., both the income and price elasticities are positive. As for beans, the study has obtained good results for the elasticities. But R^2 is low and the coefficients are highly nonsignificant. The price elasticity of the aggregate demand is about -0.26. While the income elasticity is about -1.47. On a per capita basis, the price elasticity is about -0.46 and the income elasticity is about -1.40. The implications of the income elasticities are true, i.e., with high income people tend to consume less beans, i.e., beans are an inferior good in the high range of income.

As for corn, the price elasticity is about -0.15. Corn tends to substitute for other crops, such as wheat and rice. But, most surprising is that the income elasticity is negative. As for rice, both income and price elasticities are good. The price elasticity is about -0.35, while the income elasticity is about 0.16. The data for sugarcane are much more complex to compute. Future studies may fit the demand model for sugarcane, when clear data are available.

The forecasted values of the model are good. Several forecasting techniques have been tried in this study. In general, the model forecasts fairly good.

The results of this study's policies show that Egypt could be self-sufficient in the year 2000 in beans, corn, and rice, by following this study's proposed policies. As for wheat, Egypt could achieve a 22 percent increase in the degree of self-sufficiency in the year 2000. All of this holds true under the considerations of this study's model.

Investment in the land resources and taste adoption policies, i.e., this study's policies are necessary and cheap as compared to the other alternatives such as importation, input subsidization, price support, etc. Finally, if Sudan-Egypt integration were to exist, both countries could be better off.

Conclusions and Policy Implications

The objectives of this study's policies are to shift the aggregate food supply upward, and to reduce the consumption levels through adopting a consumer taste. The major conclusions are:

(1) The vertical and horizontal land programs are now more vital to Egypt than they ever have been. The flow of investment should be changed toward improving and increasing the current supply of farmland. This is the responsibility of both the public and the government.

(2) The current crop system should be changed in the direction of the comparative advantages that Egypt has in food production. In addition to the comparative advantages, the farmers' attitude toward the crops should be taken into consideration in setting the new rotation.

(3) The annual rates of growth in the requirements should match the annual rates of growth in the production. This could be done by changing the tastes, creating more substitutes and complements, etc.

(4) The implications of elasticities on both the supply and demand sides should be studied and used for future planning.

(5) Several other general issues should be reconsidered. These are:

   (a) The efficiency of the cooperative system and the input subsidization, and

   (b) Some classical issues such as: the price interrelationships and the income distribution, subsidy for what and and whom, the price-variable cost ratios, etc.

(6) The Egyptian economy can do much better if this study's policies are put into action.

Starting from the profitability matrix up to the demand elasticities, the results of this model should be seriously considered.

Suggestions for Future Research

In many parts of this dissertation, the study pointed out some issues for future research. These issues are:

(1) The price structures and price policies need to be studied in detail. This could be done by fitting this study's model with prices as endogenous variables.

(2) If the exact figures of income per individual from all sources are available, it can be incorporated into the model. The

same could be done for the capital on the supply side. This may help in making good inferences from these two variables.

(3) This study's theoretical model can be extended to any number of variables and to any number of crops. Future studies can extend the model to a national general equilibrium model.

(4) Other analytical techniques such as a programming model can be used to create some values or some solutions. This study has considered this case in Chapter III of this dissertation. Future studies can extend the work in this way.

(5) Finally, comparing the costs of the self-sufficiency alternatives needs further work when a good data set is available. Equation (3.114) could be used in this case.

As stated before, there is still much hope for the Egyptian economy to recover. If the studies are done as accurately as possible, the welfare and the prosperity will not be far away.

REFERENCES

1. Abdel-Fadil, M. Development, Income Distribution and Social Change in Rural Egypt: 1952-1975. Cambridge, England: Cambridge University Press, 1975.

2. Askari, Hossein and Cummings, John T. "Estimating Agricultural Supply Response with the Nerlove Model: A Survey." International Economic Review 18, No. 2 (June 1977):257-292.

3. Barker, Randolph and Hayami, Yujiro. "Price Support Versus Input Subsidy for Food Self-Sufficiency in Developing Countries." American Journal of Agricultural Economics 58, No. 4 (November 1976): 617-627.

4. Branson, William H. Macroeconomic Theory and Policy. 2nd edition. New York: Harper & Row Publishers, 1979.

5. Central Agency for Public Mobilization and Statistics (CAPMS). "Income Estimation from the Agricultural Sector 1976." Reference No. 71-12425/78. Cairo, Egypt: CAPMS, July 1979.

6. Central Agency for Public Mobilization and Statistics (CAPMS). Statistical Year Book for United Arab Republic of Egypt 1952-1978. Cairo, Egypt: CAPMS, July 1979.

7. Dar Al-Ahram. "Future of Food in Egypt." Al-Ahram Iktisadi, August 18, 1980.

8a. Dorner, Peter. Land Reform and Economic Development. Baltimore: Penguin Books, Inc., 1972.

8b. El-Nagar, R. and Aita, A. "Other Farmland Uses." Arabic Youth 729 (1981):9.

9. Emarah, Riad El-S. "An Analytical Study of the Agricultural Productivity in El-Gharbia Governorate." M.Sc. thesis, Cairo University, 1977.

10. Food and Agricultural Organization of the United Nations. FAO Production Year Book. Vols. 14-33. Rome: FAO, 1960-1979.

11. Food and Agricultural Organization of the United Nations. FAO Trade Year Book. Vols. 14-33. Rome: FAO, 1960-1979.

12. Freund, John E. and Walpole, Roland E. Mathematical Statistics. 3rd edition. Englewood Cliffs, New Jersey: Prentice Hall, Inc. 1980.

13. Gadalla, Saad M. Land Reform in Relation to Social Development; Egypt. Columbia: Columbia University Press, 1962.

14. Habashy, Nabil T., Fitch, James B., and Rehiwi, Salwa. "Egypt's Agricultural Cropping Pattern. A Review of the System by which It Is Managed and the Relationship to Price Policy." Ministry of Agriculture, Cairo, Egypt. Project Research Paper No. 4: 82-141.

15. Harik, Iliya and Randolph, Susan. "Distribution of Land, Employment and Income in Rural Egypt." Center for International Studies, Cornell University, Ithaca, New York, Report LNL No. 5, December 1979.

16. Hastings, Steven E. and Goode, Frank M. "The Influence of Input Supply and Output Demand on Industrial Growth in Rural Communities." Paper presented at the American Agricultural Economics Association Meeting, Clemson, South Carolina, July 1981.

17. Heady, Earl O. "Interdisciplinary Modeling to Improve Agricultural Decision and Policies, Food Production and Human Nutrition." Raleigh: North Carolina State University, September 17, 1979.

18. Heady, Earl O., Faber, Doeke C., and Sonka, Steven T. "A World Food Analysis: Grain Supply and Export Capacity of American Agriculture Under Various Production and Consumption Alternatives." The Center for Agricultural and Rural Development, Iowa State University, CARD Report No. 60, September 1975.

19. Heady, Earl O., Short, C., and English, Burton C. "Tatonnement Modeling: A Variation to Linear Programming." Paper presented at American Agricultural Economics Association Meeting, Clemson, South Carolina, July 1981.

20. Houthakker, Hendrik S. "The Causes of the Farm Problem." In Economics Readings in Analysis and Policy. Edited by Dennis R. Starleaf. Atlanta: Scott, Foresman and Company, 1969.

21. Intriligator, Michael D. Econometric Models, Techniques, and Applications. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1978.

22. Johnston, J. Econometric Methods. 2nd edition. New York: McGraw-Hill Book Company, Inc., 1972.

23. Johnston, J. Statistical Cost Analysis. New York: McGraw-Hill Book Company, Inc. 1960.

24a. Jordan, Paul. Egypt the Black Land. New York: E. P. Dutton & Co., Inc., 1976.

24b. King, R. Land Reform, A World Survey. U. K., London: Bell & Sons Ltd., 1977.

25. Klöwer, G. G. and Spatzker, M. "The Egyptian Village in Social Change. Social Integration and Participation from the Example of the Egyptian Village and Its Agricultural Cooperatives." Internationale Afrikaforum (1978): 163-1975.

26. Ladd, George W. "Experiment with Autoregressive Error Estimation." Iowa Agricultural and Home Economics Experiment Station Research Bulletin 533, February 1965.

27. Ladd, George W. and Martin, James E. "Application of Distributed Lag and Autocorrelated Error Models to Short-Run Demand Analysis." Iowa Agricultural and Home Economics Experiment Station Research Bulletin 526, May 1964.

