MONITORING, VERIFICATION AND EVALUATION UNIT
AGRICULTURAL POLICY REFORM PROGRAM

MVE UNIT
APRP

Sponsored by:
Government of Egypt,
Ministry of Agriculture and Land Reclamation

United States Agency for International Development/Cairo
Office of Economic Growth, Agricultural Policy Division

GROWTH AND THE PRODUCTIVITY OF INPUTS IN AGRICULTURE ON EGYPT'S OLD LANDS: 1990 - 1997

Douglas J. Krieger
MSI

Ali Assem F. Abdel Aziz
Sherif M. S. Fayyad
EQI

Abt Associates Inc.

Prime Contractor:
Abt Associates Inc.

Subcontractors:
Environmental Quality International,
Management Systems International

USAID Award: 263-C-00-97-00003-00

Project Office: 15th Floor, 7 Nadi El Seid Street, Dokki, Cairo
Telephones: (202) 337-0357, 337-0592, 337-0378
Fax: (202) 336-2009

July, 1999

Special Study
No. 2

TABLE OF CONTENTS

LIST OF TABLES

ANNEX TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

In the late 1980s, the Government of Egypt began a series of policy reforms in the agricultural sector. This report represents one component of an ongoing evaluation of the impact of those reforms. The analysis focuses on changes in agricultural production on Egypt's Old Lands - roughly, the agricultural lands in the Nile River valley - between 1990 and 1997. In 1990, the Old Lands comprised 88 percent of the cropped area in Egypt. Specifically, the analysis estimated trends in aggregate production for the Old Lands and changes in the partial productivity of five key factor inputs: land, water, fertilizer, hired labor, and machinery.

Three factors - changes in physical yields, expansion of cropped area, and changes in cropping patterns - drive changes in aggregate production. The analysis estimated the separate impact of these factors on aggregate production and their influence on input productivity measures. For comparison with previous work (Rady et al, 1996), aggregate production estimates were derived from data on 23 key crops that, together, accounted for 91 percent of cropped area in the Old Lands in 1990.[1]

The availability and quality of data required for the analysis significantly compromised the reliability and interpretation of results. The analysis depended primarily on data collected and compiled by the Ministry of Agriculture and Land Reclamation (MALR). A recent study of these data concluded that the quality of many key agricultural data series were not adequate for accurate analysis (Fawzy et al., 1998). Specifically, the study found that data on several important factors such as area, production, and yield were relatively accurate at the village level but were likely significantly inflated when compiled to the governorate level. Estimates of aggregate production are thus likely to overstate actual sectoral growth. Furthermore, data on family labor in agriculture, fertilizer use, and water use were not directly available. Until resolved, these data issues will continue to limit the ability to produce accurate forecasts, engage in planning, or conduct future analyses of Egypt's agricultural sector.

Between 1990 and 1997, agricultural production on Egypt's Old Lands continued the post-reform expansion noted by Rady et al. (1996). In the pre-reform period between 1980 and 1986, aggregate production increased at an average annual rate of 1.1 percent. Growth increased to 2.7 percent between 1987 and 1993, immediately after the policy reforms began. For the overlapping period between 1990 and 1997 considered in this analysis, the average annual rate of growth in aggregate production was 1.5 percent, implying a slowing of the growth rate since 1993. Aggregate production since 1993 has been quite variable, however, and the apparent decline in the rate of growth may be an artifact of the time period chosen for the analysis. For instance, aggregate production fell by 3.8 percent between 1993 and 1994 and by 2.3 percent between 1996 and 1997. In the two years from 1994 to 1996, however, aggregate production increased by over 11 percent (an average annual rate of 5.3 percent), the largest increase in the period from 1980 to 1997.

[1] Excluded crops included horticultural crops (with the exception of tomatoes and potatoes) and medicinal and aromatic crops.

Growth of aggregate production is the result of three factors, increased physical yields, changes in cropping patterns, and expansion of cropped area. Between 1990 and 1997, increased physical yields accounted for all of the growth in aggregate production on the Old Lands - at least as represented by the 23 crops used in this analysis. Small losses in cropped area and changes in cropping patterns actually depressed aggregate production slightly over the period. Given the extreme limitations on area expansion on the Old Lands, future growth will likely have to come largely from increasing physical yields as a result of using non-land inputs - water, labor, fertilizer, and machinery - more efficiently or from cropping patterns that make more efficient use of available inputs.

Farmers appear to be using factor inputs more efficiently to increase yields. Cropped area and fertilizer inputs likely declined over the period of analysis. Inputs of hired labor and water likely rose slightly. Growth of aggregate production, however, outpaced growth in all of these inputs. The partial productivity - aggregate production per unit of input - of land, hired labor, water, and fertilizer thus increased. Machinery inputs increased more rapidly than aggregate production thereby reducing the partial productivity of machinery. Dramatic increases in machinery inputs in summer rice production, however, drove the reduced productivity of machinery. If summer rice is eliminated from both aggregate production and machinery input calculations, the measured partial productivity of machinery increases rapidly rather than declining.

The partial productivity measures presented in this report warrant careful interpretation. Limited availability of data prevented accurate estimation of input quantities for most key factors. Likewise, the accuracy of data required to calculate aggregate production is questionable.

Changes in cropping patterns between 1990 and 1997 tended to increase the relative importance (as a group) of the five key crops that contributed most to cropped area and aggregate production.
In 1990, long berseem, wheat, summer rice, cotton, and summer maize accounted for 68 percent of cropped area and 66 percent of aggregate production. By 1997, these five crops accounted for 73 and 72 percent of cropped area and aggregate production, respectively. Between 1990 and 1997, cropped area in long berseem, cotton, and summer maize fell while cropped area in wheat and rice increased.

Expansion of the agricultural sector increased employment in agriculture on the Old Lands. Increased inputs of hired labor amounted to the equivalent of 34,000 full-time jobs. Since many agricultural jobs are seasonal, however, many more than 34,000 people may have been newly employed in agriculture. Regions of the country did not share equally in employment gains however. While growth between 1990 and 1997 increased hired labor inputs in Lower and Middle Egypt by more than 42,500 full-time equivalent jobs, hired labor inputs decreased by the equivalent of almost 8,500 full-time jobs in Upper Egypt.

Similarly, the governorates and regions of Egypt did not share equally in the growth of aggregate production. Lower and Upper Egypt each increased their share of aggregate production slightly between 1990 and 1997 at the expense of Middle Egypt, where the share of aggregate production decreased.

1. INTRODUCTION

In the late 1980s, the Government of Egypt, in cooperation of USAID, embarked on a program of agricultural policy reforms aimed at stimulating growth in Egypt's agricultural sector. The policy reforms were meant to contribute to a national policy objective of encouraging sustainable development with increased employment and improved quality of life for a majority of Egyptians. Growth of the agricultural sector is an important component of overall economic growth and job creation. Growth of agricultural output creates more jobs than equivalent output growth in either the industrial or service sectors (Rady et al., 1996; Mellor, forthcoming). This report represents one component of an ongoing evaluation of the impact of those reforms.

The information developed in this report serves several specific purposes. First, it is targeted directly at evaluating recent agricultural policy reforms in Egypt. Specifically, it provides information for the Monitoring, Verification, and Evaluation (MVE) component of the Agricultural Policy Reform Program (APRP). Second, it was designed to aid USAID in internal evaluation of overall progress toward strategic objectives. Third, the report identifies constraints to conducting economic analyses of agriculture in Egypt and discusses how to improve capacity to evaluate agricultural sector programs and policy reform activities.

This report examines trends and determinants of agricultural sector growth on Egypt 's Old Lands - agricultural lands in the Nile River valley - between 1990 and 1997. The analysis draws on a number of data sources to describe changes in the agricultural sector on the Old Lands over the period. In particular, it derives partial productivity measures for five key agricultural inputs - water, fertilizer, land, hired labor, and machinery. These measures define the contribution of changes in these inputs to changes in aggregate production. It also explores trends in other factors - such as changes in cropping patterns, physical and economic yields, and area expansion - that shed additional light on the pattern and determinants of growth.

The report begins with a brief review of methods. It then describes data sources, availability, and quality with an emphasis on the limits data quality imposed on interpretation of results. The main body of the report summarizes the partial productivity measures and discusses their implications. It also draws on the data to describe the pattern and determinants of growth. A final section discusses implications of the analysis for policy evaluation and future policy design. Appendix A documents the basic data series and derivation of input measures. Tables in Appendix B report additional details of production at the level of governorates and regions.

2. STUDY AREA AND METHODS

The analysis focused on Egypt's Old Lands. The Old Lands encompass the core of Egypt's agricultural lands and account for a majority of cultivated area (88 percent in 1990 and 77 percent in 1997) and agricultural output. In terms of governorates - the basic unit of aggregation for national agricultural statistics - the study defined Old Lands as the governorates of Behera, Gharbia, Kafr El Sheikh, Dakahlia, Damietta, Sharkia, Menoufia, and Kalyoubia in Lower Egypt; Giza, Beni Suef, Fayoum, and Menia in Middle Egypt; and Assiut, Sohag, Qena, and Aswan in Upper Egypt.

Since 1990, the New Lands - land reclaimed in the eastern and western delta and in the Sinai since 1971 - have assumed an increasingly important role in Egypt's agricultural sector. Between 1990 and 1997, cultivated area in the 16 governorates covered by this study declined by roughly 148,000 feddans. Over the same time period, cultivated area in Egypt increased by about 800,000 feddans. As much as 87 percent of the increase occurred on the New Lands (MALR, 1990 - 1997). Thus, restricting the analysis to the Old Lands likely substantially underestimates growth in the agricultural sector.

Analysis was restricted to the Old Lands for three reasons. First, the Old and New Lands likely differ substantially in terms of cropping patterns, labor composition, water use, and fertilizer use. Thus, technology related indicators such as partial productivity measures are better studied separately on the Old and New Lands. Future work to examine productivity growth on the New Lands and compare it to that on the Old Lands will provide a more complete picture of growth in the agricultural sector, productivity of inputs, and the effectiveness of policy reform. Second, the data series required for the analysis were incomplete for the New Lands for the time period addressed in this study. Finally, the analysis built on existing analysis of the Old Lands (Rady et al., 1996; Nassar et al., 1996).

The analysis estimated partial productivity measures for water, fertilizer, land, hired labor, and machinery. The partial productivity of an input is the ratio of aggregate production to the quantity of the input. Aggregate production was estimated on the basis of 23 key crops identified in a previous study of agricultural productivity on the Old Lands (Rady et al., 1996).[2] These crops accounted for 91 percent of the cropped area in the selected governorates in 1990 and 90 percent in 1997. Excluded crop categories included horticultural crops (except tomatoes and potatoes) and medicinal and aromatic crops for which cropped area and contribution to aggregate production were relatively small on the Old Lands. To remove the impact of price changes from the comparison of aggregate production across time, production in each year was valued at the average farmgate price for the three year period of 1994 through 1996.

[2] The analysis considers 23 key crops. For crops that are grown in several seasons, however, published data on area, yield, and production are compiled for each season. For instance, data for tomatoes distinguish between summer tomatoes, winter tomatoes, and nili tomatoes. Similarly, data for crops grown in conjunction with other crops (*i.e.,* garlic and onion) are separated by single and intercropped crops. At the level of the data, therefore, the 23 key crops are reported as 36 different crops. The tables contained in this report often list all 36 seasonal and cropping variations of the 23 key crops.

3. DATA COLLECTION AND QUALITY

Government data sources directly or indirectly supplied all of the data used in this analysis. Primary sources included the Ministry of Agriculture and Land Reclamation (MALR), the Ministry of Public Works and Water Resources (MPWWR), the Ministry of Planning (MOP), and the Central Agency for Public Mobilization and Statistics (CAPMAS). Other data sources included the Egypt Fertilizer Development Center, the Principal Bank for Development and Agricultural Credit (PBDAC), and a number of special reports.

The basic agricultural time series came from statistics compiled and published annually by the MALR. A recent study of the quality of these data suggested that basic agricultural data series such as area, production, yield, and prices are reasonably good at the village level. Once they are collected and aggregated to the governorate level, however, they are, "inadequate to meet current and future information and data analysis requirements" (Fawzy et al., 1998). Of particular relevance to this analysis, the data quality study suggested that data were often adjusted at the governorate level to indicate increasing physical yields from year to year. It seems likely, therefore, that trends in production, cropped area, and yields are inflated. The data quality study also suggested that estimates of labor and mechanical inputs are not derived from valid statistical samples and are unlikely to accurately represent actual labor and machinery use in agriculture.

The remainder of this section describes the sources and structure of the basic data series used in the analysis. These data include time series from 1990 to 1997 for agricultural production, cropped area, yields, and prices; hired labor inputs; machinery inputs; water availability; and fertilizer availability and prices. The tables in Appendix A report the data series disaggregated to the level of the 23 selected crops.

3.1 Cropped Area, Production, and Prices

The Central Administration for Agricultural Economics of the MALR publishes annual data on the key components of agricultural production - cropped area, production, yield, and prices (MALR, 1990 - 1997). These data are the basic information necessary to calculate aggregate production. The published data break out values for each crop by governorate. Tables A-1 through A-4 in Appendix A summarize the basic data series for cropped area, production, yields, and nominal farmgate prices, respectively aggregated to the level of crops. The tables for cropped area, production, and yield report the data in the form in which it was published. Farmgate prices varied by governorate. The prices reported in Table A-4 represent the weighted average nominal price over the 16 governorates. Weights were the governorate's share of total production. Prices for long and short berseem were reported in LE per cut, while production was reported in tons. A conversion factor of 3.9 cuts per feddan was used to convert long berseem prices to an LE per ton basis.[3] Since long and short berseem are perfect substitutes, the price for short berseem was set equal to the price for long berseem. Appendix B summarizes production and price data disaggregated to the governorate level for each of the 36 selected crops.

[3] Personal communication with Dr. Mohamed Omran, USAID/Cairo.

A recent report provided evidence that yield data at the governorate level may be inflated (Fawzy et al., 1998). Since production is estimated as area times yield, production data may also suffer from inflation. The Egypt Integrated Household Survey (EIHS) provides an alternative source of data on crop yields for 1997.[4] Table 1 compares MALR data on yields for selected crops with the EIHS yield estimates. While the table does not provide a rigorous comparison, the consistent direction and magnitude of the differences suggests that the MALR estimates may be high. If the MALR data on production, yields, and cropped area are inflated, then estimates of aggregate production will also be inflated.

3.2 Labor and Machinery

Measures of hired labor and machinery inputs were based on technical coefficients for hired labor and machinery estimated by the Central Administration for Agricultural Economics of the MALR.[5] Technical coefficients for hired labor describe estimated man-days and woman/child-days of hired labor per feddan used in the cultivation of each crop. The measure of hired labor inputs used in the analysis aggregates these two coefficients into a single unit of labor-days per feddan by adding one-half the coefficient for women/children to the coefficient for men.[6] Thus, a day of labor for a woman or child counts for half a man-day. Total labor-days were then converted to full-time equivalent jobs by dividing by 295 (El-Deep, 1992). Table A-5 in Appendix A summarizes hired labor inputs (in terms of labor-days) by crop calculated from the technical coefficients.

The MALR estimates technical coefficients and machine costs by crop for eight different types of machines - tractors, machine irrigation, manual spraying, machine spraying, transportation, threshing, winnowing, and combining. The coefficients for a particular crop represent days of machine input per feddan for the crop. An aggregate measure of machinery inputs was calculated for each crop as the weighted average over all machines. Weights were the relative cost of the machine. Tables A-6 and A-7 in Appendix A summarize machinery inputs by crop. Table A-7 reports total machine hours. Table A-6 reports the weighted input measure per feddan used in the analysis.

Technical coefficients for labor and machinery were not available for all crops. Labor and machinery inputs for intercropped crops were accounted for in the technical coefficients for the primary crop. The absence of technical coefficients for the remaining crops is not likely to affect results substantially as they accounted for only six percent of cropped area and six percent of aggregate production in 1997.

---

[4] The EIHS was specifically designed to estimated household income, not agricultural yields. It was based on a sample of about 2,500 households, about a quarter of which were farm households. For these households, the survey collected information on crop yields from which to estimate sources of income. Since the EIHS was based on a random sample, the consistent sign and magnitude of the differences between the MALR and EIHS yield estimates suggest that the MALR estimates may overstate yield.

[5] Central Administration for Agricultural Economics, MALR, unpublished data.

[6] This is the standard practice for weighting man-days relative to woman/child days in Egypt.