28. Larson, Harold J. Introduction to Probability Theory and Statistical Inference. 2nd edition. New York: John Wiley & Sons, 1974.

29. Layard, P. R. G. and Walters, A. A. Microeconomic Theory. New York: McGraw-Hill Book Company, Inc., 1978.

30. Luppold, William and Havlicek, Joseph, Jr. "Demand, Supply and Price of Hardwood Lumber." Paper presented at American Agricultural Economics Association Meeting, Clemson, South Carolina, July 1981.

31. Mayfield, James B. "Local Institutions and Egyptian Rural Development." Center for International Studies, Cornell University, Ithaca, New York, Report RLG No. 3, November 1974.

32. Ministry of Agriculture. Records of the Research Institute of Agricultural Economics and Statistics. Cairo, Egypt: Author, 1978 and 1979.

33. Ministry of Agriculture. Records of the Research Institute of Soil. Cairo, Egypt: Author, 1974.

34. Murdoch, William W. The Poverty of Nations: The Political Economy of Hunger and Population. Baltimore: The Johns Hopkins University Press, 1980.

35. Orcutt, Guy H. and Winokur, Herbert S., Jr. "First Order Autoregression: Inference, Estimation, and Prediction." Econometrica 37, No. 1 (1969):1-13.

36. Parker, C. Egypt in Developing Agriculture of the Middle East - Opportunities and Prospects. U. K., London: Graham and Trotman Ltd., 1976.

37. Paulsen, Arnold. "Assessment of the Policy of Self-Sufficiency Especially for Food and Agriculture in Syria." Department of Economics, Iowa State University, July 21, 1979.

38. Pongsihadulchai, Apichart. "Supply Analysis of Important Crops in Thailand." Ph.D. Dissertation. Iowa State University, Ames, 1981.

39. Radwan S. "The Impact of Agrarian Reform on Rural Egypt (1952-1975)." Working papers. World Employment Programme Research, the International Labor Office, Geneva, 1977.

40. "Report of the World Land Reform Conference, Rome, Italy, June 20-July 2, 1966." New York: United Nations, 1968.

41. Ricardo, David. The Principles of Political Economy and Taxation. U. K., London: J. M. Dent & Sons Ltd., 1911.

42. Schultz, T. W. Transforming Traditional Agriculture. New Haven: Yale University Press, 1964.

43. Silberberg, Eugene. The Structure of Economics: A Mathematical Analysis. New York: McGraw-Hill Book Company, Inc., 1978.

44. Smith, Adam. The Wealth of Nations. Book I. New York: The Modern Library, 1937.

45. Timmons, John F. "Identification and Achievement of Environmental Quality Levels in Managing the Use of Natural Resources." Iowa Agricultural and Home Economics Experiment Station Journal Paper 7157, 1974.

46. Timmons, John F. "Issues in Land Use, Planning and Control." Proceedings of Iowa State University Faculty Symposium on Land Use Planning and Control, January 11, 1973.

47. Tweeten, Luther G. "An Economic Analysis of the Resource Structure of United States Agriculture." Ph.D. Dissertation. Iowa State University, Ames, 1962.

48. Ulmer, Martin J. "Impact of Modern Medicine and Biology on Developing Nations." A Symposium on Technology and Social Change in Foreign Cultures. Department of Zoology and Entomology, Iowa State University, February 1973.

49. Weaver, Robert D. "Agricultural Price Expectations: An Erroneous, but Better Approach to Measurement." The Pennsylvania Experiment Station Staff Paper 43, January 1981.

50. Weaver, Robert D. "Supply and Input Choice Response by Multiproduct Firms: New Approaches." Proceedings of a Symposium Presented at Joint Meetings of the American Agricultural Economics Association and Canadian Agricultural Economics Society. Virginia Polytechnic Institute and State University, August 8, 1978. University Park, PA: Pennsylvania State University, October 1978.

51. "World Tables 1976." From the Data Files of the World Bank. Baltimore: The Johns Hopkins University Press, 1976.

52. "World Tables 1980." 2nd edition. Baltimore: The Johns Hopkins University Press, 1980.

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APPENDIX

Table A.1. Report of the Minister of Food and Agriculture about the agricultural production, consumption, and importation, 1960-1979[a]

Commodity	1960	1970	1977	1978	1979
Wheat:					
Production	1,443	1,269	1,697	1,933	1,856
Consumption	2,185	2,361	5,999	7,053	6,707
Imports	624	1,036	4,302	5,120	4,851
Rice:					
Production	1,056	1,736	1,477	1,528	1,630
Consumption	846	1,136	1,284	1,375	1,505
Imports	-	-	-	-	-
Exports	207	605	193	153	125
Beans:					
Production	208	297	270	231	236
Consumption	230	297	293	263	255
Imports	22	-	32	32	19
Oils:					
Production	109	130	91	112	123
Consumption	104	178	327	355	414
Imports	-	57	236	243	291
Exports	5	-	-	-	-
Sugar:					
Production	338	324	603	629	620
Consumption	278	230	808	922	971
Imports	-	-	205	293	351
Exports	43	89	-	-	-

[a]Source: Dar Al-Ahram (7).

Table A.2. Actual and projected food deficits in selected less developed countries[a]

Country	Actual 1975 (Million metric tons)	Actual 1975 (Percentage consumption	Actual 1990 (Million metric tons)	Actual 1990 (Percentage consumption)
India	1.4	1	17.6 -21.9	10-12
Nigeria	0.4	2	17.10-20.5	35-39
Bangladeh	1.00	7	6.4 - 8.0	30-35
Indonesia	2.1	8	6.0 - 7.7	14-17
Egypt	3.7	35	4.9	32
Shahel group	0.4	9	3.2 - 3.5	44-46
Ethiopia	0.1	2	2.1 - 2.3	26-28
Burma	0.4	(7)	1.9 - 2.4	21-25
Philippines	0.3	4	1.4 - 1.7	11-13
Afghanistan	-	-	1.3 - 1.5	19-22
Bolivia and Haiti	0.3	24	0.7 - 0.8	35-38

[a]Source: Murdoch (34).

Table A.3. Supply elasticities, by crop and region[a]

Crop	Period	Elasticity	
		Short-run	Long-run
Rice	1920-1940	-0.21	-0.24
	1953-1972	+0.08	+0.08
Wheat	1920-1940	+0.01	+0.01
	1953-1972	+0.91	+0.44
Maize	1920-1940	-0.16	-0.25
	1953-1972	+0.04	+0.09
Beans	1920-1940	+0.01	+0.01
	1953-1972	+0.19	+0.14
Onions	1920-1940	+0.05	+0.06
	1953-1972	+0.16	+0.13
Cotton	1899-1937	+0.38[b]	-
	1914-1937	+0.52[b]	-
	1920-1940	-3.36	-5.18
	1953-1972	-0.09	-0.08

[a]Source: Askari and Cummings (2).

[b]Median value.

Table A.4. Results of the soil improvement programs in the governorates of Egypt[a]

Governorate district	Year	Crop	Estimation units	Average before increase	Average after increase	Increase in the productivity	Percentage increase
Damietta	1975	Wheat	ardeb	7.00	10.00	3.00	45.00
		Cotton	kentar	-	-	-	-
		Corn	ardeb	8.00	11.00	3.00	37.50
		Rice	ton	2.00	3.50	1.50	75.00
	1976	Wheat	ardeb	7.00	10.50	3.50	50.00
		Cotton	kentar	-	-	-	-
		Corn	ardeb	8.00	12.00	4.00	50.00
		Rice	ton	2.00	3.50	1.50	75.00
	1977	Wheat	ardeb	7.00	10.00	3.00	45.00
		Cotton	kentar	-	-	-	-
		Corn	ardeb	8.00	12.00	4.00	50.00
		Rice	ton	2.00	4.00	2.00	100.00
	1978	Wheat	ardeb	7.00	12.00	5.00	71.00
		Cotton	kentar	-	-	-	-
		Corn	ardeb	8.00	14.00	6.00	75.00
		Rice	ton	2.00	3.75	1.75	112.50
Dakahlia							
1-Shrbeen	1977	Wheat	ardeb	5.50	6.50	1.00	18.50
		Cotton	kentar	4.50	7.00	2.50	55.50
		Corn	ardeb	8.00	10.00	2.00	20.00
		Rice	ton	1.50	2.00	0.50	33.30
	1978	Wheat	ardeb	5.50	8.50	3.00	58.00
		Cotton	kentar	5.00	9.00	4.00	80.00
		Corn	ardeb	7.00	11.00	4.00	56.00
		Rice	ton	2.50	3.50	1.00	40.00
2-Talka	1973	Wheat	ardeb	6.00	7.00	1.00	16.70
		Cotton	kentar	4.50	5.50	1.00	22.00
		Corn	ardeb	7.00	8.00	1.00	14.20
		Rice	ton	1.50	2.00	0.50	33.00

[a]Source: Ministry of Agriculture (33).

Table A.4 (continued)

Governorate district	Year	Crop	Estimation units	Average before increase	Average after increase	Increase in the productivity	Percentage increase
2-Talka (continued)	1974	Wheat	ardeb	5.50	6.50	1.00	11.20
		Cotton	kentar	4.50	7.00	2.50	55.50
		Corn	ardeb	8.00	13.00	5.00	62.50
		Rice	ton	2.50	3.50	1.00	40.00
	1975	Wheat	ardeb	6.00	12.00	6.00	100.00
		Cotton	kentar	4.00	6.00	2.00	50.00
		Corn	ardeb	6.50	12.00	5.50	84.50
		Rice	ton	2.00	3.50	1.50	50.00
	1976	Wheat	ardeb	6.50	12.50	6.00	105.00
		Cotton	kentar	5.00	7.00	2.00	40.00
		Corn	ardeb	9.00	11.00	2.00	22.20
		Rice	ton	2.00	3.50	1.50	50.00
	1977	Wheat	ardeb	5.50	10.00	4.50	95.00
		Cotton	kentar	5.00	8.00	3.00	60.00
		Corn	ardeb	6.50	12.00	5.50	84.50
		Rice	ton	2.00	3.50	1.50	50.00
El-Gharbia							
1-Smanood	1970	Wheat	ardeb	8.05	9.37	1.32	16.40
		Cotton	kentar	5.69	7.11	1.42	24.96
		Corn	ardeb	15.85	17.02	1.17	7.38
		Rice	ton	2.30	2.50	0.20	8.70
2-El-Mehalla El-Kobra	1969	Wheat	ardeb	7.45	8.20	0.75	10.70
		Cotton	kentar	5.15	6.70	1.55	30.09
		Corn	ardeb	13.65	15.98	2.33	17.07
		Rice	ton	2.53	2.77	0.24	9.53
Kafer El-Shaykh							
1-Kafer El-Shaykh	1976	Wheat	ardeb	3.00	4.50	1.50	50.00
		Cotton	kentar	3.50	6.00	2.50	73.00
		Corn	ardeb	7.50	11.00	3.50	47.00
		Rice	ton	1.50	2.00	0.50	33.30

Table A.4 (continued)

Governorate district	Year	Crop	Estimation units	Average before increase	Average after increase	Increase in the productivity	Percentage increase
1-Kafer El-Shykh (continued)	1977	Wheat	ardeb	3.50	6.75	3.25	92.00
		Cotton	kentar	3.50	6.00	2.50	73.00
		Corn	ardeb	6.50	12.00	5.50	85.00
		Rice	ton	1.75	3.50	1.75	100.00
	1978	Wheat	ardeb	3.50	6.00	2.50	70.00
		Cotton	kentar	3.50	6.75	3.25	93.00
		Corn	ardeb	6.50	12.50	5.50	85.00
		Rice	ton	1.50	3.25	1.75	115.00
2-Sedi Salam	1973	Wheat	ardeb	8.00	10.00	2.00	25.00
		Cotton	kentar	4.00	6.00	2.00	50.00
		Corn	ardeb	6.00	9.00	3.00	50.00
		Rice	ton	1.25	2.00	0.75	62.50
	1974	Wheat	ardeb	7.00	12.00	5.00	71.00
		Cotton	kentar	4.00	7.00	3.00	75.00
		Corn	ardeb	6.25	10.75	4.50	70.00
		Rice	ton	1.25	2.00	0.75	62.50
	1975	Wheat	ardeb	8.00	12.50	4.50	55.00
		Cotton	kentar	3.50	6.75	3.25	92.00
		Corn	ardeb	6.50	11.00	4.25	67.00
		Rice	ton	1.50	2.50	1.00	66.60
	1976	Wheat	ardeb	8.00	11.00	3.00	37.70
		Cotton	kentar	3.50	7.00	3.50	100.00
		Corn	ardeb	6.37	13.00	6.63	104.00
		Rice	ton	1.75	2.75	1.00	62.00
	1977	Wheat	ardeb	8.00	14.00	6.00	0.75
		Cotton	kentor	3.50	7.00	3.50	100.00
		Corn	ardeb	7.00	14.00	7.00	100.00
		Rice	ton	1.50	2.50	1.00	66.66
Sharkia							
1-Kafer Sakr	1973	Wheat	ardeb	7.50	10.50	3.00	40.00
		Cotton	kentar	3.95	6.65	2.70	68.25
		Corn	ardeb	11.25	15.30	4.05	36.00
		Rice	ton	2.45	3.85	1.70	79.00

Table A.4 (continued)

Governorate district	Year	Crop	Estimation units	Average before increase	Average after increase	Increase in the productivity	Percentage increase
1-Kafer Sakr (continued)	1974	Wheat	ardeb	7.25	10.50	3.25	42.00
		Cotton	kentar	4.26	6.25	1.99	47.00
		Corn	ardeb	12.00	16.00	4.00	33.00
		Rice	ton	2.50	3.85	1.35	54.00
	1975	Wheat	ardeb	7.45	10.50	3.05	41.00
		Cotton	kentar	6.90	9.90	3.00	43.00
		Corn	ardeb	11.00	16.00	5.00	45.00
		Rice	ton	2.50	3.80	1.30	52.00
	1976	Wheat	ardeb	8.25	11.50	3.25	45.00
		Cotton	kentar	4.20	6.40	2.20	52.00
		Corn	ardeb	11.50	16.50	5.00	43.00
		Rice	ton	2.50	3.80	1.30	52.00
	1977	Wheat	ardeb	8.25	12.00	3.75	45.00
		Cotton	kentar	5.10	7.40	2.30	45.00
		Corn	ardeb	11.50	16.50	5.00	43.00
		Rice	ton	2.40	3.70	1.30	54.00
2-Fakous	1974	Wheat	ardeb	5.18	6.35	1.17	22.00
		Cotton	kentar	1.80	2.75	0.95	53.00
		Corn	ardeb	12.50	13.00	0.50	4.00
		Rice	ton	7.75	8.30	0.65	7.00
	1975	Wheat	ardeb	4.30	5.25	0.95	22.00
		Cotton	kentar	4.30	5.00	0.70	16.00
		Corn	ardeb	9.87	14.00	4.13	41.00
		Rice	Ton	2.25	3.10	0.65	29.00
	1976	Wheat	ardeb	4.80	7.90	3.10	64.00
		Cotton	kentar	4.06	4.90	0.84	20.70
		Corn	ardeb	6.37	0.85	4.48	70.30
		Rice	ton	1.66	2.41	0.75	45.00
	1977	Wheat	ardeb	4.80	8.00	3.20	67.00
		Cotton	kentar	4.06	4.10	0.04	1.00
		Corn	ardeb	6.37	13.00	6.63	104.00
		Rice	ton	1.66	2.70	1.04	63.00

Table A.4 (continued)

Governorate district	Year	Crop	Estimation units	Average before increase	Average after increase	Increase in the productivity	Percentage increase
2-Fakous (continued)	1978	Wheat	ardeb	3.76	7.50	3.74	99.50
		Cotton	kentar	3.66	4.72	1.03	28.00
		Corn	ardeb	8.67	10.50	1.83	21.00
		Rice	ton	1.53	1.82	0.29	19.00
Sharkia							
3-Abo-Kebeer	1977	Wheat	ardeb	4.22	4.80	0.58	17.00
		Cotton	kentar	4.22	4.90	0.68	16.00
		Corn	ardeb	9.87	14.00	4.13	41.00
		Rice	ton	2.45	3.10	0.65	26.00
	1978	Wheat	ardeb	6.00	11.00	5.00	83.30
		Cotton	kentar	4.00	6.00	2.00	50.00
		Corn	ardeb	8.00	13.00	5.00	62.50
		Rice	ton	2.00	3.25	1.25	62.50
Buheira							
1-Kafer El-Dawar	1974	Wheat	ardeb	-	-	-	-
		Cotton	kentar	4.22	4.90	0.68	16.00
		Corn	ardeb	10.60	13.00	2.40	22.00
		Rice	ton	2.21	2.90	0.69	31.00
	1975	Wheat	ardeb	7.75	8.50	0.75	10.00
		Cotton	kentar	4.22	4.80	0.58	13.00
		Corn	ardeb	10.60	12.85	2.25	21.00
		Rice	ton	2.21	2.30	0.09	4.00
	1976	Wheat	ardeb	7.00	10.00	3.00	45.00
		Cotton	kentar	4.00	7.00	3.00	75.00
		Corn	ardeb	8.00	12.00	4.00	50.00
		Rice	ton	2.00	3.00	1.00	50.00
	1977	Wheat	Ardeb	7.00	10.50	25 0	50.00
		Cotton	kentar	4.00	8.00	4.00	100.00
		Corn	ardeb	8.00	12.00	4.00	50.00
		Rice	ton	2.00	3.50	1.50	75.00
	1978	Wheat	ardeb	7.00	12.00	5.00	71.00
		Cotton	kentar	4.00	8.00	4.00	100.00
		Corn	ardeb	8.00	14.00	6.00	75.00
		Rice	ton	2.00	3.50	1.50	75.00