Fawzy et al. (1998) suggested that the estimated technical coefficients for labor and machinery compiled at the governorate level may not accurately represent labor and machinery inputs. They concluded that the data on which published technical coefficients are based were "very subjective and covered a very narrow segment of the sector." It is unlikely that the published coefficients represent labor and machinery inputs for the average farm.

The technical coefficients for labor reflect only hired labor. By some estimates, hired labor accounts for only 15 percent of total agricultural labor inputs, while family labor accounts for the remainder (Rady et al., 1996). Thus, a measure of labor inputs based on the technical coefficients will substantially underestimate total labor inputs. Partial productivity measures of labor based solely on hired labor will not accurately represent the contribution of labor inputs to aggregate production. A measure of labor inputs based only on hired labor may also yield misleading trends in labor productivity. If wage differentials or other economic forces shifted hired labor into or out of the sector relative to family labor between 1990 and 1997, the trend in total labor productivity will be distorted.

3.3 Nitrogenous Fertilizer

The fertilizer input measure was based on domestic availability of nitrogenous fertilizer. Nitrogenous fertilizers account for more than 80 percent of fertilizer inputs in Egypt. Fairly reliable data appear to exist for production, exports, and imports of nitrogenous fertilizers in Egypt (Zalla and Saad, 1998; El Guindy et al., 1997). These data produce reasonable estimates of domestic availability - production minus exports plus imports.

A measure of actual fertilizer use would be preferable to availability. Perhaps the greatest weakness of availability as a proxy for actual use is that it does not account for stored inventories. It thus implicitly assumes that the entire quantity available in a given year is used in that year. The data on fertilizer storage by cooperatives and the private sector necessary to estimate use do not exist, however. Estimates of fertilizer use exist but appear to be constructed from recommended application levels by crop and areas in each crop. They do not seem to represent actual consumption (Mellor, 1998). Another drawback of domestic availability is that it provides no way to allocate available fertilizer between the Old and the New Lands.

The difficulties with domestic availability as a proxy for use pose little problem in the interpretation of productivity measures if the trend in total domestic availability matches that of use on the Old Lands. This is unlikely to be the case, however. Recent studies of the fertilizer sector suggest that fertilizer stocks have not remained stable between 1990 and 1997 (Mellor, 1998; Zalla and Saad, 1998; El Guindy et al., 1997). In particular, stocks may have been very low during the 'crisis' in 1995 but relatively large in 1996 and 1997. Furthermore, area in the New Lands has increased dramatically during the study period, while area in the Old Lands has contracted. The proportion of fertilizer applied to the Old Lands relative to that applied to the New Lands is unlikely to have remained constant.

Table 3-1: Comparison of Sources of Yield Data, 1997

(Kg/feddan)

Crop	EIHS[a]	MALR[b]	% difference
Rice	2538	3550	40
Wheat	1525	2502	64
Maize	1603	2227	39
Sorghum	1477	1795	21
Broadbeans	899	1336	49
Sugarcane	34534	47100	36
Cotton	804	1072	33
Berseem	22036	21378	-3

[a.] Source, 1997 Egypt Integrated Household Survey, International Food Policy Research Institute, unpublished.
[b.] Source, MALR published yields (MALR, 1997).

The fertilizer input measure used in this analysis was based on domestic availability. Two adjustments were made to account for changes in stocks over time and likely changes in the allocation of available fertilizer between the Old and the New Lands. First, existing studies suggested that stocks were particularly high in 1996 and 1997. For the measure of fertilizer inputs, availability for 1996 and 1997 was replaced by projections based on amounts available between 1990 and 1995.[7] Second, cultivated area in Egypt grew by about 800,000 feddans between 1990 and 1997 while cultivated area in the 16 selected governorates declined by almost 148,000 feddans. In an attempt to allocate available fertilizer between the Old and the New Lands, the fertilizer input measure was defined as domestic availability (adjusted as described above for stocks) multiplied by the proportion of total cultivated area in the 16 selected governorates. Table A-8 in Appendix A summarizes derivation of the fertilizer input measure.

It is difficult to assess how well the fertilizer input measure captures actual use. Little solid information exists about stocks. The adjustment for suspected large stocks in 1996 and 1997 is thus an imperfect adjustment and no adjustment is made for other years. Similarly, the allocation of a portion of available fertilizer to the Old Lands is based entirely on the relative area in Old and New Lands. Differences in cropping patterns, soil characteristics, and irrigation practices between the Old and the New Lands, however, suggest that fertilizer use may also be quite different. An adjustment based solely on relative area is unlikely, therefore, to accurately represent the actual allocation of fertilizer between the Old and the New Lands.

[7] Between 1990 and 1995, fertilizer availability declined at an average annual (exponential) rate of 0.9 percent.

3.4 Water

There were no data on the quantity of water actually used in agriculture. The MPWWR, however, estimates consumptive use of water for different crops from measurements made at research stations. These estimates, along with estimates of irrigation losses, are used to determine the amount of water to release from the High Dam each year. The water input measures used in this analysis were taken from an estimated water balance produced by the MPWWR. The water balance estimate matches the quantity of water available from different sources to the disposition of the water. The primary source of water in the water balance is the quantity of water released from the High Dam annually. Sources of disposition include drainage to the sea, navigation uses, re-use, municipal and industrial use, evaporation losses, and agricultural water use.

Table 3-2 presents the water balance data for the years 1990 through 1997 along with the two water input measures used in this analysis. The first seven rows of the table report the water balance data produced by the MPWWR. "Agricultural water use" in row seven is water released from the High Dam minus drainage to the sea, municipal and industrial use, and evaporation losses plus re-use and groundwater used in agriculture. This measure of agricultural water use potentially double counts some water. "Groundwater used in agriculture," for instance, refers to water from shallow wells that are recharged from Nile River surface water. It is not a separate source of water from that released from the High Dam to the Nile. Similarly, re-use water is water that has been used once for agricultural purposes and is retrieved from drains, treated or mixed with other water, and re-used. Like groundwater, it does not represent an additional source of water; it is merely water that is counted twice.

The analysis defined two alternative measures of water inputs to agriculture based on the water balance table. The first, called "water available to agriculture," is shown in row eight of Table 3-2 and is equal to "agricultural water use" from row seven. This measure is included for consistency with official estimates of water use. The second measure, "water available to agriculture minus re-use and groundwater," excludes re-used water and groundwater used in agriculture from the "water available to agriculture" measure. This is a more conceptually correct measure of agricultural water use as it eliminates possible double counting.

Neither of these measures is a particularly good measure of water use in agriculture. Water balance estimates provide no means to determine the relative quantities of water used on the Old and the New Lands. For purposes of interpreting partial productivity measures, it is not particularly important to determine whether water was used on the Old or the New Lands as long as the proportion of the total available water used on the Old Lands remained relatively stable over the study period. In that case, the trend in total water availability would match the trend in water use on the Old Lands. There is insufficient data on the use of surface water in the New Lands, however, to determine whether the proportion used on the Old Lands changed significantly or not.

Table 3-2: Allocation of Water and Derivation of Water Input Measures, 1990 - 1997

(billion cubic meters)

Water Allocation	1990	1991	1992	1993	1994	1995	1996	1997
Water released from the High Dam	53.99	53.8	54.25	55.3	55.24	55.5	55.5	55.97
Net drainage to the sea	10.38	10.87	10.73	11.005	10.145	10.407	10.474	10.51
Re-use	7.29	7.87	7.82	7.81	7.56	7.647	8.016	8.17
Municipal and industrial use	3.33	3.33	3.38	3.4	3.55	3.715	3.983	4.185
Evaporation losses	2.05	2.05	2.05	2.1	2.1	2.1	2.13	2.14
Groundwater used in agriculture	2.15	2.2	2.2	2.25	2.3	2.7	2.85	2.9
Agricultural water use	47.68	47.62	48.11	47.855	49.305	49.625	49.779	50.205
Water available to agriculture	47.68	47.62	48.11	47.855	49.305	49.625	49.779	50.205
Water available minus re-use and groundwater	38.24	37.55	38.09	37.795	38.61	39.278	38.913	39.135

Source: Obtained through personal communication with Engineer Gamil Mahmoud, MPWWR.

4. AGGREGATE PRODUCTION GROWTH AND INPUT PRODUCTIVITY

Agricultural production on the Old Lands increased substantially between 1990 and 1997. Aggregate production, denominated in average farmgate prices for 1994 through 1996, grew at an average annual rate of 1.5 percent,[8] increasing from LE 17.7 billion in 1990 to LE 19.7 billion in 1997. Aggregate production on the Old Lands increased despite a reduction in cropped area between 1990 and 1997. This implies increasing production per cropped feddan. Aggregate production per feddan increased at an average annual rate of 1.6 percent, from LE 1,750 per feddan to LE 1,966 per feddan. Aggregate production on the Old Lands did not keep up with population growth in the 16 governorates that represent the Old Lands. Thus, per capita aggregate production fell over the period.[9] Figure 4-1 illustrates graphically the growth of these three measures.

Between 1986 and 1993, aggregate production on the Old Lands increased at an average annual rate of 2.7 percent (Rady et al., 1996). The slower growth rate for the overlapping period of this analysis suggests that the rate of growth may be slowing. the average growth rate over the study period conceals some interesting annual variation however. For instance, aggregate production fell by 3.8 percent between 1993 and 1994 and by 2.3 percent between 1996 and 1997. In the two years from 1994 to 1996, however, aggregate production increased by over 11 percent (an average annual rate of 5.3 percent), the largest increase in the period from 1980 to 1997. The time period chosen for the analysis may be responsible for the measured reduction in growth since the 1987 - 1993 period.

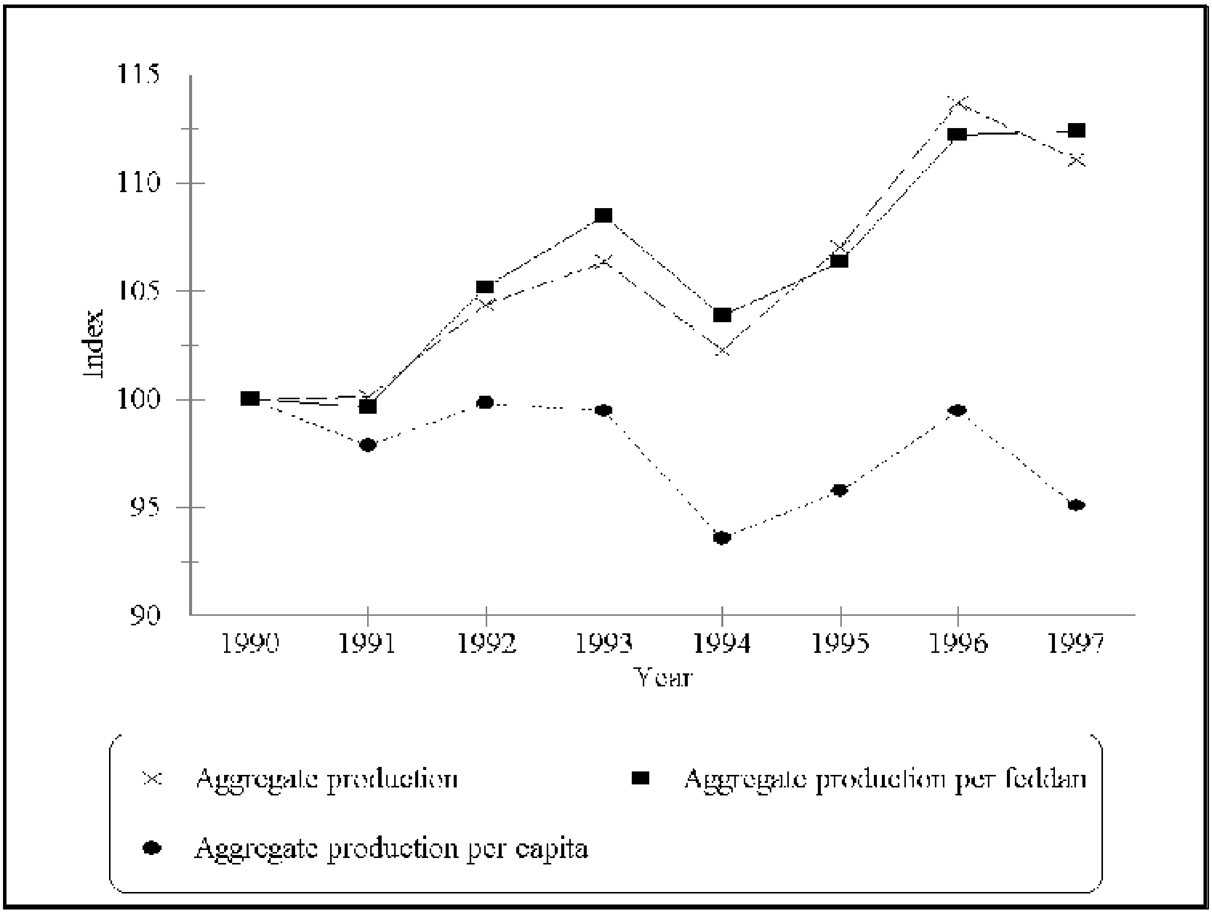
Aggregate production is the sum over crops of yield times area times (constant) price. Thus, three key factors - yield improvements, area expansion, and changes in cropping patterns - determine growth in aggregate production. In general, increases in yield result from changes in production technology or more efficient use of inputs. For instance, research that leads to improved varieties, more efficient labor and machinery combinations, or more efficient use of water and fertilizer all increase aggregate production by increasing yields. Area expansion can arise from technological improvements that lead to increases in cropping intensity or from increases in cultivated area. Changes in cropping patterns can increase aggregate production by re-allocating existing land to higher-valued crops or crops that make more efficient use of existing resources.

---

[8] Unless otherwise noted, all average annual growth rates presented in this report represent exponential growth rates obtained by estimating the equation, $x_t = x_0 e^{rt}$ where x_t and x_0 are the values of the variable of interest in year t and the base year, respectively and r is the exponential annual growth rate.

[9] The per capita aggregate production figure reported here does not represent per capita aggregate production throughout Egypt as it represents only the population of the 16 governorates selected for this analysis and includes only production on the Old Lands.

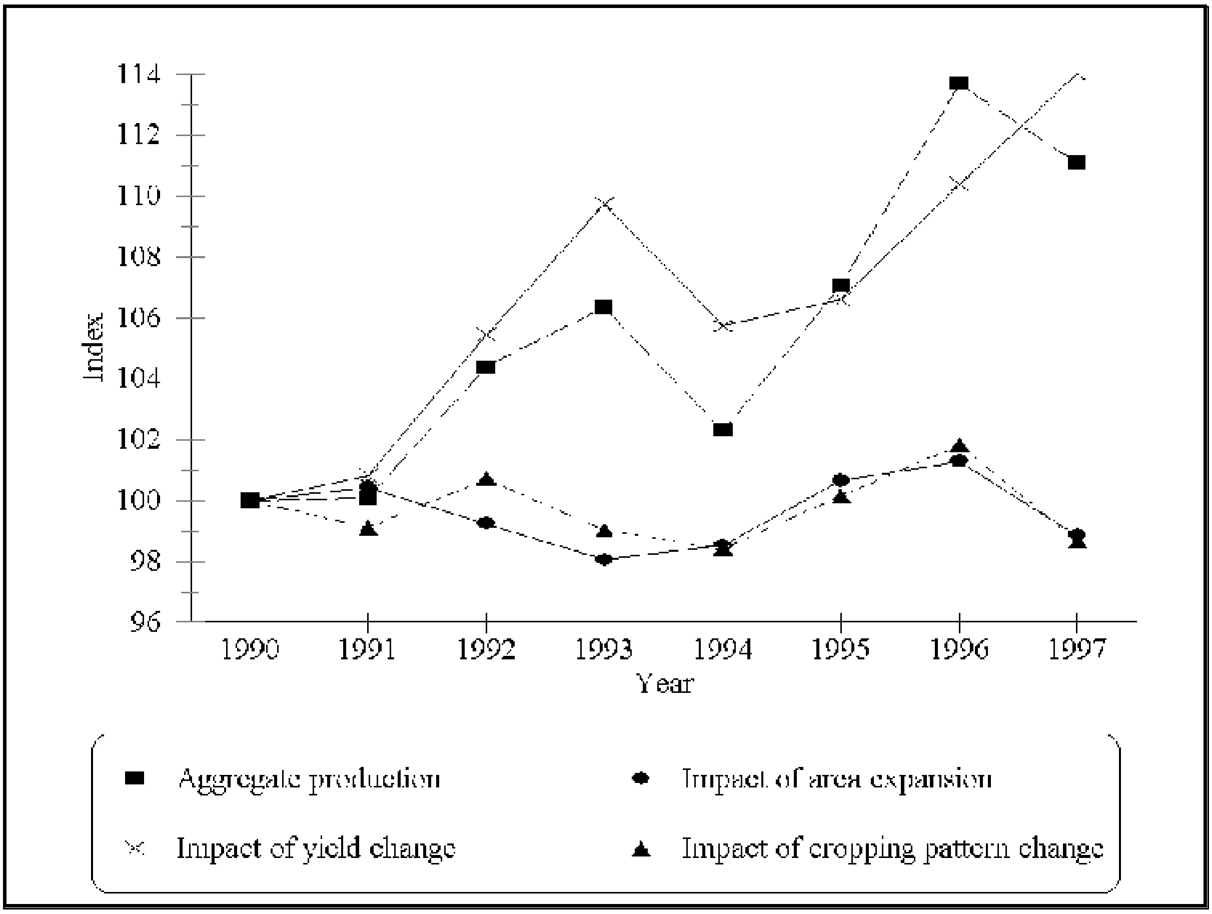
Figure 4-1: Aggregate Production Growth on the Old Lands, 1990-1997



Change in aggregate production can be partitioned into the separate impacts of yield improvements, area expansion, and changes in cropping patterns (Norton, 1994). Over the period from 1990 to 1997, increasing physical yields, in the absence of changes in cropping patterns and loss of cultivated area, accounted for 108.8 percent of the net increase in aggregate production in the selected crops on the Old Lands. Because this analysis includes only a subset of crops, however, data is not sufficiently complete to calculate the shares of aggregate production growth attributable to changes in cropping patterns or area expansion. Clearly, the impact of one or both must be negative to offset the greater-than-one-hundred percent share attributable to yield improvement.

A graphical representation provides some insight into the relative impacts of these three factors on aggregate production. Figure 4-2 graphically illustrates the impacts of yield improvement, area expansion, and changes in cropping patterns on aggregate production. The line labeled "impact of yield change" illustrates values of aggregate production between 1990 and 1997 if cropped area and cropping patterns are fixed at 1990 levels, so that only yield increases affect aggregate production. In all years except 1995 and 1996, aggregate production would have been higher with cropped area and cropping patterns fixed at 1990 levels. Similarly, the line labeled "impact of area expansion" represents aggregate production with cropping patterns and yields fixed at 1990 levels. The line labeled "impact of cropping pattern change" illustrates values of aggregate production with cropped area and yields fixed at 1990 levels.

Figure 4-2: Impact of Yield Improvement, Area Expansion, and Changes in Cropping Pattern on Aggregate Production on the Old Lands, 1990-1997



The sign of the impacts of yield improvement, area expansion, and changes in cropping patterns on aggregate production is positive if the corresponding line has a positive slope and negative otherwise. Thus, changes in cropping patterns contributed positively to aggregate production between 1991 and 1992 and again between 1994 and 1996. Changes in cropped area contributed positively to aggregate production between 1993 and 1996. While both expansion of cropped area and changes in cropping patterns contributed positively to aggregate production in some years, their overall effect during the period was to depress aggregate production slightly.

It is important that the calculated shares of output growth attributable to yield improvements, area expansion, and changes in cropping patterns be interpreted in the context of this analysis, namely its focus on the Old Lands. Area in the Old Lands is already largely in agricultural production or developed for residential, industrial, commercial, or public uses. The potential for further expansion of agricultural area is thus extremely limited. Furthermore, a growing population will continue to exert pressure to draw land out of agricultural production for other uses. Consequently, area expansion will not play a major role in output growth on the Old Lands now or in the future.

The remainder of this section explores sources of growth in aggregate production on the Old Lands between 1990 and 1997. It first examines input trends for five key factors of production (water, fertilizer, land, hired labor, and machinery) and calculates partial productivity measures for these inputs. Partial productivity measures relate growth in inputs to growth in aggregate production and serve as an indicator of how efficiently inputs are used. The discussion of each productivity measure explores sources of growth by relating changes in productivity to changes in the three key factors affecting growth of aggregate production. The section concludes with a discussion of the distributional impacts of aggregate production growth across regions.

4.1 Partial Productivity of Inputs

Agricultural policy reforms rationalized input and output prices and gave farmers control over cropping choices. Policy reforms thus gave farmers opportunities to increase production by changing cropping patterns or using inputs more efficiently. One measure of the efficiency of input use is the productivity of inputs. Increasing productivity of inputs such as land, labor, machinery, nitrogenous fertilizer, and water contribute to growth in agricultural production. Increased productivity of inputs is also an important indicator of the impacts of policy reforms because it contributes to increased incomes in agriculture and increased employment throughout the economy.

Figures 4-3 and 4-4 and Table 4-1 summarize trends in the growth of aggregate production and selected factor inputs from 1990 to 1997. Quantities of all selected inputs except machinery grew more slowly than aggregate production between 1990 and 1997. Water available to agriculture grew at an average annual rate of 0.6 percent. Water availability minus re-use and groundwater grew at an average annual rate of 0.1 percent. Inputs of both fertilizer and land declined over the period. Machinery inputs grew at an average annual rate of 1.8 percent. The remainder of this section explores the productivity of these inputs and their contribution to growth of aggregate production on the Old Lands.

Table 4-2 summarizes partial productivity measures for water, nitrogenous fertilizer, land, hired labor, and machinery for the period from 1990 through 1997. The table also displays average annual growth rates for each of the partial productivity measures. The partial productivity measure for a given input in year t is aggregate productivity in year t divided by the quantity of the input used in year t. It thus represents the average aggregate production per unit of the selected input. The remainder of the section explores the partial productivity of each factor input separately and determinants of changes in factor productivity.

4.1.1 Productivity of Water Inputs

Inputs of water to agriculture - by either measure - increased between 1990 and 1997, but not as quickly as aggregate production. Thus, the partial productivity of water inputs on the Old Lands increased. This is not to say that some areas of the country did not experience water shortages that adversely affected production. In fact, a 1998 survey of Egyptian farmers revealed that more than 50 percent of farmers throughout Egypt had lost crops due to water shortages during the past year (El-Zanaty & Associates, 1998). Increasing partial productivity merely implies that the overall units of production per unit of water increased. Improved crop varieties may have contributed to increased productivity of water use (Nassar, 1996).

Changes in cropping patterns may also have contributed to improved productivity of water inputs. Shifts in cropped area from crops that make less efficient use of water and land resources to those that use these resources more efficiently may have contributed to the increased productivity of water. A crop's Domestic Resource Cost (DRC) coefficient is the ratio of the opportunity cost of resources used to produce the crop domestically and the cost of importing it. A DRC greater than one implies a comparative disadvantage while a DRC less than one implies a comparative advantage. For Egypt, sugarcane (DRC=1.4), short berseem (1.2), sugarbeets (0.9), maize (0.8), and long berseem (0.8) have relatively high DRC coefficients, meaning they use domestic resource relatively inefficiently. Rice (0.7), wheat (0.6), cotton (0.6), and tomatoes (0.4) have relatively lower DRC coefficients (Nassar, 1996; Omran, 1997). In general, between 1990 and 1997, area in crops with relatively low DRC coefficients increased at the expense of crops with relatively high DRC coefficients. The DRCs may be sensitive to the opportunity cost of water used in the calculation. This may explain the relatively low DRC for rice relative to sugarcane, both water intensive crops.

Figure 4-3: Trends in Aggregate Production and Hired Labor and Machinery Inputs on the Old Lands, 1990-1997

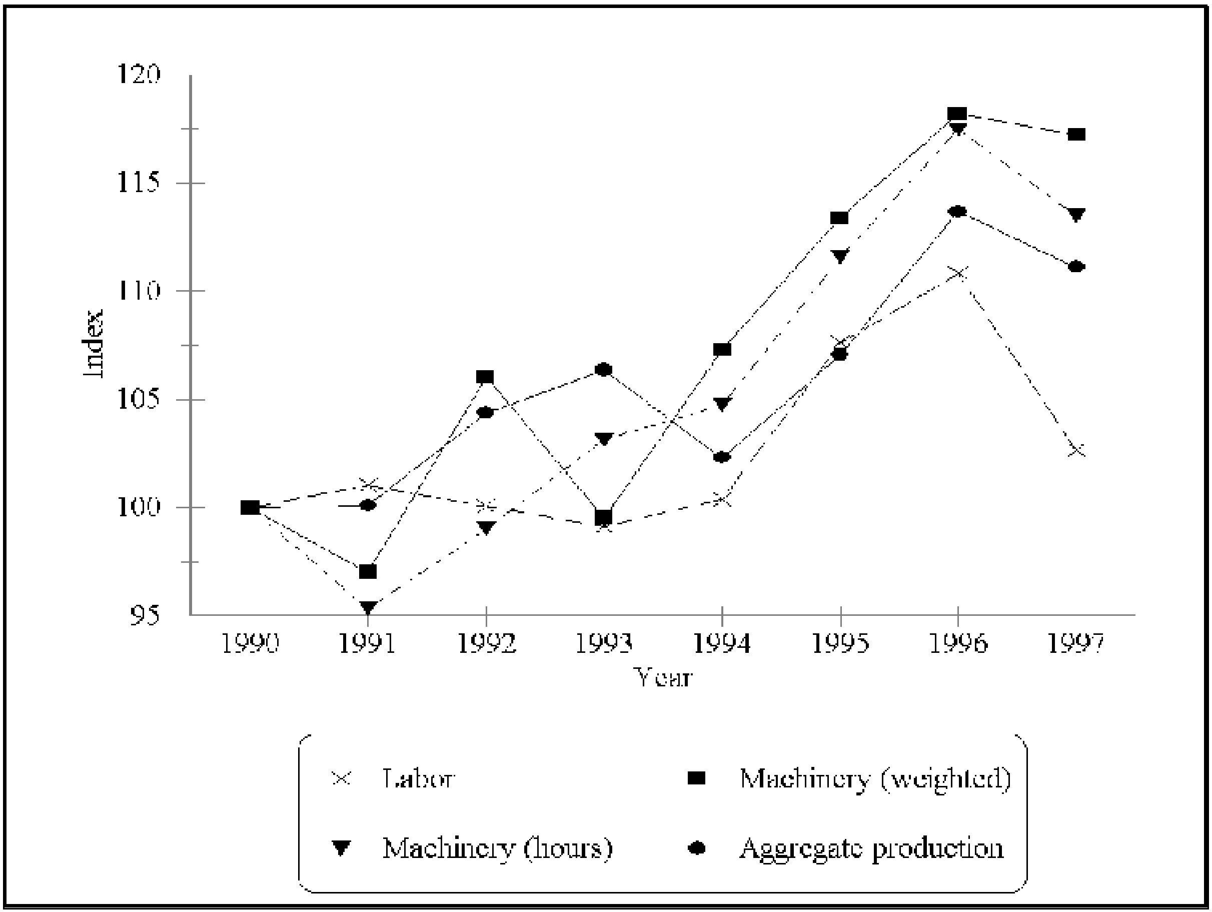
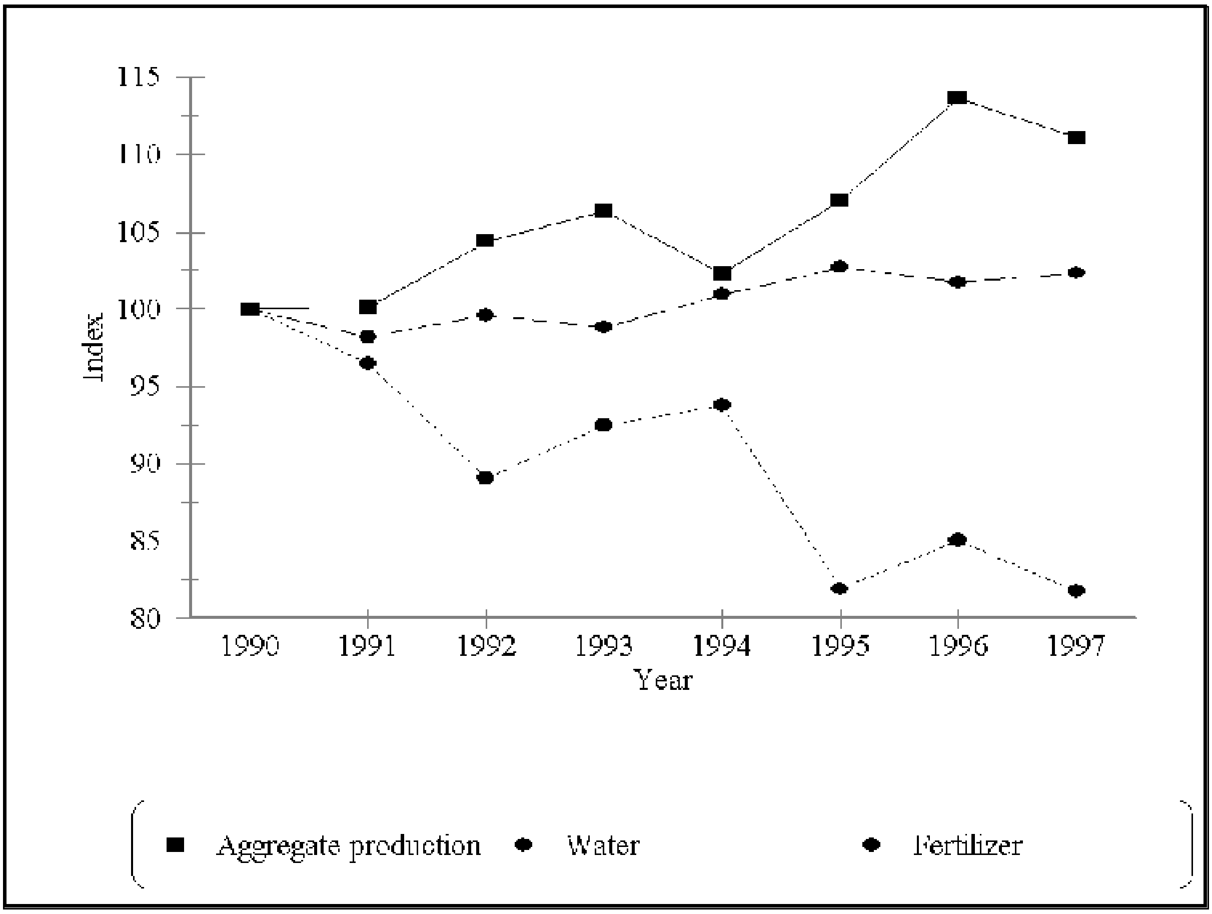


Figure 4-4: Trends in Aggregate Production, Water Available to Agriculture Minus Re-Use and Groundwater, and Fertilizer Availability on the Old Lands, 1990-1997



4.1.2 Productivity of Fertilizer Inputs

Between 1990 and 1997, fertilizer availability declined by an average of 3.1 percent annually, while aggregate production increased. The partial productivity of available fertilizer thus increased during the period. As previously discussed, the measure of fertilizer availability is not an ideal measure of fertilizer use. If the trend in fertilizer use matches the trend in availability, however, then the partial productivity measure implies that aggregate production increased even as fertilizer use declined.

Increasing productivity of fertilizer is unusual in developing countries but is consistent with the relatively high application rates of fertilizer in Egypt and the ready availability of water. As Mellor (1997) suggests, the high rates of application imply that further growth in yields depends more on raising the efficiency of fertilizer use than on increasing application rates. This provides

Table 4-1: Trends in Quantity of Selected Inputs to Agriculture on Egypt's Old Lands, 1990 - 1997

Input	Year								Average Annual Growth Rate (%)[a]
	1990	1991	1992	1993	1994	1995	1996	1997	
Aggregate Production (million LE, average 1994-96 prices)	17715.7	17730.2	18489.9	18838.3	18121.1	18963.4	20137.6	19679.7	
Index	888.451	889.178	927.276	944.751	908.784	951.024	1009.91	986.948	0.01502
Water Availability (billion m^3)	47.68	47.62	48.11	47.855	49.305	49.625	49.779	50.205	
Index	1589.33	1587.33	1603.67	1595.17	1643.5	1654.17	1659.3	1673.5	0.006
Water Consumption (billion m^3)	38.24	37.55	38.09	37.795	38.61	39.278	38.913	39.135	
Index	??	??	??	??	??	??	??	??	0.001
Fertilizer (1,000 tons, nutrient basis)	711.393	686.404	633.659	658.08	667.079	582.525	605.089	581.88	
Index	71.1393	68.6404	63.3659	65.808	66.7079	58.2525	60.5089	58.188	-0.0313
Cropped Area (1,000 feddans)	10125.8	10168.9	10048.1	9927.77	9974.48	10191	10256	10009.4	
Index	1012.58	1016.89	1004.81	992.777	997.448	1019.1	1025.6	1000.94	-0.001
Hired labor (1,000 full-time job equivalents)	1279.55	1292.7	1280.03	1268.28	1284.41	1377.04	1418.1	1313.46	
Index	127.955	129.27	128.003	126.828	128.441	137.704	141.81	131.346	0.0068
Machinery (1,000 hours)	24697.5	23963.4	26182.6	24574	26494.7	28003.6	29182	28945	
Index	2469.75	2396.34	2618.26	2457.4	2649.47	2800.36	2918.2	2894.5	0.01763

Source: Calculated from data provided by the MALR (1990 - 1997).

a. Average annual growth rate is the exponential growth rate estimated by fitting a semi-log equation to the data..