Table A.4 (continued)

Governorate district	Year	Crop	Estimation units	Average before increase	Average after increase	Increase in the productivity	Percentage increase
2-Damanhoor	1974	Wheat	ardeb	-	-	-	-
		Cotton	kentar	5.18	6.60	1.42	28.00
		Corn	ardeb	12.50	16.50	4.00	32.00
		Rice	ton	1.80	2.25	0.45	39.00
	1975	Wheat	ardeb	7.75	8.30	0.65	7.00
		Cotton	kentar	5.18	6.35	1.17	22.00
		Corn	ardeb	12.50	13.00	0.50	4.00
		Rice	ton	1.80	2.75	0.95	53.00
	1976	Wheat	ardeb	7.00	10.50	3.50	50.00
		Cotton	kentar	4.00	4.75	0.75	18.70
		Corn	ardeb	8.00	12.00	4.00	50.00
		Rice	ton	2.00	3.00	1.00	50.00
	1977	Wheat	ardeb	7.00	12.00	5.00	71.00
		Cotton	kentar	4.00	6.50	2.50	62.50
		Corn	ardeb	8.00	14.00	6.00	75.00
		Rice	ton	2.00	3.25	1.25	62.50
	1978	Wheat	ardeb	6.00	11.00	5.00	83.30
		Cotton	kentar	4.00	7.00	3.00	75.00
		Corn	ardeb	6.50	12.00	5.50	94.60
		Rice	ton	1.50	3.00	1.50	100.00
3-Gor-Esa	1971	Cotton	kentar	4.06	5.52	1.47	36.00
		Corn	ardeb	6.27	9.64	2.37	51.00
		Rice	ton	1.66	2.60	0.94	57.00
	1972	Wheat	ardeb	4.80	7.90	3.10	64.00
		Cotton	kentar	4.06	4.90	0.84	20.70
		Corn	ardeb	6.37	10.85	4.48	70.30
		Rice	ton	1.66	2.60	0.94	56.60
	1973	Wheat	ardeb	4.80	6.45	1.65	34.00
		Cotton	kentar	4.06	4.48	0.42	10.35
		Corn	ardeb	6.37	13.43	7.06	110.00
		Rice	ton	1.66	2.41	0.75	40.00
	1974	Wheat	ardeb	4.80	6.58	1.78	37.00
		Cotton	kentar	4.06	4.64	0.85	14.10

Table A.4 (continued)

Governorate district	Year	Crop	Estimation units	Average before increase	Average after increase	Increase in the productivity	Percentage increase
3-Gor-Esa (continued)	1974	Corn	ardeb	6.37	10.80	4.43	69.50
		Rice	ton	1.66	2.42	0.76	45.80
	1975	Wheat	ardeb	4.80	8.00	3.20	67.00
		Cotton	kentar	4.06	4.10	0.04	1.00
		Corn	ardeb	6.37	13.00	6.62	104.00
		Rice	ton	1.66	2.70	1.04	63.00
4-Abo Homous	1974	Wheat	ardeb	-	-	-	-
		Cotton	kentar	4.30	5.00	0.70	16.00
		Corn	ardeb	9.87	13.00	3.13	34.00
		Rice	ton	2.45	2.90	0.45	18.00
	1975	Wheat	ardeb	8.00	9.00	1.00	13.00
		Cotton	kentar	4.30	5.25	0.95	22.00
		Corn	ardeb	9.87	14.00	4.13	41.00
		Rice	ton	2.45	3.10	0.65	26.00
	1976	Wheat	ardeb	7.75	8.30	0.65	7.00
		Cotton	kentar	3.50	7.00	3.50	100.00
		Corn	ardeb	5.00	11.00	6.00	120.00
		Rice	ton	1.25	2.25	1.00	5.00
	1977	Wheat	ardeb	6.00	12.00	6.00	100.00
		Cotton	kentar	3.50	6.70	3.20	91.43
		Corn	ardeb	5.00	12.00	7.00	140.00
		Rice	ton	1.25	2.75	1.50	120.00
	1978	Wheat	ardeb	7.00	12.50	5.50	76.00
		Cotton	kentar	3.50	7.50	4.00	105.00
		Corn	ardeb	5.00	14.50	9.50	185.00
		Rice	ton	1.25	2.75	1.50	120.00
5-Abo El-Matameer	1971	Wheat	ardeb	-	-	-	-
		Cotton	kentar	3.69	4.43	0.74	20.00
		Corn	ardeb	8.67	3.43	5.24	60.44
		Rice	ton	1.53	2.30	0.77	50.00
	1972	Wheat	ardeb	3.76	7.12	3.36	89.00
		Cotton	kentar	3.69	5.04	1.35	36.50

Table A.4 (continued)

Governorate district	Year	Crop	Estimation units	Average before increase	Average after increase	Increase in the productivity	Percentage increase
5-Abo El-Matameer (continued)	1972	Corn	ardeb	8.67	13.80	5.12	59.00
		Rice	ton	1.53	2.30	0.77	50.00
	1973	Wheat	ardeb	3.76	7.71	3.95	105.00
		Cotton	kentar	3.69	4.20	0.51	14.00
		Corn	ardeb	8.67	12.55	1.88	45.00
		Rice	ton	1.53	1.70	0.17	11.00
	1974	Wheat	ardeb	3.76	7.50	0.74	19.50
		Cotton	kentar	3.69	4.72	1.03	28.00
		Corn	ardeb	8.97	10.50	1.83	21.00
		Rice	ton	1.53	1.82	0.29	19.00
	1975	Wheat	ardeb	3.16	9.50	5.84	152.00
		Cotton	kentar	3.69	4.20	0.51	14.00
		Corn	ardeb	8.70	11.50	2.83	33.00
		Rice	ton	1.53	1.60	0.07	5.00
6-Shubra-Kate	1970	Wheat	ardeb	3.00	4.62	1.62	54.00
		Cotton	kentar	3.50	6.05	2.55	73.00
		Corn	ardeb	5.00	9.00	4.00	80.00
		Rice	ton	1.25	2.12	0.87	70.00
	1971	Wheat	ardeb	3.00	7.00	4.00	133.00
		Cotton	kentar	3.50	6.70	3.20	91.00
		Corn	ardeb	5.00	12.00	7.00	140.00
		Rice	ton	1.25	2.75	1.50	120.00
	1972	Wheat	ardeb	3.00	8.50	5.50	183.00
		Cotton	kentar	3.50	6.70	3.20	91.00
		Corn	ardeb	5.00	14.80	9.80	196.00
		Rice	ton	1.25	2.81	1.56	125.00
	1973	Wheat	ardeb	3.00	8.70	5.70	190.00
		Cotton	kentar	3.50	5.50	2.00	57.00
		Corn	ardeb	5.00	14.50	9.00	180.00
		Rice	ton	1.25	2.40	1.15	92.00
	1974	Wheat	ardeb	3.00	13.15	10.15	338.00
		Cotton	kentar	3.50	5.95	2.45	70.00

Table A.4 (continued)