Table 4-2: Partial Productivity Measures of Selected Factor Inputs on Egypt's Old Lands, 1990 - 1997

Partial productivity measures	Year								Average Annual Growth Rate (%)[a]
	1990	1991	1992	1993	1994	1995	1996	1997	
Aggregate production (million LE) per bcm of water available to agriculture	371.55	372.33	384.33	393.65	367.53	382.13	404.54	391.99	
Index	??	??	??	??	??	??	??	??	0.009
Aggregate production (million LE) per bcm of water available to agriculture minus re-use and groundwater)	463.28	472.18	485.43	498.43	469.34	482.8	517.5	502.87	
Index	??	??	??	??	??	??	??	??	0.0143
Aggregate production (million LE) per 1,000 metric tons of nitrogenous fertilizer available, nutrient basis	24.903	25.831	29.18	28.626	27.165	32.554	33.28	33.821	
Index	2.4903	2.5831	2.918	2.8626	2.7165	3.2554	3.328	3.3821	0.0463
Aggregate production (million LE) per thousand cropped feddans	1.7496	1.7436	1.8401	1.8975	1.8168	1.8608	1.9635	1.9661	
Index	??	??	??	??	??	??	??	??	0.0164
Aggregate production (million LE) per thousand hired full time job equivalents	13.845	13.716	14.445	14.853	14.109	13.771	14.2	14.983	
Index	??	??	??	??	??	??	??	??	0.008
Aggregate production (million LE) per price weighted hour of machinery	0.7173	0.7399	0.7062	0.7666	0.684	0.6772	0.6901	0.6799	
Index	??	??	??	??	??	??	??	??	0

Source: Calculated from data provided by the MALR (1990 - 1997).

a. Average annual growth rate is the exponential growth rate estimated by fitting a semi-log equation to the data.

one explanation for the apparently increasing productivity of fertilizer. It is possible that farmers used fertilizers more efficiently, obtaining the same or higher yields without increasing fertilizer inputs. In addition to reducing production costs, increased productivity of fertilizer may also reduce environmental impacts of fertilizer use.

4.1.3 Productivity of Land

Aggregate production increased in spite of a slight decline in area planted to the 23 selected crops between 1990 and 1997. Thus, the partial productivity of land increased over the period. As with all partial productivity measures, the partial productivity of land captures sources of growth not directly attributable to land. Of the three sources of growth in aggregate production - yield improvements, area expansion, and changes in cropping patterns - area expansion and changes in cropping patterns relate most closely to changes in the measured productivity of land. Yield improvements stem primarily from increased productivity of other factors such as labor, machinery, water, seed, or fertilizer.

Increases in hired labor and machinery inputs likely accounted for some of the increase in the partial productivity measure for land. Table 4-3 reports changes in the ratios of machinery to cropped area and hired labor to cropped area between 1990 and 1997. The machinery/cropped area ratio increased at an average annual rate of 1.4 percent, while the labor/cropped area ratio increased by 0.8 percent annually. The remainder of this section explores in more detail the impacts of area expansion and changes in cropping patterns on aggregate production.

Area Expansion – Table 4-4 summarizes changes in cultivated and cropped area in the Old Lands. Cultivated area is the total area under cultivation. Farmers in the Old Lands cultivated about 148,000 fewer feddans in 1997 than in 1990 - an average annual rate of change in cultivated area of -0.8 percent. This figure corresponds to land cultivated for all crops in the 16 selected governorates. Cropped area - area planted to each crop, summed over crops - increased by 54,000 feddans over the same period. This was made possible by an increase in cropping intensity. Cropping intensity is the ratio of cropped to cultivated area and is a measure of the average number of crops grown on a given area in a year.

Despite an increase in cropped area on the Old Lands, cropped area in the 23 crops selected for this study declined by about 114,000 feddans. This implies either that crops not considered in the analysis accounted for most of the increase in cropping intensity or that area shifted from the 23 crops selected for the analysis to crops not included in the analysis. Data inconsistencies for cropped area prevented more detailed examination of this question.

Changes in Cropping Patterns – Agricultural policies that affect relative prices, costs, or yields may affect the relative profitability of individual crops or crop rotations and ultimately show up at the farm level as changes in cropping choices. Table A-9 in Appendix A summarizes the share of cropped area in each of the 23 crops considered in this report between 1990 and 1997.

The primary crops on the Old Lands changed little from the 1987 - 1993 period (Nassar et al., 1996). Wheat, long berseem, maize, rice, and cotton continued to occupy a majority of the cropped area. Trends in cropping patterns for these crops, however, did change. Between 1987 and 1993, each of the five crops, with the exception of cotton, experienced substantial growth

Table 4-3: Changes in Selected Factor Input Ratios on the Old Lands, 1990 - 1997

Ratio	1990	1991	1992	1993	1994	1995	1996	1997	Average Annual Growth Rate (%)[a]
Hired labor / machinery (full time job equivalents per 1,000 machine hours)	5.4263	5.74889	5.48109	5.21547	5.20036	5.23469	5.12002	1.44841	
Index	0.5426	0.57489	0.54811	0.52155	0.52004	0.52347	0.512	0.14484	-0.037
Machinery / cultivated area (machine hours per feddan)	23.288	22.1126	23.2418	24.4946	24.7616	25.8131	27.0058	26.7262	
Index	??	??	??	??	??	??	??	??	0.0136
Hired labor / cultivated area (full-time equivalent jobs per 100 feddans)	12.636	12.7123	12.7391	12.7751	12.8769	13.5123	13.827	13.1222	
Index	12.636	12.7123	12.7391	12.7751	12.8769	13.5123	13.827	13.1222	0.008

Source: Calculated from data provided by the MALR (1990 - 1997).

a. Average annual growth rate is the exponential growth rate estimated by fitting a semi-log equation to the data.

Table 4-4: Cropped and Cultivated Areas, 1990 - 1997

	1990	1991	1992	1993	1994	1995	1996	1997	Average Annual Growth Rate (%)[a]
Cropped area in selected crops (1,000 feddans)	10125.85	10168.93	10048.08	9927.77	9974.475	10190.97	10255.96	10009.43	-0.001
Total cropped area (1,000 feddans)	11105.92	11166.97	11044.11	10974.61	10987.73	11241.32	11367.78	11159.5	0
Percent of cropped area in selected crops (%)	91.17524	91.06259	90.98133	90.46124	90.77827	90.6563	90.21963	89.69425	-0.002
Cultivated area (1,000 feddans)	6073.174	6054.332	5913.722	5886.471	5711.425	5892.344	5975.86	5925.578	-0.008
Cropping intensity for all crops	1.828684	1.844459	1.867539	1.864379	1.923817	1.907785	1.902283	1.883277	0.008

Source: Calculated from data provided by the MALR (1990 - 1997).

a. Average annual growth rate is the exponential growth rate estimated by fitting a semi-log equation to the data.

in cropped area. Between 1990 and 1997, cropped area in wheat and rice (summer plus nili) continued to increase while area in long berseem, maize (summer plus nili), and cotton declined. Other notable changes in cropping patterns between 1990 and 1997 included the accelerated loss of cropped area in tomato relative to 1987 - 1993 and a substantially increased growth rate for area in onion.

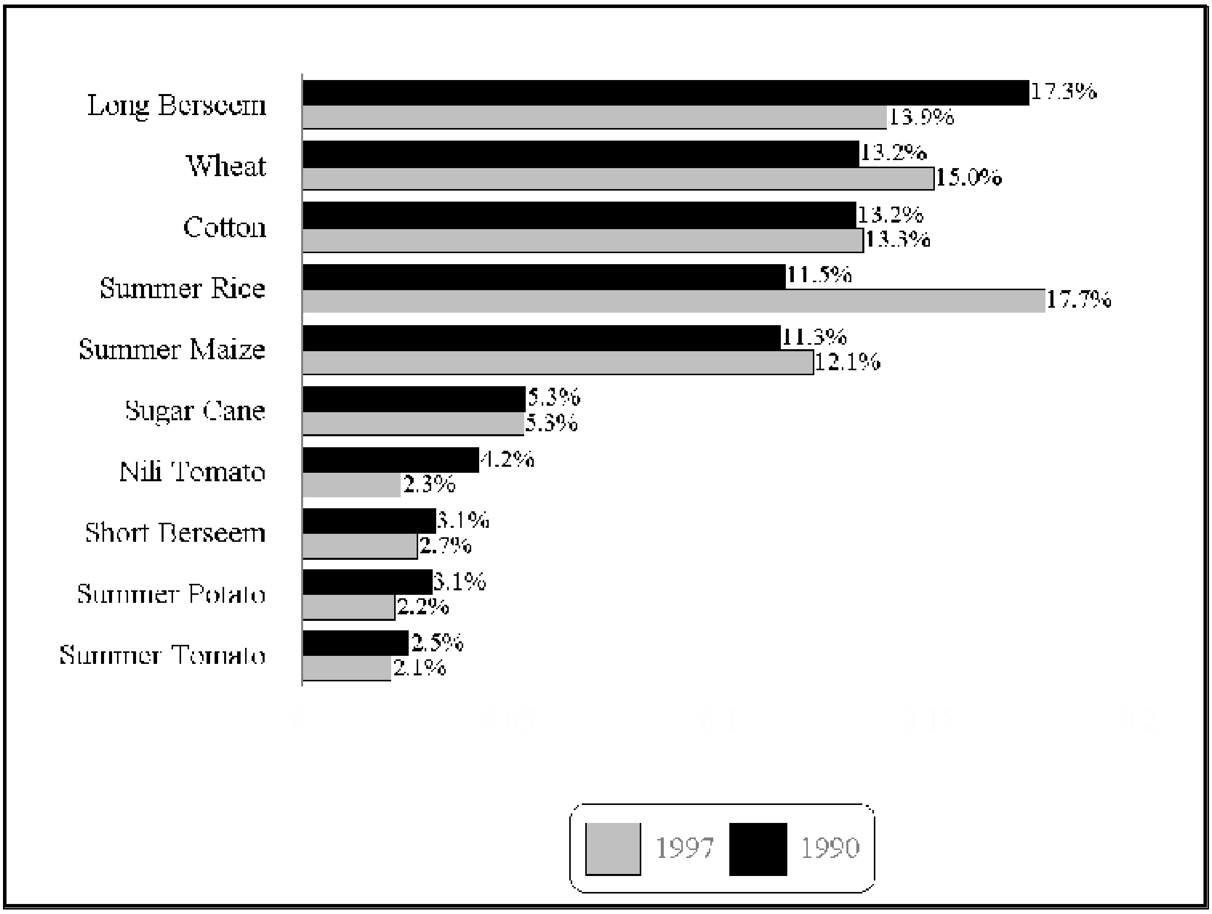
Figure 4-5 illustrates the share of aggregate production attributable to ten key crops in 1990 and in 1997. These ten crops accounted for almost 85 percent of aggregate production on the Old Lands. Some notable shifts in the relative importance of these crops occurred between 1990 and 1997. In 1990, long berseem was the largest contributor to aggregate production followed by wheat, cotton, summer rice, and summer maize. By 1997, summer rice was the largest contributor followed by wheat, long berseem, cotton, and summer maize.

Changes in cropping patterns over the 23 crops considered in this analysis had a negative impact on aggregate production between 1990 and 1997. Changes in cropping patterns for the most important crops, however, had a substantial positive impact. Table 4-5 summarizes changes in cropping patterns and impacts of those changes on aggregate production for the period from 1990 to 1997. Wheat, summer maize, summer rice, cotton, and winter tomato contributed the most to growth in aggregate production between 1990 and 1997. Together these five crops accounted for 146 percent of net growth in aggregate production. Increased yields for cotton and summer maize more than offset reductions in cropped area so that both contributed positively to growth in aggregate production. Cropped area in cotton declined from 9.8 percent to 8.5 percent of cropped area while yields increased at an average annual rate of 6.0 percent. Area in summer maize declined from 14.8 percent to 14.7 percent of cropped area while yields increased at an average annual rate of 1.3 percent. Yield increases for fava beans, groundnuts, sugarcane, and winter tomato were also large enough that production increased despite loss of cropped area.

Yield increases were also an important factor in the increased share of aggregate production attributable to summer rice. Summer rice accounted for 74 percent of total growth in aggregate production. The 2.3-percent average annual increase in yield accounted for one-third of the growth in production of summer rice, while increased area (from 10.1 percent to 15.1 percent of cropped area) accounted for two thirds.

Prices and Cropping Patterns – Prices for the major crops appear to have had a significant impact on cropping patterns between 1990 and 1977. The correlation between nominal farmgate prices lagged two years and cropped area was 0.71 for wheat and 0.94 for summer rice. The correlation between maize and cotton prices and cropped area in these crops was -0.65 and -0.13, respectively. Nominal price changes do not necessarily reflect profitability. It is likely that, despite price increases for both cotton and maize during the period, they were not as profitable as rice and wheat (Nassar et al., 1996). Other crops with high, positive correlation between two year lagged prices and cropped area were sugarbeets (0.92), garlic (0.75), onion (0.62), and potato (0.45).

Figure 4-5: Share of Aggregate Production Attributable to Selected Important Crops on the Old Lands, 1990 and 1997



The rate at which farmers are shifting cropping patterns seems to be declining. Between 1987 and 1993, cropped area in wheat, long berseem, and summer maize increased at annual rates of 5.6 percent, 0.1 percent, and 0.7 percent, respectively. Between 1990 and 1997, the annual rates of change in cropped area for these four crops were 1.8 percent, -0.1 percent, and -0.2 percent, respectively. Of the major crops, only rice experienced an increase in the rate of growth of cropped area - from a 5.8-percent annual growth rate between 1987 and 1993 to a 6.1-percent rate between 1990 and 1997. The decline in the rate at which farmers are adjusting crop mix suggests that, following an expected surge in cropping adjustments to policy reforms, cropping patterns are nearing equilibrium.

4.1.4 Productivity of Hired Labor

Hired labor inputs in the 16 selected governorates increased at an average annual rate of 0.7 percent between 1990 and 1997 - slower than the 1.5 percent annual growth rate of aggregate production. Thus, the partial productivity of hired labor increased. Increased machinery inputs

Table 4-5: The Impact of Cropping Pattern Changes on Aggregate Production on the Old Lands, 1990 - 1997

Crop	Share of cropped area (%)		Average annual growth in yield (%)	Share of change in aggregate production, 1990 - 1997	
	1990	1997		Million LE	% of total
Wheat	17.26	20.37	0.87676	612.18817	31.170081
Long Berseem	15.71	13.97	-0.2266	-325.5663	-16.57649
Summer Maize	14.76	14.68	1.3476	379.14532	19.304506
Summer Rice	10.14	15.13	2.26953	1447.1	73.682651
Cotton (Zahr)	9.801	8.525	6.04413	291.58459	14.846277
Short Berseem	7.839	6.809	3.52873	-21.60251	-1.09991
Nili Maize	4.092	2.656	4.07756	-73.65517	-3.750215
Summer Sorghum	3.063	3.486	1.13213	67.59114	3.4414604
Fava beans	2.954	2.797	-6.455	3.0464611	0.1551132
Sugarcane	2.598	2.593	1.84075	96.031959	4.8895488
Seed Berseem	1.61	1.369	1.67477	-8.244932	-0.419798
Winter Tomato	1.271	1.087	7.82205	133.06083	6.7749053
Nili Potato	1.153	0.52	0.89058	-185.1001	-9.424527
Summer Tomato	0.982	0.871	1.1487	-32.54563	-1.657089
Soybeans	0.973	0.308	1.58832	-71.84625	-3.658113
Nili Tomato	0.784	0.436	-0.624	-286.9914	-14.61241
Barley	0.68	0.385	2.26977	-19.55024	-0.995417
Summer Potato	0.668	0.581	-3.2859	-112.6791	-5.73715
Summer Onion	0.6	0.417	2.61119	-12.99536	-0.66167
Winter Onion	0.519	0.382	1.69545	-11.28532	-0.574601
Sesame	0.347	0.31	0.96677	-5.566881	-0.283442
Sugarbeets	0.337	0.562	4.81435	34.421625	1.7526063
Flax (Seed)	0.281	0.183	2.52952	-4.655124	-0.23702
Flax (Fiber)	0.281	0.183	2.10383	-4.247289	-0.216254
Groundnuts	0.218	0.218	5.20811	11.600556	0.5906522
Winter Onion (Single)	0.205	0.269	0.67005	30.934057	1.5750338
Garlic (Single)	0.143	0.158	-0.277	5.9718115	0.3040599
Fenugreek	0.137	0.07	-3.1858	-8.134214	-0.41416
Lentils	0.133	0.08	-4.5421	-8.996993	-0.45809
Chickpeas	0.13	0.112	-0.7281	-3.41831	-0.174046
Summer Onion (Single)	0.09	0.1	4.96624	5.7611559	0.2933341
Nili Sorghum	0.08	0.113	2.35815	5.2639877	0.2680204
Garlic (Intercropped)	0.07	0.1	-0.1275	6.7137025	0.3418339
Lupines	0.06	0.06	-2.2106	-3.363936	-0.171278
Nili Onion	0.03	0.115	3.2661	34.830205	1.7734095
Nili Rice	0.01	1e-10	2.8834	-0.821202	-0.04181

Source: Calculated from data provided by the MALR (1990 - 1997).

likely accounted for some of the measured increase in hired labor productivity. Between 1990 and 1997, the labor/machinery ratio decreased by almost six percent - from 1.60 to 1.51 (see Table 4-3).

Between 1990 and 1997, hired labor inputs to agriculture in the selected governorates increased by about ten million labor-days. This is the equivalent of about 34,000 full time workers in agriculture - assuming an average 295 day work year (El-Deep, 1992). This estimate accounts for only one-tenth of the census estimates of an increase of 350,000 workers in the agricultural labor force between 1990 and 1996 - an annual growth rate of 1.0 percent (CAPMAS, 1997; CAPMAS, 1998). Several factors may account for this difference. First, the estimates of this study do not account for growth in the agricultural labor force on the New Lands while the census estimates are for the Old and the New Lands. Given the area of New Lands relative to Old, however, this is not likely to account for an order of magnitude difference in estimates of the change in the labor force.

A more likely explanation for the difference is that the estimates based on the technical coefficients for labor exclude family labor. Family labor accounted for an estimated 85 percent of agricultural labor in 1989 (Rady et al., 1996). This alone accounts for most of the difference between census estimates of agricultural labor changes and those of this analysis. The greater growth rate of the census figures relative to hired labor may imply that family labor inputs grew faster than hired labor inputs during the period between 1990 and 1997. If family labor inputs increased more quickly than hired labor, then the calculated productivity of hired labor reported in Table 4-2 overestimates actual labor productivity. Reliable and accessible data on family labor are needed to meaningfully address questions of the role of labor in the agricultural sector.

Treatment of seasonal labor may also distort employment figures. The census estimates report the number of workers in agriculture rather than labor-days. If seasonal or part-time workers make up a large part of the agricultural labor force, then calculating full-time equivalent jobs by dividing labor-days by 295 days per year underestimates the total agricultural work force.

The apparent inconsistencies in measured labor inputs - particularly the hard-to-explain decline in labor inputs between 1996 and 1997 - emphasizes the weaknesses in the technical coefficients and the need for better estimates of labor inputs.

4.1.5 Productivity of Machinery

Machinery inputs grew by 1.8 percent annually between 1990 and 1997. Measured in terms of hours of machine use - regardless of machine type or cost - machinery inputs increased from 236 million hours in 1990 to 268 million hours in 1997. Machinery inputs grew more quickly than aggregate production. The partial productivity of machinery thus decreased over the period. Farmers added machinery inputs at a faster rate than either labor or cropped area (see Table 4-3).

Substantial changes in technical coefficients and cropped area for a few key crops drove much of the increase in machinery inputs. Table 4-6 summarizes changes in machinery technical coefficients and cropped area for the 22 crops for which machinery technical coefficients exist. Summer rice accounted for a vast majority of the total increase in machinery inputs. The technical coefficients for machinery use in summer rice cultivation increased at an average annual rate of 25.0 percent. Cropped area in summer rice increased by 6.1 percent. Together, these forces increased total machinery inputs for summer rice from 11,036 million hours in 1990 to 63,617 million hours in 1997 - over 100 percent of the net change in machinery inputs over all crops. At the same time, smaller technical coefficients and reductions in cropped area in cotton and long berseem substantially reduced machinery inputs for those crops.

The measured reduction in the partial productivity of machinery use was entirely a product of the dramatic increase in machinery use in summer rice. If summer rice is subtracted from both aggregate production and machinery inputs, machinery inputs actually declined by an average annual rate of 2.3 percent between 1990 and 1997. This implies that the partial productivity of machinery increased at an average annual rate of 3.8 percent over the period.

Closer examination of the types of machinery used provides clues to the source of the substantial changes in machinery inputs for some crops. Increased use of threshing machinery in summer rice, for instance, accounted for 44.8 percent of the total increase in machinery inputs for summer rice. Increases in irrigation machinery, spraying machinery, and transportation accounted for 22.4 percent, 7.2 percent, and 25.6 percent, respectively. For long berseem, decreased use of tractors accounted for 15.5 percent of the reduction in machinery inputs for that crop, irrigation machinery for 49.3 percent, and transportation for 35.2 percent. In cotton, inputs of irrigation machinery and tractors decreased substantially, by 111.6 and 23.4 percent, respectively of the total change in machinery inputs for cotton.

The dramatic increases in machinery technical coefficients for crops such as summer rice seem suspicious. Consultation with individuals familiar with changes in Egyptian agriculture, however, suggest that the changes in machinery technical coefficients may be realistic, at least for summer rice.

4.2 Regional Impacts of Aggregate Production Growth

Aggregate production growth varied substantially by governorate and region. Table 4-7 illustrates shares of aggregate production growth by governorate and region. The second, third, and fourth columns show aggregate production by governorate and region in 1990 and 1997 and the absolute change between 1990 and 1997. The fifth and sixth columns show the share of total aggregate production in 1990 and in 1997. Between 1990 and 1997, Lower Egypt's share of aggregate production increased from 60.8 percent to 61.8 percent. This growth came largely at the expense of Middle Egypt where the share of aggregate production fell from 22.0 percent to 19.9 percent. Upper Egypt's share of aggregate production increased from 17.2 percent to 18.3 percent.

The impacts of changes in the agricultural sector on hired labor also differed across regions and governorates. Table 4-8 illustrates changes in hired labor between 1990 and 1997 by crop and region. Columns report the total change in hired labor between 1990 and 1997 by region and for all regions. Overall, hired labor inputs in Upper Egypt declined between 1990 and 1997, while hired labor inputs in Lower and Middle Egypt increased.

Table 4-6: Machinery Inputs for Selected Important Crops on the Old Lands, 1990-1997

Crop	Machine inputs (1,000 hours)			Annual rate of change, 1990 - 1997 (%)	
	1990	1997		Machine hours	Cropped area
Summer Rice	11036.2725	63616.728		0.2503112	0.06141
Soybeans	2799.37569	958.939464		0.054601	-0.175153
Nili Potato	3232.45947	1450.457		0.032684	-0.132863
Short Berseem	10588.9185	12268.584		0.031349	-0.03553
Chickpeas	306.885496	216.598963		0.028817	0.023339
Sugarcane	17310.7167	21214.5974		0.018887	0.014446
Lentils	299.587512	171.072884		0.017938	-0.04428
Summer Potato	2056.35596	1871.79309		0.00896	0.010462
Wheat	46508.435	52389.739		0.00461	0.016668
Winter Tomato	4945.03536	4306.01635		0.00333	-0.04481
Sesame	782.945703	596.31187		0.00304	0.041612
Summer Maize	41551.131	40078.0846		-0.0022	0.017699
Garlic (Single)	418.70224	439.280765		-0.0091	0.02623
Summer Sorghum	8637.89648	9584.46707		-0.01313	0.020913
Nili Sorghum	211.624551	310.14759		-0.01313	0.1212773
Sugarbeets	812.65792	1377.22054		-0.01523	0.04471
Cotton (Zahr)	30082.1597	23112.1182		-0.02258	-0.05408
Flax (Fiber)	672.380175	398.050198		-0.02472	-0.0093
Winter Onion	525.494004	613.036424		-0.03503	0.06478
Barley	1560.59858	626.60484		-0.06207	-0.07465
Groundnuts	863.92608	441.699102		-0.0651	0.019552
Long Berseem	42056.7793	25058.2692		-0.11604	-0.0022

Source: Calculated from unpublished machinery technical coefficients, Central Administration for Agricultural Economics, MALR.

Summer rice accounted for the largest increase in hired labor inputs. As Lower Egypt produces a vast majority of the summer rice in Egypt, the benefits of increased employment in summer rice production accrued almost exclusively to that region. Lower Egypt also benefitted disproportionately from increased labor inputs in the production of fava beans. Lower and Middle Egypt gained significant employment in production of wheat. Middle Egypt gained a disproportionate share of increased employment in the production of summer maize and sorghum. Upper Egypt gained substantial employment due to expanded area of sugarcane. It suffered large and disproportionate losses in employment, however, because of shifts out of fava beans, sesame, and sorghum.

Changes in cropping patterns and cropped area between 1990 and 1997 also changed the composition of the hired labor force. Table 4-9 illustrates the distribution of hired labor-days by men and women/children across regions and governorates. The second column of the table represents the proportion of men in the hired labor force by governorate in 1990. Men account for the vast majority of hired agricultural labor in all governorates. Columns three and four illustrate the change in full time equivalent jobs in absolute terms and as a percent of the total change in labor inputs across all governorates. Columns five and six show the gain or loss in full time equivalent jobs for men and for women/children as a percent of the total change in the hired labor force for the governorate or region. Women and children gained a disproportionate percentage of the added employment in agriculture. Across all 16 governorates, men accounted for 77 percent of the labor force in 1990, but they gained only 62 percent of the new jobs between 1990 and 1997. Women and children, on the other hand, accounted for 23 percent of the hired labor force in 1990 but accounted for 38 percent of the new jobs between 1990 and 1997.

Changes in labor force composition varied considerably across regions and governorates. Lower Egypt gained over 35,000 full-time equivalent hired labor jobs in agriculture between 1990 and 1997. Women and children accounted for a disproportionate percentage of this increase, 55 percent compared to 45 percent for men. Upper Egypt lost 8,790 full-time equivalent jobs between 1990 and 1997. Jobs for women and children accounted for 68 percent of the loss, a loss that is less than proportionate to their 21-percent presence in the labor force in 1990. In Middle Egypt, men accounted for 107 percent of the new jobs, while the woman and child labor force declined.

Part of the increase in woman/child labor relative to men is accounted for by large changes in relative technical coefficients for men and woman/children for key crops such as summer rice. For summer rice, man-days of labor per feddan increased from 26.1 to 27.1 days per feddan, while woman/child days increased from 2.8 to 11.0 days per feddan. Across regions, women and children gained the largest percentage of the new jobs in Lower Egypt but lost ground in Upper and Middle Egypt.

Table 4-7: Aggregate Production by Governorate and Region, 1990 and 1997

Governorate/ region	Aggregate production (million LE at 1994-96 prices)			Share of aggregate production (%)	
	1990	1997	Change	1990	1997
Lower Egypt	10777	12157	1380	60.8308	61.7735
Behera	2457	2600	143.463	13.8672	13.2122
Gharbia	1314	1337	22.9725	7.41472	6.79147
Kafr El Sheikh	1447	1866	418.882	8.16911	9.48233
Dakahlia	1960	2332	372.152	11.0623	11.8493
Damietta	309.887	338.351	28.4637	1.74922	1.71929
Sharkia	1757	2184	426.657	9.91775	11.096
Menofia	1048	985.06	-63.424	5.91839	5.00545
Kalyoubia	484.031	515.112	31.0813	2.73221	2.61747
Middle Egypt	3891	3919	27.795	21.9631	19.9124
Giza	712.297	648.487	-63.809	4.0207	3.2952
Beni-Suef	786.629	866.771	80.1416	4.44029	4.40438
Fayoum	1075	858.354	-216.68	6.06827	4.36161
Menia	1317	1545	228.145	7.43382	7.85122
Upper Egypt	3048	3604	555.983	17.2061	18.3141
Assiut	827.637	1048	220.257	4.67177	5.32474
Sohag	865.403	1029	163.889	4.88494	5.23021
Qena	1061	1143	82.4919	5.98768	5.80929
Aswan	294.379	383.724	89.3453	1.66168	1.94984
Total	17716	19680	1964	100	100

Source: Calculated from data provided by the MALR (MALR, 1990 - 1997).

Table 4-8: Distribution of Changes in Hired Labor by Selected Important Crops and by Region on the Old Lands, 1990 - 1997 (full-time job equivalents)

Crop	Absolute change by region			
	Lower	Middle	Upper	Total
Summer Rice	91598.3876	3328.16574	0	94926.5533
Wheat	18573.4125	12720.565	-2850	28443.7708
Sugarcane	-759	-786	10148.0371	8602.88236
Sugarbeets	3084.82538	95.8273661	1.88829153	3182.54103
Winter Onion (Single)	474.686208	221.95472	469.366671	1166.0076
Groundnuts	92.219339	18.949439	523.806792	634.975569
Garlic (Single)	-247	639.764078	-82	311.087814
Summer Sorghum	0	3518.60262	-3423	95.7483271
Chickpeas	-156	25.5712	-110	-241
Lentils	-432	-20	129.844573	-322
Flax (Fiber)	-1071	-46	0	-1117
Sesame	91	63.1461661	-1207	-1235
Summer Potato	-2041	685.086356	22.0014407	-1334
Barley	-1315	215.335739	-408	-1508
Winter Tomato	-2197	-2596	1812.22394	-2980
Summer Tomato	-4538	1035.9374	457.141632	-3045
Fava beans	8378.03372	-10183	-3887	-5692
Summer Maize	-18208	11524.263	874.466458	-5809
Soybeans	-3354	-3971	-1433	-8759
Nili Potato	-10714	-826	124.769688	-11415
Long Berseem	-5418	-10404	2057.54223	-13765
Short Berseem	-19069	-435	-1102	-20605
Cotton (Zahr)	-17412	2691.56327	-10912	-25632
Total	35180.1713	7516.53492	-8792	33904.2211

Source: Calculated from unpublished labor technical coefficients provided by the Central Administration for Agricultural Economics, MALR.

Table 4-9: Changes in Labor Force Composition by Governorate on the Old Lands, 1990-1997

Governorate	Percent of labor force that are men	Change in full-time job equivalents (1,000)	Change as % of total change	Percent of change in governorate	
				Men	Women/ children
Lower Egypt	76.47091	35.1801713	103.7634	45.06472	54.93528
Behera	76.47095	5.58839088	16.48288	11.18628	88.81372
Gharbia	76.11731	-3.5241915	-10.3946	97.74447	2.255534
Kafr El Sheikh	75.84676	16.0580664	47.36303	57.84783	42.15217
Dakahlia	75.55076	16.9158724	49.89312	57.76417	42.23583
Damietta	77.25586	1.74862636	5.157548	30.22888	69.77112
Sharkia	76.51925	6.98474409	20.6014	65.91305	34.08695
Menofia	78.14455	-7.3614985	-21.7126	63.8098	36.1902
Kalyoubia	78.63723	-1.2298389	-3.62739	66.85693	33.14307
Middle Egypt	77.36469	7.51653492	22.16991	106.9625	-6.96253
Giza	79.0214	-1.2665098	-3.73555	27.03855	72.96145
Beni-Suef	75.38702	4.0510972	11.94865	88.37029	11.62971
Fayoum	76.41933	-0.8829319	-2.60419	55.44796	44.55204
Menia	78.3808	5.61487939	16.561	94.2482	5.751798
Upper Egypt	79.32784	-8.792485	-25.9333	31.76493	68.23507
Assiut	76.27732	-2.8644989	-8.4488	19.86219	80.13781
Sohag	76.39962	-2.2523486	-6.64327	-48.8479	148.8479
Qena	83.15284	-10.408552	-30.6999	83.95965	16.04035
Aswan	83.89194	6.73291439	19.85863	80.42259	19.57741
Old Lands	77.21777	33.9042211	100	62.23648	37.76352

Source: Calculated from unpublished labor technical coefficients provided by the Central Administration for Agricultural Economics, MALR.