Governorate district	Year	Crop	Estimation units	Average before increase	Average after increase	Increase in the productivity	Percentage increase
6-Shubra-Kate (continued)	1974	Corn	ardeb	5.00	15.52	10.52	210.00
		Rice	ton	1.25	2.40	1.15	92.00
	1975	Wheat	ardeb	3.00	13.50	10.50	350.00
		Cotton	kentar	3.70	5.30	1.60	43.00
		Corn	ardeb	5.00	14.70	9.70	194.00
		Rice	ton	1.25	2.20	0.95	76.00
Al-Fayyum							
1-Al-Fayyum	1976	Wheat	ardeb	6.00	11.00	5.00	83.00
		Cotton	kentar	4.50	7.00	2.50	55.50
		Corn	ardeb	8.00	10.00	2.00	25.00
		Rice	ton	1.50	2.00	0.50	33.30
	1977	Wheat	ardeb	7.00	13.00	6.00	85.30
		Cotton	kentar	4.50	7.00	2.50	55.50
		Corn	ardeb	8.00	13.00	5.00	62.50
		Rice	ton	1.70	2.70	1.00	59.00
	1978	Wheat	ardeb	6.00	11.00	5.00	83.30
		Cotton	kentar	4.00	6.00	2.00	50.00
		Corn	ardeb	6.00	12.00	6.00	100.00
		Rice	ton	1.25	2.50	1.25	100.00
2-Atsa	1975	Wheat	ardeb	6.00	9.00	3.00	50.00
		Cotton	kentar	3.50	6.00	2.50	73.00
		Corn	ardeb	5.00	9.00	4.00	80.00
		Rice	ton	1.25	2.10	0.85	70.00
	1976	Wheat	ardeb	6.00	10.00	4.00	66.00
		Cotton	kentar	3.50	6.70	3.20	91.00
		Corn	ardeb	5.00	9.00	4.00	80.00
		Rice	ton	1.25	2.70	1.45	120.00
	1977	Wheat	ardeb	7.00	11.00	4.00	57.00
		Cotton	kentar	3.50	6.75	3.25	92.00
		Corn	ardeb	5.00	14.80	9.80	196.00
		Rice	ton	1.27	2.27	1.00	79.00

Table A.4 (continued)

Governorate district	Year	Crop	Estimation units	Average before increase	Average after increase	Increase in the productivity	Percentage increase
2-Atsa (continued)	1978	Wheat	ardeb	8.00	11.00	3.00	38.00
		Cotton	kentar	3.50	6.00	2.50	70.00
		Corn	ardeb	5.00	10.00	5.00	100.00
		Rice	ton	1.25	2.50	1.25	100.00

Table A.5. ALS[a] best fit of the time equations for the study's major crops[b]

Crops / Explanatory variables	Winter crops						
	Wheat						
	Area in 1000 feddan	Area index number 1959=100	Yield in ardeb per feddan	Yield index number 1959=100	Production in 1000 ardeb	Production index number 1959=100	Per capita production in Kg./Ind.[c]
Intercept	1535.85	104.68	7.31	112.09	11543.42	119.70	66.59
SE[d]	(70.89)	(4.63)	(0.72)	(11.00)	(853.83)	(8.98)	(3.89)
$\overset{\cdot}{\sim}$ probability[e]	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
X_i	-73.76	-5.16	-0.23	-3.74	-941.45	-9.68	-5.92
SE	(29.79)	(1.94)	(0.31)	(4.71)	(359.18)	(3.78)	(1.64)
$\overset{\cdot}{\sim}$ probability	(0.03)	(0.018)	(0.46)	(0.44)	(0.02)	(0.02)	(0.003)
X_i^2	6.18	0.43	0.042	0.68	106.70	1.10	0.53
SE	(3.41)	(0.22)	(0.035)	(0.46)	(41.12)	(0.43)	(0.19)
$\overset{\cdot}{\sim}$ probability	(0.09)	(0.071)	(0.25)	(0.23)	(0.02)	(0.02)	(0.013)
X_i^3	-0.14	-0.01	-0.001	-0.021	-2.73	-0.03	-0.014
SE	(0.11)	(0.01)	(0.001)	(0.02)	(1.35)	(0.014)	(0.006)

~ probability	(0.23)	(0.20)	(0.30)	(0.27)	(0.06)	(0.07)	(0.04)
$\bar{R}^2$ [f]	0.41	0.45	0.57	0.57	0.80	0.80	0.52
Estimation period	1960-1978	1960-1978	1960-1978	1960-1978	1960-1978	1960-1978	1960-1978

[a]ALS stands for Autoregressive Least-Squares.

[b]Source: Computed upon data from (14, 32).

[c]Kg./Ind. is kilogram per individual.

[d]SE is the standard error of the coefficient.

[e]~ stands for the word "approximate."

[f]$\bar{R}^2$ is the adjusted R^2.

Table A.5 (continued)

Crops / Explanatory variables	Winter Crops							
	Wheat (continued)				Beans			
	Imports in 1000 ardeb	Exports in 1000 ardeb	Total requirements in 1000 ardeb	Per capita requirements in Kg./Ind.	Area in 1000 feddan	Area index number 1960/1964 = 100	Yields in tons per feddan	Yield index number 1960/1964 = 100
Intercept	9958.59	--	20624.52	118.11	417.06	114.14	0.83	107.13
SE	(6252.56)	--	(6563.56)	(28.45)	(23.75)	(6.50)	(0.10)	(12.65)
probability	(0.14)	--	(0.009)	(0.002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
X_i	3062.21	--	1882.07	2.40	-21.75	-5.91	-0.02	-1.96
SE	3254.74	--	(3420.99)	(14.83)	(6.82)	(1.87)	(0.05)	(6.54)
probability	(0.37)	--	(0.59)	(0.87)	(0.008)	(0.008)	(0.75)	(0.77)
X_i^2	-631.37	--	-411.26	-1.27	0.75	0.20	0.01	0.88
SE	(463.58)	--	(487.53)	(2.11)	(0.42)	(0.11)	(0.01)	(0.93)
probability	(0.201)	--	(0.42)	(0.56)	(0.10)	(0.10)	(0.35)	(0.36)
X_i^3	36.03	--	27.25	0.093	--	--	-0.0004	-0.05
SE	(19.10)	--	(20.08)	(0.087)	--	--	(0.0003)	(0.04)
probability	(0.09)	--	(0.20)	(0.31)	--	--	(0.23)	(0.25)
$\bar{R}^2$	0.67	--	0.72	0.49	0.74	0.74	0.48	0.46
Estimation period	1964-1978		1964-1978	1964-1978	1964-1978	1965-1978	1964-1978	1964-1978

Table A.5 (continued)

Crops / Explanatory variables	Winter crops							Summer
	Beans (continued)							Corn
	Production in 1000 tons	Production index number 1964-1978	Per capita production in Kg./Ind.	Imports in 1000 tons	Exports in 1000 tons	Total requirement in 1000 tons	Per capita requirement in Kg./Ind.	Area in 1000 feddan
Intercept	318.01	112.62	11.15	--	--	--	9.76	1799.08
SE	(21.66)	(7.73)	(0.69)	--	--	--	(0.75)	(83.10)
t probability	(0.0001)	(0.0001)	(0.0001)	--	--	--	(0.0001)	(0.0001)
X_i	-4.96	-1.75	-0.35	--	--	--	-0.14	-149.51
SE	(2.40)	(0.86)	(0.08)	--	--	--	(0.10)	(43.14)
t probability	(0.06)	(0.06)	(0.001)	--	--	--	(0.18)	(0.005)
X_i^2	--	--	--	--	--	--	--	20.20
SE	--	--	--	--	--	--	--	(6.14)
t probability	--	--	--	--	--	--	--	(0.007)
X_i^3	--	--	--	--	--	--	--	-0.66
SE	--	--	--	--	--	--	--	(0.25)
t probability	--	--	--	--	--	--	--	(0.03)
$\bar{R}^2$	0.19	0.18	0.59	--	--	--	0.08	0.86
Estimation period	1964-1978	1964-1978	1964-1978	1964-1978	1964-1978	1964-1978	1964-1976	1964-1978

Table A.5 (continued)