5. IMPLICATIONS AND RECOMMENDATIONS

Agricultural production on Egypt's Old Lands has increased substantially since 1990. Improved physical yield, rather than area expansion or changes in cropping patterns, was the primary driving force behind the observed growth. Policy reforms may have contributed to improved yields by encouraging more efficient use of inputs. The apparent negative impact of changes in cropping patterns on aggregate production must be interpreted with caution. Data on production and yields are not accurate enough to strongly support such a conclusion. Furthermore, the variability of aggregate production since 1994 makes the results susceptible to the time period chosen for the analysis. Aggregate production experienced the most rapid growth of the period between 1994 and 1996.

Increased production likely created additional employment (i.e., hired labor) in the agricultural sector. Overall, the equivalent of as many as 34,000 full-time jobs may have been created on the Old Lands. The vast majority of employment increases occurred in Lower Egypt largely as a result of increased summer rice production. At the same time, employment in Upper Egypt actually declined. Reduced labor inputs for cotton, sorghum, and fava beans had the greatest impact on employment in Upper Egypt.

These results must be interpreted very cautiously. The suspect nature of the key data series and the limited availability of information about input quantities substantially limit the ability to draw policy-relevant conclusions from the study. While broad trends are probably generally representative, there is likely considerable error in the magnitudes of trends in production estimates, input quantities, and productivity measures.

At this time, the availability and quality of data severely constrain the types of analyses that can be conducted and the relevance and interpretation of results. Specific concerns regarding data issues and recommendations for improvement include:

- Basic agricultural data on cropped area, production, yield, and prices are likely inflated once they are aggregated to the governorate level. Estimates of aggregate production are thus likely to be inflated as well. If, as Fawzy et al. (1998) suggest, pressure exists to show annual improvements in yields, then trends in these basic data are also likely inaccurate. Inaccurate data on these basic measures of agricultural activity severely compromise planning, monitoring, and evaluation efforts in the agricultural sector.

  Fawzy et al. (1988) suggest that the problems lie mainly in the transmission of data from the village to the governorate level. Still, estimates at the village level may often be subjective and not based on statistical sampling methods. Training in data collection and statistical methods, improved sampling techniques, recognition of the value of accurate information, and institutional as well as financial support for reliable data collection and transmission are needed to improve data quality.

  Village level data should probably be used whenever possible until the accuracy of data transmission from the village to the governorate level is improved. For national or governorate level studies, collection of village level data is probably prohibitively expensive and time consuming. For smaller scale studies, however, the quality of the village level data may justify the added expense.

- Readily accessible data on the agricultural labor force includes only hired labor. By some estimates, however, family labor accounts for as much as 85 percent of agricultural labor in Egypt (Rady et al., 1996). It is, therefore, very difficult to track a large portion of the agricultural labor force - a portion that may be disproportionately comprised of women and children.

  It will be important to develop accurate data on family labor in agriculture. Such data are necessary to estimate production costs as well as social and economic impacts of change in the agricultural sector.

- The best available estimates of hired labor and machinery inputs in agriculture are based on technical coefficients that may not accurately represent the average farm operation (Fawzy et al., 1998). It is, therefore, difficult to accurately estimate hired labor and machinery inputs to agriculture.

  As with area, production, yield, and price data, training in data collection and statistical methods, improved sampling methods, and a commitment to improving data quality are urgently needed to improve these data.

- Data on fertilizer use were inadequate to accurately estimate farm-level fertilizer use. Improved data on farm-level fertilizer use will aid in increasing fertilizer productivity and reducing the environmental impacts of fertilizer application.

- Irrigation water is a crucial agricultural input in Egypt. Yet little information is available about water use in agriculture. Land reclamation projects currently underway are expected to dramatically increase water use in agriculture. An expanding population and industrial sector are also making increasing demands on available water. As water of adequate quality becomes more scarce, accurate data on water use in different sectors and regions will become increasingly important.

- The preceding analysis is also partial in the sense that it concentrates only on the Old Lands. The New Lands, however, may account for much of the recent growth in the agricultural sector. Furthermore, crops, soil characteristics, irrigation technology, and fertilizer use may all differ substantially between the Old and the New Lands.

  A parallel study of productivity on the New Lands should be undertaken. Such a study will provide a more complete description of growth in Egypt's agricultural sector.

REFERENCES

CAPMAS (Central Agency for Public Mobilization and Statistics). June 1997. *Statistical Yearbook, 1991 - 1996, Arab Republic of Egypt*. Arab Republic of Egypt, Cairo, Egypt.

CAPMAS (Central Agency for Public Mobilization and Statistics). June 1998. *Statistical Yearbook, 1992 - 1997, Arab Republic of Egypt*. Arab Republic of Egypt, Cairo, Egypt.

El Guindy, Magdy, Ibrahim Siddik, and Edgar Ariza-Nino. 1997. *Marketing and Price Policies for Nitrogen Fertilizers in Egypt*. Reform, Design and Implementation Unit, Agricultural Policy Reform Program, Cairo, Egypt.

El-Deep, Mohamed A. 1992. *Labor Force in Egyptian Agriculture: Seventies and Eighties Changes and Future Outlook for the Nineties.* Workshop of Agricultural Policies in Egypt, MALA, FAO, Cairo.

El-Zanaty & Associates. 1998. *Knowledge, Attitudes and Practices of Egyptian Farmers Toward Water Resources: A National Survey*. GreenCom Egypt III of the Water Policy Reform Program, Agricultural Policy Reform Project, United States Agency for International Development, Cairo, Egypt.

Fawzy, Morsy A., Larry Pope, Yehia M. El-Din, and Ghazal Amer. 1998. *Availability and Quality of Agricultural Data in Egypt*. Monitoring, Verification and Evaluation Unit, Agricultural Policy Reform Program, Impact Assessment Report No. 4, Cairo, Egypt.

MALR (Ministry of Agriculture and Land Reclamation). 1990 - 1997. *Agricultural Economy*. Economics Affairs Administration, Ministry of Agriculture and Land Reclamation, Cairo, Egypt.

Mellor, forthcoming

Mellor, John. 1997. *Fertilizer Policy Options for Egypt*. Chemonics International Inc., Washington, D.C.

Nassar, Saad, Fenton B. Sands, Mohamed A. Omran, and Ronald Krenz. 1996. Crop Production Responses to the Agricultural Policy Reforms, in *Egypt's Agriculture in a Reform Era*, Lehman B. Fletcher (ed.), Iowa State University Press, Ames, Iowa.

Omran, Mohamed Abdel-Raheem Sherif. 1997. *The Impact of the Liberalization of Agricultural Input and Output Prices on the Cropping Pattern*. Doctoral Dissertation, Department of Agricultural Economics, Faculty of Agriculture, Suez Canal University, Egypt.

Rady, Abdel-Moneim, Mohamed A. Omran, and Fenton B. Sands. 1996. Impacts of the Policy Reforms on Agricultural Income, Employment, and Rural Poverty, in *Egypt's Agriculture in a Reform Era*, Lehman B. Fletcher (ed.), Iowa State University Press, Ames, Iowa.

Zalla, Tom, and Abdel-Hamid Youssef Saad. 1998. *Fertilizer Production and Marketing in Egypt: Baseline Study*. Monitoring, Verification and Evaluation Unit, Agricultural Policy Reform Program, Impact Assessment Report No. 2, Cairo, Egypt.

APPENDIX A:
SUMMARY OF BASIC DATA SERIES

Table A-1: Cropped Area for Selected Crops on the Old Lands, 1990 - 1997 (feddans)

Crop	1990	1991	1992	1993	1994	1995	1996	1997
Barley	68,855	62,086	67,159	52,693	55,352	42,206	43,567	38,520
Long Berseem	1,590,349	1,572,415	1,601,454	1,614,520	1,659,937	1,626,235	1,496,912	1,398,497
Seed Berseem	163,014	153,933	150,741	142,071	151,287	152,600	142,437	137,051
Short Berseem	793,772	717,705	718,111	731,079	721,070	617,763	689,267	681,588
Fava beans	299,111	287,702	377,933	216,335	282,756	236,799	261,649	280,010
Chickpeas	13,192	11,834	13,756	20,292	16,549	14,227	13,148	11,221
Fenugreek	13,862	7,105	10,498	14,203	19,703	19,942	10,375	6,592
Flax (Seed)	28,475	39,228	24,971	25,922	26,219	35,830	20,880	18,342
Flax (Fiber)	28,475	39,228	24,971	25,922	26,219	35,830	20,880	18,302
Garlic (Single)	14,440	16,532	14,356	18,479	11,850	13,059	25,171	15,785
Garlic (Intercropped)	7,351	9,339	6,994	11,269	7,941	9,185	13,912	9,812
Lentils	13,484	15,600	13,907	17,491	11,128	6,583	7,208	8,132
Lupines	5,795	5,515	5,575	6,013	6,842	6,439	6,200	5,608
Sugarbeets	34,088	49,296	31,024	34,012	34,734	38,870	48,261	56,282
Wheat	1,747,452	1,899,159	1,741,277	1,788,834	1,697,848	2,005,329	1,953,274	2,039,146
Groundnuts	22,084	21,816	23,279	24,343	24,892	25,424	24,778	21,822
Summer Maize	1,494,645	1,621,100	1,594,853	1,549,045	1,625,796	1,617,679	1,620,791	1,469,138
Nili Maize	414,358	377,065	290,540	293,014	296,272	300,886	278,082	265,838
Winter Onion (Single)	20,732	23,534	25,108	25,455	18,401	34,627	37,797	26,936
Winter Onion (Intercropped)	52,590	45,592	43,764	50,405	33,909	38,471	45,563	38,239
Summer Onion (Single)	8,963	8,529	11,056	7,542	7,508	8,067	12,080	10,054
Summer Onion (Intercropped)	60,708	49,945	43,656	51,739	38,610	31,954	38,792	41,763
Nili Onion	3,484	4,422	8,443	3,733	8,993	8,901	11,078	11,470

Table A-1: Cropped Area for Selected Crops on the Old Lands, 1990 - 1997 (feddans)

Crop	1990	1991	1992	1993	1994	1995	1996	1997
Summer Rice	1,026,630	1,086,445	1,198,442	1,265,494	1,356,533	1,378,027	1,376,589	1,514,684
Nili Rice	1,098	803	1,145	1,090	575	621	975	0
Sesame	35,127	47,611	42,377	44,842	34,612	40,270	38,794	31,066
Summer Sorghum	310,169	312,660	331,763	333,528	361,479	341,241	321,336	348,894
Nili Sorghum	7,599	8,962	20,108	12,039	9,542	10,704	10,620	11,290
Soybeans	98,521	100,714	51,275	43,094	52,983	58,772	34,817	30,842
Cotton (Zahr)	992,483	850,395	837,895	881,583	718,737	707,884	915,853	853,255
Sugarcane	263,077	266,840	270,647	278,105	296,605	298,700	268,527	259,573
Summer Potato	67,670	78,161	84,668	53,406	48,604	76,162	110,531	58,123
Nili Potato	116,729	102,871	77,395	51,859	57,830	96,712	79,107	52,025
Winter Tomato	128,653	114,904	108,120	104,002	108,253	103,433	124,870	108,768
Summer Tomato	99,398	94,092	105,572	73,353	88,341	86,274	93,183	87,160
Nili Tomato	79,415	65,790	75,242	60,964	56,565	65,261	58,660	43,604
Total cropped area	10,125,848	10,168,928	10,048,075	9,927,770	9,974,475	10,190,967	10,255,964	10,009,432

Source: Economic Affairs Administration, MALR (MALR, 1990-1997).

Table A-2: Production of Selected Crops on the Old Lands, 1990 - 1997

Crop	Units[a]	1990	1991	1992	1993	1994	1995	1996	1997
Barley	Ardab	795,741	701,074	832,980	668,026	698,746	559,858	590,338	495,767
Long Berseem	Metric Ton	41,517,668	40,960,402	40,855,153	42,032,991	42,580,730	41,872,077	38,993,761	37,101,528
Seed Berseem	Ardab	286,265	289,204	299,496	251,560	288,352	271,639	259,097	255,005
Short Berseem	Metric Ton	7,746,229	7,750,122	7,582,619	8,381,726	7,923,880	6,958,113	8,039,437	7,445,930
Fava beans	Ardab	2,396,102	1,807,106	1,338,730	1,544,345	1,774,577	1,970,282	2,239,381	2,415,060
Chickpeas	Ardab	68,863	63,952	67,120	103,326	72,186	77,643	72,751	56,912
Fenugreek	Ardab	81,575	38,385	56,489	70,237	98,380	106,677	54,348	37,311
Flax (Seed)	Metric Ton	126,853	171,966	121,426	131,067	126,947	179,827	109,041	93,409
Flax (Fiber)	Metric Ton	79,139	110,454	71,858	79,103	79,364	112,302	64,528	57,718
Garlic (Single)	Metric Ton	139,325	160,288	137,358	185,281	104,463	118,321	252,464	154,404
Garlic (Intercropped)	Metric Ton	45,433	59,474	47,315	62,114	45,364	54,688	90,595	62,172
Lentils	Ardab	72,241	75,560	64,978	83,770	45,221	27,719	33,456	37,964
Lupines	Ardab	33,251	31,089	30,262	32,471	37,750	34,869	36,430	19,745
Sugarbeets	Metric Ton	574,745	1,106,061	624,607	708,154	717,137	739,716	799,662	1,014,170
Wheat	Ardab	26,963,007	27,346,916	27,819,530	29,222,126	26,610,085	33,101,315	33,424,447	34,007,283
Groundnuts	Ardab	271,540	281,859	310,155	330,233	390,555	435,222	420,835	381,994
Summer Maize	Ardab	28,267,076	30,718,005	30,918,035	30,113,166	32,926,621	30,439,709	34,175,911	33,598,013
Nili Maize	Ardab	5,229,809	5,038,566	4,260,981	4,283,023	4,538,626	4,240,073	4,202,369	4,230,132
Winter Onion (Single)	Metric Ton	205,006	236,257	256,764	269,268	170,651	346,965	365,540	309,844
Winter Onion (Intercropped)	Metric Ton	345,431	253,330	299,469	386,645	240,247	293,845	336,044	305,404

Table A-2: Production of Selected Crops on the Old Lands, 1990 - 1997

Crop	Units[a]	1990	1991	1992	1993	1994	1995	1996	1997
Summer Onion (Single)	Metric Ton	70,595	69,420	98,259	70,521	87,520	81,698	113,235	91,211
Summer Onion (Intercropped)	Metric Ton	285,288	229,541	207,991	290,284	186,359	176,982	226,608	237,405
Nili Onion	Metric Ton	31,837	36,639	94,086	33,248	92,132	95,154	144,996	142,408
Summer Rice	Metric Ton	3,140,989	3,417,337	3,870,001	4,119,226	4,526,063	4,729,881	4,814,255	5,381,518
Nili Rice	Metric Ton	1,264	887	1,348	1,450	765	883	1,552	0
Sesame	Ardab	151,936	213,376	197,062	209,272	156,150	169,054	165,481	136,271
Summer Sorghum	Ardab	4,412,259	4,721,758	5,228,129	5,421,106	5,075,349	4,622,581	4,214,136	5,268,936
Nili Sorghum	Ardab	76,353	95,725	207,335	120,409	102,352	124,726	124,872	144,785
Soybeans	Metric Ton	106,688	120,036	58,098	49,943	65,244	60,931	38,799	34,238
Cotton (Zahr)	Kintar	5,165,782	5,016,959	5,674,857	6,862,865	4,307,916	4,056,033	5,743,599	5,811,645
Sugarcane	Metric Ton	11,091,933	11,620,768	11,704,066	12,407,835	13,658,575	13,795,536	12,501,708	12,226,212
Summer Potato	Metric Ton	717,998	747,873	826,198	452,946	464,521	737,915	1,059,016	569,411
Nili Potato	Metric Ton	878,143	783,205	604,891	339,334	461,271	818,537	643,470	451,230
Winter Tomato	Metric Ton	1,254,915	1,256,969	1,042,520	1,210,247	1,760,270	1,616,618	1,993,696	1,663,394
Summer Tomato	Metric Ton	1,295,025	1,119,916	1,585,634	1,017,639	1,187,380	1,155,777	1,327,626	1,200,727
Nili Tomato	Metric Ton	1,091,589	788,809	1,107,701	854,621	668,150	945,711	764,328	670,220

a. See Table A-10 for definitions of units and conversion factors.
Source: Economic Affairs Administration, MALR (MALR, 1990-1997).

Table A-3: Average Yield for Selected Crops on the Old Lands, 1990 - 1997 (units/feddan)

Crop	Units[a]	1990	1991	1992	1993	1994	1995	1996	1997
Barley	Ardab	11.56	11.29	12.40	12.68	12.62	13.26	13.55	12.87
Long Berseem	Metric Ton	26.11	26.05	25.51	26.03	25.65	25.75	26.05	26.53
Seed Berseem	Ardab	1.76	1.88	1.99	1.77	1.91	1.78	1.82	1.86
Short Berseem	Metric Ton	9.76	10.80	10.56	11.46	10.99	11.26	11.66	10.92
Fava beans	Ardab	8.01	6.28	3.54	7.14	6.28	8.32	8.56	8.62
Chickpeas	Ardab	5.22	5.40	4.88	5.09	4.36	5.46	5.53	5.07
Fenugreek	Ardab	5.88	5.40	5.38	4.95	4.99	5.35	5.24	5.66
Flax (Seed)	Metric Ton	4.45	4.38	4.86	5.06	4.84	5.02	5.22	5.09
Flax (Fiber)	Metric Ton	2.78	2.82	2.88	3.05	3.03	3.13	3.09	3.15
Garlic (Single)	Metric Ton	9.65	9.70	9.57	10.03	8.82	9.06	10.03	9.78
Garlic (Intercropped)	Metric Ton	6.18	6.37	6.77	5.51	5.71	5.95	6.51	6.34
Lentils	Ardab	5.36	4.84	4.67	4.79	4.06	4.21	4.64	4.67
Lupines	Ardab	5.74	5.64	5.43	5.40	5.52	5.42	5.88	3.52
Sugarbeets	Metric Ton	16.86	22.44	20.13	20.82	20.65	19.03	16.57	18.02
Wheat	Ardab	15.43	14.40	15.98	16.34	15.67	16.51	17.11	16.68
Groundnuts	Ardab	12.30	12.92	13.32	13.57	15.69	17.12	16.98	17.50
Summer Maize	Ardab	18.91	18.95	19.39	19.44	20.25	18.82	21.09	22.87
Nili Maize	Ardab	12.62	13.36	14.67	14.62	15.32	14.09	15.11	15.91
Winter Onion (Single)	Metric Ton	9.89	10.04	10.23	10.58	9.27	10.02	9.67	11.50
Winter Onion (Intercropped)	Metric Ton	6.57	5.56	6.84	7.67	7.09	7.64	7.38	7.99
Summer Onion (Single)	Metric Ton	7.88	8.14	8.89	9.35	11.66	10.13	9.37	9.07
Summer Onion (Intercropped)	Metric Ton	4.70	4.60	4.76	5.61	4.83	5.54	5.84	5.68
Nili Onion	Metric Ton	9.14	8.29	11.14	8.91	10.24	10.69	13.09	12.42

Table A-3: Average Yield for Selected Crops on the Old Lands, 1990 - 1997 (units/feddan)

Crop	Units[a]	1990	1991	1992	1993	1994	1995	1996	1997
Summer Rice	Metric Ton	3.06	3.15	3.23	3.26	3.34	3.43	3.50	3.55
Nili Rice	Metric Ton	1.15	1.10	1.18	1.33	1.33	1.42	1.59	0.10
Sesame	Ardab	4.33	4.48	4.65	4.67	4.51	4.20	4.27	4.39
Summer Sorghum	Ardab	14.23	15.10	15.76	16.25	14.04	13.55	13.11	15.10
Nili Sorghum	Ardab	10.05	10.68	10.31	10.00	10.73	11.65	11.76	12.82
Soybeans	Metric Ton	1.08	1.19	1.13	1.16	1.23	1.04	1.11	1.11
Cotton (Zahr)	Kintar	5.20	5.90	6.77	7.78	5.99	5.73	6.27	6.81
Sugarcane	Metric Ton	42.16	43.55	43.24	44.62	46.05	46.19	46.56	47.10
Summer Potato	Metric Ton	10.61	9.57	9.76	8.48	9.56	9.69	9.58	9.80
Nili Potato	Metric Ton	7.52	7.61	7.82	6.54	7.98	8.46	8.13	8.67
Winter Tomato	Metric Ton	9.75	10.94	9.64	11.64	16.26	15.63	15.97	15.29
Summer Tomato	Metric Ton	13.03	11.90	15.02	13.87	13.44	13.40	14.25	13.78
Nili Tomato	Metric Ton	13.75	11.99	14.72	14.02	11.81	14.49	13.03	15.37

a. See Table A-10 for definitions of units and conversion factors.
Source: Economic Affairs Administration, MALR (MALR, 1990 - 1997).

Table A-4: Average Nominal Farmgate Prices for Selected Crops on the Old Lands, 1990 - 1997 (LE/unit)

Crop	Units	1990	1991	1992	1993	1994	1995	1996	1997	Average1994-96
Barley	Ardab	37.81	42.72	59.54	60.00	59.76	64.71	71.05	76.43	65.17
Long Berseem	Metric Ton	36.35	42.13	51.74	56.42	63.23	70.68	87.26	90.53	73.72
Seed Berseem	Ardab	184.80	198.75	231.80	239.14	243.29	255.66	292.32	321.78	263.75
Short Berseem	Metric Ton	36.11	41.77	50.66	55.94	61.87	69.22	84.72	90.31	71.94
Fava beans	Ardab	106.77	135.41	163.98	158.11	149.55	160.76	171.78	188.91	160.70
Chickpeas	Ardab	187.19	206.25	226.72	236.49	241.25	291.80	325.03	338.00	286.03
Fenugreek	Ardab	135.75	133.18	157.23	165.56	173.16	181.19	196.95	204.56	183.77
Flax (Seed)	Metric Ton	83.03	91.98	110.54	132.77	133.62	138.76	145.19	152.87	139.19
Flax (Fiber)	Metric Ton	121.36	141.15	148.48	181.98	188.84	195.59	210.39	225.86	198.28
Garlic (Single)	Metric Ton	135.27	140.48	185.18	192.92	492.11	341.91	354.09	389.76	396.03
Garlic (Intercropped)	Metric Ton	145.00	151.79	200.23	206.79	497.16	345.17	360.92	397.88	401.08
Lentils	Ardab	207.19	216.96	236.15	248.14	251.70	255.33	280.42	285.79	262.48
Lupines	Ardab	176.03	173.27	230.00	234.42	243.79	245.59	257.83	260.78	249.07
Sugarbeets	Metric Ton	54.96	55.00	54.54	55.00	63.00	81.00	91.00	91.00	78.33
Wheat	Ardab	70.90	74.71	79.09	79.19	80.19	84.46	96.07	100.05	86.91
Groundnuts	Ardab	80.46	80.39	77.55	83.62	89.17	105.98	119.93	132.41	105.03
Summer Maize	Ardab	59.81	61.78	60.61	64.17	66.45	71.45	75.47	76.89	71.12
Nili Maize	Ardab	59.40	61.88	64.02	67.37	70.18	74.20	76.66	77.95	73.68
Winter Onion (Single)	Metric Ton	166.67	213.74	211.92	165.67	395.09	240.78	249.33	265.82	295.07
Winter Onion (Intercropped)	Metric Ton	151.58	184.22	200.42	153.71	385.56	226.51	233.76	251.82	281.94
Summer Onion (Single)	Metric Ton	169.67	212.17	195.88	160.90	353.40	235.77	249.18	254.50	279.45
Summer Onion (Intercropped)	Metric Ton	130.78	186.99	204.70	160.76	386.34	211.20	216.65	238.03	271.40

Table A-4: Average Nominal Farmgate Prices for Selected Crops on the Old Lands, 1990 - 1997 (LE/unit)

Crop	Units	1990	1991	1992	1993	1994	1995	1996	1997	Averag e1994-96
Nili Onion	Metric Ton	179.58	228.11	219.23	194.29	417.92	261.10	265.99	278.86	315.00
Summer Rice	Metric Ton	367.24	435.79	451.40	504.22	580.21	655.61	701.86	717.54	645.89
Nili Rice	Metric Ton	367.00	436.61	454.00	510.00	617.00	640.00	692.06	0.00	649.69
Sesame	Ardab	212.93	252.77	259.74	268.89	297.60	380.98	387.54	391.56	355.37
Summer Sorghum	Ardab	58.27	62.04	63.12	69.04	72.72	79.22	84.76	86.53	78.90
Nili Sorghum	Ardab	57.40	61.84	63.27	68.66	71.22	78.19	81.36	83.50	76.92
Soybeans	Metric Ton	800.00	849.60	810.50	800.00	875.00	1050.00	1050.00	1050.00	991.67
Cotton (Zahr)	Kintar	262.67	316.09	378.69	370.90	325.19	531.64	497.56	472.74	451.47
Sugarcane	Metric Ton	55.95	56.25	64.14	70.48	78.99	87.66	87.34	92.36	84.66
Summer Potato	Metric Ton	272.48	306.35	249.63	500.74	817.07	815.53	642.41	650.68	758.34
Nili Potato	Metric Ton	290.20	353.71	205.75	452.25	585.73	400.18	314.83	434.48	433.58
Winter Tomato	Metric Ton	335.49	397.27	428.08	266.64	254.52	352.93	369.80	398.10	325.75
Summer Tomato	Metric Ton	185.72	420.80	458.90	314.35	269.04	370.09	396.28	430.43	345.14
Nili Tomato	Metric Ton	348.78	400.35	384.69	392.29	782.17	688.60	572.50	392.26	681.09

Source: Economic Affairs Administration, MALR (MALR, 1990 - 1997).

Table A-5: Hired Labor Inputs for Selected Crops, 1990 - 1997 (labor-day per feddan)

Crop	1990	1991	1992	1993	1994	1995	1996	1997
Barley	21.30	20.55	24.86	24.81	26.79	26.54	23.57	26.53
Long Berseem	42.14	48.98	45.92	45.01	45.01	45.01	45.01	45.01
Short Berseem	16.84	16.84	16.73	16.86	11.66	11.12	10.46	10.69
Fava beans	34.93	33.55	30.82	30.92	28.83	31.54	32.19	31.32
Chickpeas	24.97	24.97	33.04	30.51	30.03	30.81	23.46	23.03
Flax (Fiber)	34.14	34.23	37.82	35.67	37.01	37.04	36.50	35.10
Garlic (Single)	59.52	66.38	58.53	61.29	53.11	55.90	61.29	60.26
Lentils	24.97	26.97	28.22	24.80	26.19	26.17	26.87	29.71
Sugarbeets	49.10	51.27	52.89	44.69	44.70	35.63	37.79	46.42
Wheat	31.88	28.33	31.22	28.60	29.20	30.94	32.60	31.44
Groundnuts	36.16	38.38	36.71	29.60	41.31	43.18	47.11	45.17
Summer Maize	38.62	38.89	37.25	37.29	38.46	40.46	42.70	38.12
Winter Onion (Single)	53.31	55.70	57.84	50.94	46.89	60.23	54.87	53.80
Summer Rice	28.85	29.10	29.64	37.49	39.86	42.61	42.51	38.04
Sesame	36.88	35.97	34.06	33.46	34.61	35.17	32.20	29.97
Summer Sorghum	39.12	38.62	44.58	46.73	37.28	36.07	33.66	34.86
Soybeans	36.14	36.10	36.90	31.07	36.66	37.30	39.83	31.66
Cotton (Zahr)	68.38	68.38	68.38	69.10	64.15	67.47	71.16	70.67
Sugarcane	93.19	90.30	90.24	78.65	103.25	114.62	104.56	104.22
Summer Potato	79.47	74.74	74.31	68.65	103.36	103.36	85.60	85.76
Nili Potato	51.21	48.94	47.46	46.58	47.64	55.24	53.30	50.16
Winter Tomato	51.78	51.45	36.74	48.26	52.19	51.58	50.63	53.16
Summer Tomato	87.11	91.03	86.13	79.41	83.26	88.57	89.26	89.04

Source: Central Administration for Agricultural Economics, MALR, unpublished data.
Note: The MALR does not estimate technical coefficients for hired labor for all crops.

Table A-6: Machinery Inputs for Selected Crops, 1990 - 1997 (price weighted hours per feddan)

Crop	1990	1991	1992	1993	1994	1995	1996	1997
Barley	3.34	2.32	2.68	2.50	2.56	2.78	2.51	2.31
Long Berseem	1.91	1.13	1.47	1.21	1.32	1.43	1.38	1.41
Short Berseem	0.62	0.66	0.69	0.96	1.16	1.21	1.21	1.30
Fava beans	3.40	2.81	2.86	0.00	2.56	2.77	2.89	2.64
Chickpeas	2.78	2.53	3.38	3.11	3.10	3.24	2.89	2.34
Flax (Fiber)	2.87	2.66	2.55	2.47	2.30	2.60	2.61	2.51
Garlic (Single)	2.79	2.90	2.87	2.79	2.45	2.49	2.63	2.69
Lentils	2.67	2.72	3.02	3.07	2.80	2.95	2.85	2.48
Sugarbeets	2.45	2.39	3.11	2.28	2.34	2.15	2.52	2.35
Wheat	3.52	3.62	3.89	3.12	2.95	3.06	3.06	2.87
Groundnuts	2.36	2.35	2.20	2.26	2.00	2.00	1.86	1.92
Summer Maize	2.56	2.61	2.66	2.53	2.37	2.50	2.47	2.51
Winter Onion (Single)	2.69	2.21	2.41	2.48	2.18	2.50	2.46	2.42
Summer Rice	2.89	2.68	3.94	4.87	5.75	5.75	5.96	6.18
Sesame	1.86	1.84	1.86	1.89	2.26	1.84	1.99	1.59
Summer Sorghum	2.67	2.71	2.32	2.38	3.14	2.59	2.95	2.67
Nili Sorghum	2.67	2.71	2.32	2.38	3.14	2.59	2.95	2.67
Soybeans	3.29	3.42	3.98	4.52	3.78	3.70	2.98	3.27
Cotton (Zahr)	2.63	2.63	2.63	2.43	2.31	2.23	2.45	2.52
Sugarcane	5.83	6.29	5.59	6.14	6.04	6.26	8.20	7.42
Summer Potato	3.17	3.20	3.11	3.06	2.71	3.21	3.37	3.10
Nili Potato	3.04	3.33	4.47	3.10	2.92	2.99	3.01	2.87
Winter Tomato	4.84	4.28	4.49	4.11	3.76	4.48	4.50	4.23

Source: Central Administration for Agricultural Economics, MALR, unpublished data.
Note: The MALR does not estimate machinery technical coefficients for all crops.

Table A-7: Machinery Inputs for Selected Crops, 1990 - 1997 (hours per feddan)

Crop	1990	1991	1992	1993	1994	1995	1996	1997
Barley	22.66	16.76	19.21	17.62	19.01	21.16	17.86	16.27
Long Berseem	26.44	16.40	20.80	16.61	16.55	17.40	17.80	17.92
Short Berseem	13.34	12.87	8.70	23.75	15.75	16.50	16.50	18.00
Fava beans	29.62	26.21	28.70	0.00	22.16	24.47	25.33	22.91
Chickpeas	23.26	21.81	30.02	28.09	27.00	28.41	25.29	19.30
Flax (Fiber)	23.61	22.61	21.35	20.93	19.42	23.16	22.89	21.75
Garlic (Single)	29.00	29.44	29.92	29.22	25.55	26.17	27.20	27.83
Lentils	22.22	23.05	24.40	24.29	22.95	24.96	24.53	21.04
Sugarbeets	23.84	23.07	25.46	19.88	20.20	20.59	26.15	24.47
Wheat	26.62	27.12	28.91	26.58	25.70	27.17	27.54	25.69
Groundnuts	24.93	24.90	24.21	24.46	22.76	22.29	20.80	20.24
Summer Maize	27.80	28.04	28.50	27.76	26.28	27.65	27.05	27.28
Winter Onion (Single)	25.35	20.58	23.40	23.10	20.37	23.79	24.31	22.76
Summer Rice	10.75	11.43	16.15	33.75	38.75	39.00	40.50	42.00
Sesame	22.29	22.26	22.64	22.98	24.50	23.57	21.54	19.20
Summer Sorghum	27.85	27.89	23.80	24.12	29.10	25.67	30.45	27.47
Nili Sorghum	27.85	27.89	23.80	24.12	29.10	25.67	30.45	27.47
Soybeans	28.41	31.25	35.23	40.92	36.48	35.79	29.48	31.09
Cotton (Zahr)	30.31	30.31	30.31	28.37	25.77	24.68	27.75	27.09
Sugarcane	65.80	71.33	61.25	63.49	66.75	72.27	91.44	81.73
Summer Potato	30.39	30.73	30.24	29.22	29.12	35.65	35.63	32.20
Nili Potato	27.69	29.56	39.63	30.45	29.03	29.64	29.67	27.88
Winter Tomato	38.44	37.36	39.66	37.95	34.73	41.47	44.57	39.59

Source: Central Administration for Agricultural Economics, MALR, unpublished data.
Note: The MALR does not estimate machinery technical coefficients for all crops.