Crops / Explanatory variables	Summer crops							
	Corn (continued)							
	Area index number 1960/1964 = 100	Yield in ardeb per feddan	Yield index number 1960-1964 = 100	Production in 1000 ardeb	Production index number 1960-1964 = 100	Per capita requirement in Kg./Ind.	Imports in 1000 ardeb	Exports in 1000 ardeb
Intercept	104.38	7.09	94.29	14395.20	101.02	66.92	2246.24	--
SE	(4.87)	(0.64)	(8.57)	(784.01)	(9.02)	(1.72)	(767.97)	--
probability	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.01)	--
X_i	-8.84	1.57	20.65	263.89	8.07	0.26	-626.85	--
SE	(2.53)	(0.34)	(4.46)	(225.33)	(4.70)	(0.19)	(220.63)	--
probability	(0.005)	(0.0007)	(0.001)	(0.26)	(0.11)	(0.19)	(0.02)	--
X_i^2	1.20	-0.19	-2.46	14.34	-0.79	--	56.58	--
SE	(0.36)	(0.05)	(0.64)	(13.71)	(0.67)	--	(14.43)	--
probability	(0.007)	(0.002)	(0.003)	(0.32)	(0.26)	--	(0.001)	--
X_i^3	-0.04	0.007	0.09	--	0.04	--	--	--
SE	(0.02)	(0.002)	(0.03)	--	(0.03)	--	--	--
probability	(0.02)	(0.005)	(0.005)	--	(0.02)	--	--	--
$\bar{R}^2$	0.86	0.73	0.73	0.87	0.88	0.06	0.77	--
Estimation period	1964-1978	1964-1978	1964-978	1964-1978	1964-1978	1964-1978	1964-1978	

Table A.5 (continued)

Crops / Explanatory variables	Summer crops							
	Corn (continued)		Rice					
	Total requirements in 0000 ardeb	Per capita requirements in Kg./Ind.	Area in 1000 feddan	Area index number 1959 = 100	Yields in tons per feddan	Yield index number 1959=100	Production in 1000 tons	Production index number 1959 = 100
Intercept	16521.90	87.03	512.14	75.66	2.24	99.94	1234.41	77.03
SE	(1270.89)	(4.69)	(117.02)	(11.24)	(0.14)	(6.05)	(221.34)	(13.82)
t probability	(0.0001)	(0.0001)	(0.001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
X_i	-333.40	-2.72	105.61	12.68	-0.02	-0.75	183.34	11.42
SE	(365.42)	(1.35)	(49.62)	(2.59)	(0.06)	(2.57)	(50.97)	(3.18)
t probability	(0.38)	(0.07)	(0.05)	(0.0002)	(0.77)	(0.77)	(0.002)	(0.003)
X_i^2	69.37	0.24	-5.35	-0.49	0.001	0.06	-6.88	-0.43
SE	(22.22)	(0.08)	(5.70)	(0.13)	(0.01)	(0.30)	(2.47)	(0.15)
t probability	(0.01)	(0.01)	(0.36)	(0.001)	(0.86)	(0.85)	(0.01)	(0.01)
X_i^3	--	--	0.06	--	-0.00001	-0.001	--	--
SE	--	--	(0.19)	--	(0.0002)	(0.01)	--	--
t probability	--	--	(0.75)	--	(0.96)	(0.94)	--	--
$\bar{R}^2$	0.87	0.58	0.64	0.65	0.05	0.04	0.52	0.52
Estimation period	1964-1978	1964-1978	1960-1978	1960-1978	1960-1978	1960-1978	1960-1978	1960-1978

Table A.5 (continued)

Crops / Explanatory variables	Summer crops						
	Rice (continued)					Sugarcane	
	Per capita production in Kg./Ind.	Imports in 1000 tons	Exports in 1000 tons	Total requirements in 1000 tons	Per capita requirements in Kg./Ind.	Area in 1000 feddan	Area index number 1959=100
Intercept	35.38	--	45.03	823.46	30.48	112.24	100.25
SE	(5.13)	--	(149.20)	(112.65)	(3.66)	(10.38)	(9.22)
probability	(0.0001)	--	(0.77)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
X_i	3.13	--	272.20	-14.57	-1.37	-0.37	-0.37
SE	(1.18)	--	(79.03)	(58.57)	(1.91)	(4.44)	(3.95)
probability	(0.02)	--	(0.01)	(0.81)	(0.49)	(0.93)	(0.93)
X_i^2	-0.16	--	-39.80	15.45	0.49	0.79	0.71
SE	(0.06)	--	(11.36)	(8.34)	(0.27)	(0.52)	(0.46)
probability	(0.014)	--	(0.01)	(0.09)	(0.10)	(0.15)	(0.14)
X_i^3	--	--	1.49	-0.81	-0.03	-0.021	-0.02
SE	--	--	(0.47)	(0.34)	(0.01)	(0.02)	(0.02)
probability	--	--	(0.01)	(0.04)	(0.04)	(0.24)	(0.23)
$\bar{R}^2$	0.23	--	0.63	0.90	0.69	0.95	0.65
Estimation period	1960-1978		1964-1978	1964-1978	1964-1978	1960-1978	1960-1978

Table A.5 (continued)

Crops / Explanatory variables	Summer crops						
	Sugarcane (continued)						
	Yield in tons per feddan	Yield index number 1959=100	Production in 1000 tons	Production index number 1959=100	Per capita production in Kg./Ind.	Imports in 1000 tons	Exports in 1000 tons
Intercept	40.07	103.62	4592.50	105.70	154.80	--	--
SE	(1.49)	(3.83)	(522.81)	(11.91)	(10.03)	--	--
probability	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	--	--
X_i	-0.68	-1.83	-125.79	-2.75	5.80	--	--
SE	(0.63)	(1.61)	(223.48)	(5.09)	(2.31)	--	--
probability	(0.30)	(0.27)	(0.58)	(0.60)	(0.02)	--	--
X_i^2	0.09	0.23	45.79	1.04	-0.14	--	--
SE	(0.07)	(0.18)	(25.83)	(0.59)	(0.11)	--	--
probability	(0.24)	(0.23)	(0.10)	(0.10)	(0.22)	--	--
X_i^3	-0.004	-0.01	-1.53	-0.04	--	--	--
SE	(0.002)	(0.01)	(0.85)	(0.02)	--	--	--
probability	(0.12)	(0.12)	(0.09)	(0.09)	--	--	--
$\bar{R}^2$	0.65	0.64	0.87	0.88	0.61	--	--
Estimation period	1960-1978	1960-1978	1960-1978	1960-1978	1960-1978		

Table A.5 (continued)

Crops / Explanatory variables	Summer crops: Sugarcane (continued) Total requirements in 1000 tons	Summer crops: Sugarcane (continued) Per capita requirements in Kg./Ind.	Shifters: Cotton Area in 1000 feddan	Shifters: Cotton Area index number 1959=100	Shifters: Cotton Yield in kentar per feddan	Shifters: Cotton Yield index number 1959=100	Shifters: Cotton Production in 1000 kentar
Intercept	3940.08	164.27	1908.71	108.28	4.01	77.10	7864.90
SE	(181.75)	(5.83)	(61.50)	(3.57)	(0.41)	(7.99)	(723.05)
probability	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
X_i	251.17	3.16	-32.05	-1.81	0.36	6.97	408.98
SE	(15.89)	(0.51)	(5.38)	(0.31)	(0.09)	(1.84)	(166.48)
probability	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.001)	(0.002)	(0.03)
X_i^2	--	--	--	--	-0.01	-0.28	-21.65
SE	--	--	--	--	(0.005)	(0.09)	(8.09)
probability	--	--	--	--	(0.01)	(0.006)	(0.02)
X_i^3	--	--	--	--	--	--	--
SE	--	--	--	--	--	--	--
probability	--	--	--	--	--	--	--
$\bar{R}^2$	(0.94)	0.67	0.66	0.64	0.52	0.49	0.24
Estimation period	1960-1978	1960-1978	1960-1978	1960-1978	1960-1978	1960-1978	1960-1978

Table A.5 (continued)

Crops / Explanatory variables	Shifters: Cotton (continued) Production index number 1959=100	Berseem: Area in 1000 feddan	Berseem: Area index number 1952=100	Winter vegetables: Area in 1000 feddan	Winter vegetables: Area index number 1952=100	Summer vegetables: Area in 1000 feddan	Summer vegetables: Area index number 1952=100
Intercept	85.94	2409.73	109.83	123.75	191.65	115.15	213.11
SE	(7.76)	(49.78)	(2.22)	(0.32)	(14.05)	(13.11)	(24.40)
$\underset{\sim}{:}$ probability	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
X_i	4.52	-6.56	-0.45	3.14	7.73	5.95	10.95
SE	(1.79)	(21.01)	(0.94)	(1.46)	(6.00)	(5.65)	(10.34)
$\underset{\sim}{:}$ probability	(0.02)	(0.78)	(0.64)	(0.05)	(0.22)	(0.30)	(0.31)
X_i^2	-0.24	6.18	0.30	0.11	-0.17	0.59	1.10
SE	(0.09)	(2.41)	(0.11)	(0.07)	(0.69)	(0.64)	(1.19)
$\underset{\sim}{:}$ probability	(0.01)	(0.02)	(0.01)	(0.14)	(0.81)	(0.37)	(0.37)
X_i^3	--	-0.26	-0.012	--	(0.011)	-0.03	-0.061
SE	--	(0.08)	(0.004)	--	(0.02)	(0.02)	(0.04)
$\underset{\sim}{:}$ probability	--	(0.01)	(0.003)	--	(0.63)	(0.14)	(0.14)
$\bar{R}^2$	0.25	0.93	0.93	0.92	0.93	0.90	0.91
Estimation period	1960-1978	1960-1978	1960-1978	1960-1978	1960-1978	1960-1978	1960-1978

Table A.6. ALS[a] best fit of the time equations for the prices of the major crops[b]

Crops / Explanatory variables	Wheat: Nominal[c] price of final output P/T	Wheat: Real[d] price of final output P/T	Wheat: Price of wheat/ berseem P/T	Wheat: Price of wheat/ barley P/T	Wheat: Price of wheat/ beans P/T	Wheat: Price of wheat/ winter tomatoes P/T
Intercept	25.04	36.32	14.15	7.89	0.77	0.56
SE[e]	(4.35)	(1.51)	(3.52)	(1.19)	(0.05)	(0.21)
$\dot{\sim}$ probability[f]	(0.0001)	(0.0001)	(0.001)	(0.0001)	(0.0001)	(0.02)
X_i	2.07	-0.17	-1.41	0.88	-0.03	0.30
SE	(1.83)	(0.19)	(1.50)	(0.70)	(0.006)	(0.12)
$\dot{\sim}$ probability	(0.28)	(0.41)	(0.36)	(0.24)	(0.0008)	(0.04)
X_i^2	-0.24	--	0.19	-0.21	--	-0.06
SE	(0.21)	--	(0.17)	(0.11)	--	(0.02)
$\dot{\sim}$ probability	(0.27)	--	(0.30)	(0.10)	--	(0.01)
X_i^3	0.013	--	-0.007	0.011	--	0.0003
SE	(0.007)	--	(0.006)	(0.005)	--	(0.001)

$\dot{\sim}$ probability	(0.08)	--	(2.23)	(0.06)	--	(0.01)
$\bar{R}^2$ [g]	0.89	0.06	0.12	0.39	0.63	0.59
Estimation period	1961-1979	1965-1977	1961-1977	1967-1979	1967-1979	1967-1979

[a]ALS stands for Autoregressive Least-Squares.

[b]Source: Computed upon data from (14, 32, 51, 52).

[c]P/T stands for Egyptian pound per ton.

[d]No best fit has been obtained.

[e]SE is the standard error of the coefficient.

[f]$\dot{\sim}$ stands for the word "approximate."

[g]$\bar{R}^2$ is the adjusted R^2.

Table A.6 (continued)

Crops / Explanatory variables	Beans: Nominal price of final output P/T	Real price of final output P/T	Price of beans/ wheat P/T	Price of beans/ berseem P/T	Price of beans/ barley P/T	Price of beans/ winter tomatoes P/T
Intercept	68.24	70.79	1.73	17.81	12.93	0.92
SE	(12.35)	(10.95)	(0.16)	(2.67)	(1.16)	(0.37)
$\dot{\sim}$ probability	(0.001)	(0.0003)	(0.0001)	(0.0001)	(0.0001)	(0.03)
X_i	-16.15	-17.17	-0.28	0.64	-0.43	0.33
SE	(7.32)	(7.55)	(0.09)	(0.88)	(0.38)	(0.22)
$\dot{\sim}$ probability	(0.06)	(0.06)	(0.02)	(0.48)	(0.29)	(0.17)
X_i^2	3.07	3.51	0.06	-0.07	0.07	-0.07
SE	(1.19)	(1.43)	(0.02)	(0.06)	(0.03)	(0.04)
$\dot{\sim}$ probability	(0.03)	(0.04)	(0.004)	(0.29)	(0.03)	(0.08)
X_i^3	-0.11	-0.18	-0.003	--	--	0.004
SE	(0.06)	(0.08)	(0.001)	--	--	(0.002)
$\dot{\sim}$ probability	(0.08)	(0.06)	(0.004)	--	--	(0.05)
$\bar{R}^2$	0.95	0.70	0.92	0.14	0.80	0.33
Estimation period	1967-1979	1967-1977	1967-1979	1967-1979	1967-1979	1967-1979

Table A.6 (continued)

Crops / Explanatory variables	Corn: Nominal price of final output P/T	Real price of final output P/T	Price of corn/ cotton P/T	Price of corn/ rice P/T	Price of corn/ sugarcane P/T	Price of corn/ summer potatoes P/T
Intercept	22.60	29.71	0.28	1.31	9.14	1.37
SE	(5.35)	(2.04)	(0.04)	(0.23)	(2.58)	(0.37)
t probability	(0.001)	(0.0001)	(0.0001)	(0.0002)	(0.01)	(0.005)
X_i	3.29	0.92	-0.01	-0.14	2.20	0.14
SE	(2.76)	(0.26)	(0.02)	(0.12)	(1.54)	(0.22)
t probability	(0.26)	(0.005)	(0.50)	(0.29)	(0.19)	(0.54)
X_i^2	-0.46	--	0.002	0.02	-0.44	-0.03
SE	(0.39)	--	(0.002)	(0.02)	(0.25)	(0.04)
t probability	(0.26)	--	(0.25)	(0.19)	(0.11)	(0.40)
X_i^3	0.03	--	-0.0001	-0.001	(0.02)	0.001
SE	(0.02)	--	(0.0001)	(0.001)	(0.01)	(0.002)
t probability	(0.07)	--	(0.18)	(0.15)	(0.12)	(0.44)
$\bar{R}^2$	0.95	0.49	0.26	0.02	0.52	0.56
Estimation period	1964-1978	1965-1977	1961-1979	1965-1979	1967-1979	1967-1979

Table A.6 (continued)

Crops / Explanatory variables	Rice: Nominal price of final output P/T	Real price of final output P/T	Price of rice/ corn P/T	Price of rice/ cotton P/T	Price of rice/ sugarcane P/T	Price of rice/ summer potatoes P/T
Intercept	12.99	20.74	0.52	0.15	9.47	1.35
SE	(5.35)	(3.15)	(0.14)	(0.04)	(1.34)	(0.21)
: probability	(0.03)	(0.0001)	(0.002)	(0.001)	(0.0001)	(0.0001)
X_1	3.56	6.08	0.12	0.02	1.48	0.10
SE	(2.28)	(1.88)	(0.06)	(0.02)	(0.80)	(0.12)
: probability	(0.14)	(0.01)	(0.05)	(0.17)	(0.10)	(0.44)
X_1^2	-0.38	-1.05	-0.01	-0.002	-0.38	-0.03
SE	(0.26)	(0.31)	(0.01)	(0.002)	(0.13)	(0.02)
: probability	(0.17)	(0.008)	(0.08)	(0.41)	(0.02)	(0.14)
X_1^3	0.02	0.053	0.0004	0.00004	0.02	(0.002)
SE	(0.01)	(0.014)	(0.0002)	(0.0001)	(0.01)	(0.001)
: probability	(0.05)	(0.005)	(0.10)	(0.58)	(0.01)	(0.10)
$\bar{R}^2$	0.90	0.64	0.14	0.30	0.81	0.79
Estimation period	1961-1979	1965-1977	1961-1979	1961-1979	1967-1979	1967-1979

Table A.6 (continued)

Crops / Explanatory variables	Sugarcane: Nominal price of final output P/T	Real price of final output P/T	Price of sugarcane/ corn P/T	Price of sugarcane/ cotton P/T	Price of sugarcane/ rice P/T	Price of sugarcane/ summer potatoes P/T
Intercept	4.58	4.34	0.12	0.044	0.12	0.13
SE	(1.07)	(1.02)	(0.03)	(0.008)	(0.02)	(0.04)
t probability	(0.002)	(0.004)	(0.01)	(0.0003)	(0.0004)	(0.01)
X_i	-1.67	-1.35	-0.03	-0.012	-0.03	-0.003
SE	(0.64)	(0.71)	(0.02)	(0.005)	(0.013)	(0.02)
t probability	(0.03)	(0.10)	(0.20)	(0.03)	(0.07)	(0.91)
X_i^2	0.34	0.29	0.006	0.0024	0.007	0.001
SE	(0.11)	(0.13)	(0.003)	(0.0007)	(0.002)	(0.004)
t probability	(0.01)	(0.07)	(0.12)	(0.01)	(0.01)	(0.82)
X_i^3	-0.014	-0.014	-0.0003	-0.0001	-0.0003	-0.0001
SE	(0.005)	(0.007)	(0.0002)	(0.00003)	(0.0001)	(0.0002)
t probability	(0.019)	(0.10)	(0.12)	(0.008)	(0.008)	(0.74)
$\bar{R}^2$	0.92	0.76	0.43	0.61	0.76	0.07
Estimation period	1967-1979	1967-1977	1967-1979	1967-1979	1967-1979	1967-1979

Table A.7. ALS[a] best fit of the time equations for the nominal and real variable costs of the major crops[b]

Explanatory variables	Nominal variable costs in pounds per feddan				
	Wheat	Beans	Corn	Rice	Sugarcane
Intercept	29.04	22.53	34.18	35.53	66.73
SE[c]	(2.98)	(1.96)	(3.05)	(11.93)	(13.12)
$\dot{\sim}$ probability[d]	(0.0001)	(0.0001)	(0.0001)	(0.02)	(0.001)
X_i	-3.10	-3.59	-4.72	1.27	-10.40
SE	(1.78)	(0.64)	(1.00)	(6.98)	(7.91)
$\dot{\sim}$ probability	(0.12)	(0.0002)	(0.001)	(0.86)	(0.22)
X_i^2	0.37	0.52	0.67	-0.42	1.70
SE	(0.29)	(0.05)	(0.07)	(1.13)	(1.30)
$\dot{\sim}$ probability	(0.23)	(0.0001)	(0.0001)	(0.72)	(0.22)
X_i^3	0.012	--	--	0.05	-0.012
SE	(0.014)	--	--	(0.05)	(0.06)
$\dot{\sim}$ probability	(0.44)	--	--	(0.39)	(0.85)
$\bar{R}^2$[e]	0.99	0.98	0.98	0.86	0.95
Estimation period	1967-1979	1967-1979	1967-1979	1967-1979	1967-1979

[a] ALS stands for Autoregressive Least-Squares.

[b] Source: Computed upon data from (14, 32, 51, 52).

[c] SE is the standard error of the coefficient.

[d] $\dot{\sim}$ stands for the word "approximate."

[e] $\bar{R}^2$ is the adjusted R^2.

Real variable costs in pound per feddan				
Wheat	Beans	Corn	Rice	Sugarcane
27.26	17.86	28.21	36.75	56.25
(2.47)	(2.41)	(2.49)	(4.09)	(7.42)
(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
-0.71	0.68	0.83	2.08	2.65
(1.69)	(1.65)	(1.69)	(2.80)	(5.12)
(0.69)	(0.69)	(0.64)	(0.48)	(0.62)
-0.05	-0.23	-0.31	-0.72	-1.05
(0.32)	(0.31)	(0.32)	(0.53)	(0.97)
(0.88)	(0.48)	(0.36)	(0.22)	(0.313)
0.02	0.02	0.03	0.06	0.11
(0.02)	(0.02)	(0.02)	(0.03)	(0.05)
(0.37)	(0.20)	(0.12)	(0.09)	(0.08)
0.87	0.90	0.91	0.77	0.93
1967-1977	1967-1977	1967-1977	1967-1977	1967-1977

Table A.8. The stepwise results for estimating the aggregate demand functions for beans, 1967-1978[a]

Variables	Best one variable model	Best two variable model	Best three variable model	Best four variable model	Best five variable model	Best six variable model
Intercept	5.17	19.05	19.44	19.06	77.05	77.33
SE[b]	--	--	--	--	--	--
$P_r > F$[c]	--	--	--	--	--	--
$\ln P_t^j$[d]	--	--	-0.33	-0.47	-1.55	-1.70
SE	--	--	(0.35)	(0.43)	(0.67)	(0.50)
$P_r > F$	--	--	(0.36)	(0.31)	(0.06)	(0.07)
$\ln P_t^{01}$[e]	--	--	--	0.33	--	0.35
SE	--	--	--	(0.57)	--	(0.50)
$P_r > F$	--	--	--	(0.58)	--	(0.52)
$\ln P_t^{02}$[f]	--	--	--	--	4.15	4.19
SE	--	--	--	--	(2.02)	(2.11)

[a]Source: Computed upon data from (6, 32, 52).

[b]SE is the standard error of the coefficient.

[c]$P_r > F$ is the probability of the calculated F greater than the tabulated F.

[d]$\ln P_t^j$ stands for log P_t^j. Where P_t^j is the price of final output of beans in £E per ton in year t.

[e]$\ln P_t^{01}$ stands for log P_t^{01}. Where P_t^{01} is the price of wheat in £E per ton in year t.

[f]$\ln P_t^{02}$ stands for log P_t^{02}. Where P_t^{02} is the price of corn in £E per ton in year t.

Table A.8 (continued)

Variables	Best one variable model	Best two variable model	Best three variable model	Best four variable model	Best five variable model	Best six variable model
$P_r > F$	--	--	--	--	(0.09)	(0.10)
$\ln \bar{Y}_t$[g]	--	--	--	--	-10.49	-10.67
SE	--	--	--	--	(5.35)	(5.61)
$P_r > F$	--	--	--	--	(0.10)	(0.12)
N_g[h]	--	-0.47	-0.44	-0.45	-1.11	-1.12
SE	--	(0.27)	(0.28)	(0.29)	(0.42)	(0.44)
$P_r > F$	--	(0.12)	(0.15)	(0.17)	(0.04)	(0.05)
T[i]	0.03	0.40	0.39	0.41	1.19	1.21
SE	(0.01)	(0.22)	(0.22)	(0.24)	(0.43)	(0.46)
$P_r > F$	(0.06)	(0.10)	(0.12)	(0.13)	(0.03)	(0.05)
R^2	0.31	0.48	0.53	0.55	0.72	0.75

[g]$\ln \bar{Y}$ stands for log $\bar{Y}_t$. Where $\bar{Y}_t$ is the limited disposable income per capita in year t.

[h]N_g stands for the total population in million individuals.

[i]T is the time.

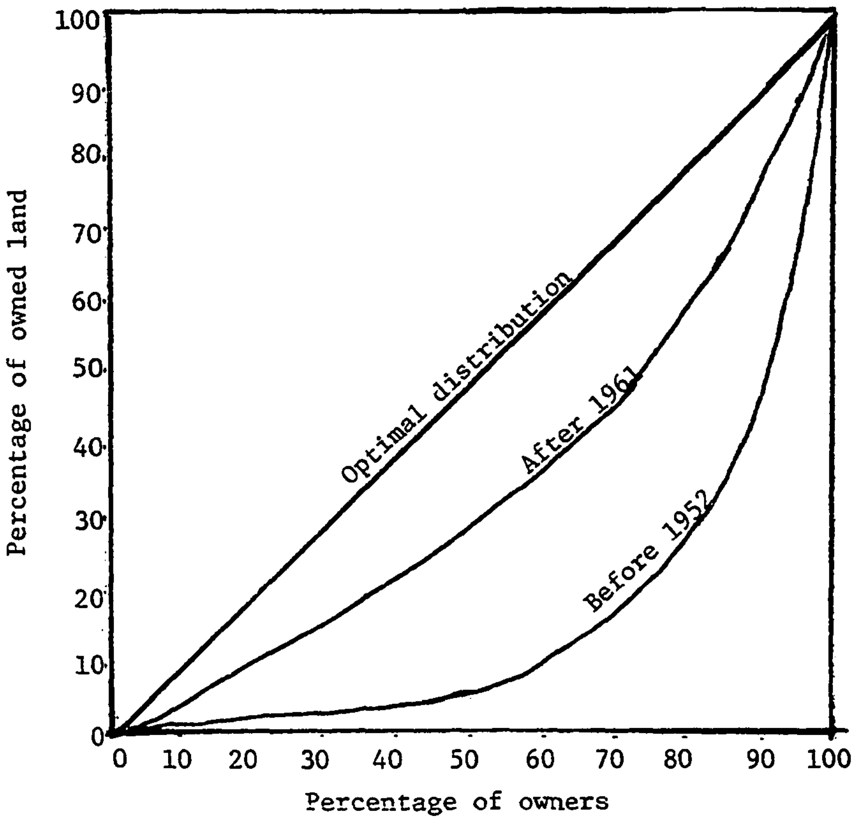

Figure A.1. Lorenz curve for land ownership before and after the land reform laws

Source: Emarah (9).