Table A-8: Derivation of Fertilizer Availability Measure (thousand tons nutrient basis)

	1990	1991	1992	1993	1994	1995	1996	1997
Production								
Urea	347	425	402	385	428	422	481	489
AN (335%)	335	195	375	448	450	501	529	522
AS (20.6%)	12	13	14	14	14	14	16	18
CN (15.5%)	13	35	33	15	17	4	1	0
Exports								
Urea	14	13	71	33	71	85	8	0
AN (335%)	14	13	56	60	39	103	0	10
AS (20.6%)	0	0	0	0	0	2	0	0
CN (15.5%)	0	0	0	0	0	0	0	0
Imports								
Urea	11	13	5	3	3	2	0	10
AN (335%)	46	54	23	12	14	8	55	16
AS (20.6%)	72	84	36	19	21	12	68	35
CN (15.5%)	3	3	1	1	1	0	3	1
Availability								
Urea	343	425	336	355	360	338	474	499
AN (335%)	367	236	343	400	425	406	584	528
AS (20.6%)	84	97	50	33	36	24	84	53
CN (15.5%)	16	38	34	16	17	4	4	1
Total	810	796	763	803	838	772	1,145	1,081
Adjusted for stocks								
Urea	343	425	336	355	360	338	317	350
AN (335%)	367	236	343	400	425	406	391	370
AS (20.6%)	84	97	50	33	36	24	56	37
CN (15.5%)	16	38	34	16	17	4	3	1
Total	810	796	763	803	838	772	766	759
% of land in Old								
	0.88	0.86	0.83	0.82	0.80	0.75	0.79	0.77
Fertilizer available for Old Lands								
Urea	2782	3380	2565	2847	30138	26111	24256	265865
AN (335%)	2974	1879	2613	3206	35593	31338	29907	281004
AS (20.6%)	6790	7750	3811	2615	29864	18686	42879	28117.7
CN (15.5%)	1313	3048	2613	1247	14655	3375	2000	594.098
Total	6566	6340	5820	6440	70184	59656	58651	575581

Source: Zalla et al. (1998), El Guindy et al. (1997), Mellor(1997).

Table A-9: Share of Cropped Area by Crop on the Old Lands, 1990 - 1997 (percent)

Crop	1990	1991	1992	1993	1994	1995	1996	1997
Barley	0.68	0.61	0.67	0.53	0.55	0.41	0.42	0.38
Long Berseem	15.71	15.46	15.94	16.26	16.64	15.96	14.60	13.97
Seed Berseem	1.61	1.51	1.50	1.43	1.52	1.50	1.39	1.37
Short Berseem	7.84	7.06	7.15	7.36	7.23	6.06	6.72	6.81
Fava beans	2.95	2.83	3.76	2.18	2.83	2.32	2.55	2.80
Chickpeas	0.13	0.12	0.14	0.20	0.17	0.14	0.13	0.11
Fenugreek	0.14	0.07	0.10	0.14	0.20	0.20	0.10	0.07
Flax (Seed)	0.28	0.39	0.25	0.26	0.26	0.35	0.20	0.18
Flax (Fiber)	0.28	0.39	0.25	0.26	0.26	0.35	0.20	0.18
Garlic (Single)	0.14	0.16	0.14	0.19	0.12	0.13	0.25	0.16
Garlic (Intercropped)	0.07	0.09	0.07	0.11	0.08	0.09	0.14	0.10
Lentils	0.13	0.15	0.14	0.18	0.11	0.06	0.07	0.08
Lupines	0.06	0.05	0.06	0.06	0.07	0.06	0.06	0.06
Sugarbeets	0.34	0.48	0.31	0.34	0.35	0.38	0.47	0.56
Wheat	17.26	18.68	17.33	18.02	17.02	19.68	19.05	20.37
Groundnuts	0.22	0.21	0.23	0.25	0.25	0.25	0.24	0.22
Summer Maize	14.76	15.94	15.87	15.60	16.30	15.87	15.80	14.68
Nili Maize	4.09	3.71	2.89	2.95	2.97	2.95	2.71	2.66
Winter Onion (Single)	0.20	0.23	0.25	0.26	0.18	0.34	0.37	0.27
Winter Onion (Intercropped)	0.52	0.45	0.44	0.51	0.34	0.38	0.44	0.38
Summer Onion (Single)	0.09	0.08	0.11	0.08	0.08	0.08	0.12	0.10
Summer Onion (Intercropped)	0.60	0.49	0.43	0.52	0.39	0.31	0.38	0.42
Nili Onion	0.03	0.04	0.08	0.04	0.09	0.09	0.11	0.11

Table A-9: Share of Cropped Area by Crop on the Old Lands, 1990 - 1997 (percent)

Crop	1990	1991	1992	1993	1994	1995	1996	1997
Summer Rice	10.14	10.68	11.93	12.75	13.60	13.52	13.42	15.13
Nili Rice	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
Sesame	0.35	0.47	0.42	0.45	0.35	0.40	0.38	0.31
Summer Sorghum	3.06	3.07	3.30	3.36	3.62	3.35	3.13	3.49
Nili Sorghum	0.08	0.09	0.20	0.12	0.10	0.11	0.10	0.11
Soybeans	0.97	0.99	0.51	0.43	0.53	0.58	0.34	0.31
Cotton (Zahr)	9.80	8.36	8.34	8.88	7.21	6.95	8.93	8.52
Sugarcane	2.60	2.62	2.69	2.80	2.97	2.93	2.62	2.59
Summer Potato	0.67	0.77	0.84	0.54	0.49	0.75	1.08	0.58
Nili Potato	1.15	1.01	0.77	0.52	0.58	0.95	0.77	0.52
Winter Tomato	1.27	1.13	1.08	1.05	1.09	1.01	1.22	1.09
Summer Tomato	0.98	0.93	1.05	0.74	0.89	0.85	0.91	0.87
Nili Tomato	0.78	0.65	0.75	0.61	0.57	0.64	0.57	0.44
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Note: Cropped area refers to the cropped area in the 23 crops considered in this analysis.
Source: Economic Affairs Administration, MALR (MALR, 1990-1997).

Table A-10: Volume to Weight Conversion Factors

Volume measure		Weight equivalent
Ardab of Barley	=	120 Kg.
Ardab of Berseem Seed	=	175 Kg.
Ardab of Broadbeans	=	155 Kg.
Ardab of Chickpeas	=	150 Kg.
Ardab of Fenugreek	=	155 Kg.
Ardab of Lentils	=	160 Kg.
Ardab of Lupines	=	150 Kg.
Ardab of Wheat	=	150 Kg
Ardab of Groundnuts	=	75 Kg.
Ardab of Maize	=	140 Kg.
Ardab of Sorghum	=	140 Kg.
Ardab of Barley Sesame	=	120 Kg
Metric Kintar of Cotton (unginnned)	=	157.5 Kg.

APPENDIX B:
PRODUCTION BY REGION AND GOVERNORATE

Table B-1: Population on the Old Lands by Governorate and Region, 1990-1997

Governorate/ region	1990	1991	1992	1993	1994	1995	1996	1997
Lower Egypt	22,107,311	22,579,050	23,061,058	23,553,565	24,056,802	24,571,010	25,096,432	25,633,317
Behera	3,524,050	3,596,424	3,670,284	3,745,662	3,822,587	3,901,092	3,981,209	4,062,972
Gharbia	3,082,402	3,133,937	3,186,333	3,239,606	3,293,769	3,348,838	3,404,827	3,461,752
Kafr El Sheikh	1,964,556	2,005,431	2,047,156	2,089,749	2,133,229	2,177,613	2,222,920	2,269,170
Dakahlia	3,762,963	3,836,098	3,910,654	3,986,660	4,064,142	4,143,131	4,223,655	4,305,744
Damietta	805,680	822,890	840,468	858,421	876,757	895,486	914,614	934,151
Sharkia	3,740,050	3,826,230	3,914,396	4,004,593	4,096,869	4,191,271	4,287,848	4,386,651
Menofia	2,422,341	2,475,378	2,529,576	2,584,961	2,641,559	2,699,396	2,758,499	2,818,896
Kalyoubia	2,805,269	2,882,663	2,962,191	3,043,914	3,127,891	3,214,185	3,302,860	3,393,981
Middle Egypt	??	??	??	??	??	??	??	??
Giza	4,115,962	4,219,835	4,326,328	4,435,510	4,547,446	4,662,207	4,779,865	4,900,492
Beni-Suef	1,601,416	1,641,897	1,683,402	1,725,955	1,769,585	1,814,317	1,860,180	1,907,202
Fayoum	1,713,696	1,756,910	1,801,212	1,846,633	1,893,198	1,940,938	1,989,881	2,040,059
Menia	2,892,934	2,958,436	3,025,421	3,093,923	3,163,975	3,235,614	3,308,875	3,383,795
Upper Egypt	??	??	??	??	??	??	??	??
Assiut	2,433,901	2,491,735	2,550,943	2,611,559	2,673,615	2,737,145	2,802,185	2,868,770
Sohag	2,697,818	2,764,432	2,832,690	2,902,634	2,974,305	3,047,746	3,123,000	3,200,112
Qena	2,462,202	2,515,817	2,570,600	2,626,576	2,683,770	2,742,210	2,801,923	2,862,936
Aswan	871,364	887,636	904,213	921,098	938,299	955,822	973,671	991,854
Total Old Lands	871364.19	887636.45	904212.59	921098.28	938299.3	955821.54	973671	991853.79

Source: Central Administration for Public Mobilization and Statistics (CAPMAS, 1997, 1998).

Table B-2: Aggregate Production on the Old Lands by Governorate and Region, 1990-1997

(million LE at average 1994-96 prices)

Governorate/ region	1990	1991	1992	1993	1994	1995	1996	1997	Average Annual Growth Rate (%)[a]
Lower Egypt	??	??	??	??	??	??	??	??	2.2
Behera	2,457	2,468	2,607	2,579	2,442	2,525	2,631	2,600	1.0
Gharbia	1,314	1,283	1,409	1,363	1,217	1,352	1,425	1,337	0.5
Kafr El Sheikh	1,447	1,571	1,741	1,739	1,685	1,839	1,885	1,866	5.2
Dakahlia	1,960	2,160	2,241	2,309	2,102	2,145	2,329	2,332	3.6
Damietta	310	312	347	312	308	321	346	338	1.3
Sharkia	1,757	1,776	1,981	2,028	2,026	2,063	2,197	2,184	3.7
Menofia	1,048	982	1,047	962	928	982	1,045	985	-1.7
Kalyoubia	484	432	479	477	451	488	534	515	-0.5
Middle Egypt	??	??	??	??	??	??	??	??	-1.4
Giza	712	686	707	659	688	627	687	648	-1.5
Beni-Suef	787	774	760	921	864	811	903	867	1.6
Fayoum	1,075	808	901	865	798	849	959	858	-6.5
Menia	1,317	1,316	1,125	1,312	1,322	1,371	1,632	1,545	0.4
Upper Egypt	??	??	??	??	??	??	??	??	2.6
Assiut	828	809	773	835	817	862	993	1,048	0.8
Sohag	865	887	891	967	916	986	1,019	1,029	2.4
Qena	1,061	1,142	1,155	1,169	1,200	1,360	1,173	1,143	3.2
Aswan	294	324	327	342	358	383	380	384	4.9
Total Old Lands	294.3788	323.8379	326.5115	342.1246	357.5142	382.8639	380.3076	383.7241	1.5

Source: Calculated from data provided by the MALR (1990 - 1997).

a. Average annual growth rate is the exponential growth rate estimated by fitting a semi-log equation to the data..

Table B-3: Nominal Value of Production on the Old Lands by Governorate and Region, 1990-1997

(million LE)

Governorate/ region	1990	1991	1992	1993	1994	1995	1996	1997	Average Annual Growth Rate (%)[a]
Lower Egypt	6,669	7,838	9,212	9,604	9,894	11,871	13,457	13,580	11.9
Behera	1,477	1,756	2,051	2,109	2,144	2,584	2,842	2,874	11.5
Gharbia	806	900	1,059	1,090	1,113	1,362	1,502	1,465	10.0
Kafr El Sheikh	896	1,116	1,369	1,407	1,460	1,878	2,098	2,119	14.9
Dakahlia	1,198	1,508	1,702	1,868	1,861	2,176	2,536	2,604	13.3
Damietta	177	215	268	249	273	324	381	385	13.0
Sharkia	1,144	1,319	1,620	1,687	1,779	2,089	2,424	2,457	12.6
Menofia	662	696	756	801	856	976	1,097	1,097	7.1
Kalyoubia	308	326	388	392	407	482	576	580	8.9
Middle Egypt	2,518	2,700	2,744	3,051	3,382	3,687	4,413	4,242	7.3
Giza	458	572	578	533	666	630	725	692	8.2
Beni-Suef	512	565	584	736	785	818	965	938	9.8
Fayoum	661	571	672	676	734	850	1,020	905	2.8
Menia	886	992	910	1,105	1,197	1,389	1,703	1,706	8.3
Upper Egypt	2,143	2,422	2,607	2,780	2,993	3,642	3,827	3,982	9.5
Assiut	580	637	647	716	728	870	1,090	1,177	8.2
Sohag	602	682	740	822	822	986	1,116	1,170	9.8
Qena	760	872	964	957	1,112	1,394	1,224	1,213	9.4
Aswan	200	231	257	285	332	392	398	422	12.1
Total Old Lands	11,330	12,960	14,564	15,434	16,269	19,201	21,698	21,803	10.5

Source: Calculated from data provided by the MALR (1990 - 1997).

a. Average annual growth rate is the exponential growth rate estimated by fitting a semi-log equation to the data..

Table B-4: Nominal Value of Production per Cropped Feddan on the Old Lands by Governorate and Region, 1990-1997

(million LE)

Governorate/ region	1990	1991	1992	1993	1994	1995	1996	1997	Average Annual Growth Rate (%)[a]
Lower Egypt	1,327	1,997	2,056	1,903	2,349	2,387	2,541	2,587	14.3
Behera	1,185	1,400	1,683	1,706	1,727	1,991	2,173	2,277	11.3
Gharbia	1,128	1,299	1,520	1,595	1,626	1,958	2,083	2,133	10.9
Kafr El Sheikh	944	1,145	1,367	1,488	1,554	1,903	2,074	2,132	14.1
Dakahlia	1,002	1,229	1,390	1,548	1,512	1,823	2,034	2,149	12.7
Damietta	655	1,114	1,335	1,296	1,399	1,717	1,922	2,043	22.4
Sharkia	838	1,104	1,359	1,395	1,456	1,708	2,002	2,039	16.1
Menofia	950	1,254	1,365	1,486	1,581	1,753	2,031	2,091	14.0
Kalyoubia	962	1,321	1,572	1,563	1,653	1,841	2,205	2,329	15.8
Middle Egypt	1,034	1,318	1,367	1,522	1,672	1,773	2,068	2,054	12.3
Giza	996	1,236	1,454	1,533	1,570	1,853	2,071	2,148	13.4
Beni-Suef	956	1,227	1,257	1,540	1,626	1,665	2,041	1,928	13.2
Fayoum	987	1,083	1,267	1,312	1,396	1,540	1,683	1,679	9.1
Menia	1,007	1,281	1,244	1,513	1,639	1,797	2,213	2,212	12.8
Upper Egypt	1,148	1,361	1,528	1,675	1,813	2,135	2,358	2,452	12.4
Assiut	958	1,152	1,163	1,344	1,363	1,584	1,978	2,067	11.0
Sohag	973	1,206	1,338	1,497	1,501	1,747	2,023	2,125	12.9
Qena	1,496	1,680	2,111	2,204	2,589	3,167	3,254	3,387	13.6
Aswan	1,348	1,624	1,828	1,981	2,374	2,571	2,750	2,895	13.1
Total Old Lands	1,030	1,274	1,449	1,555	1,631	1,884	2,116	2,178	13.0

Source: Calculated from data provided by the MALR (1990 - 1997).

a. Average annual growth rate is the exponential growth rate estimated by fitting a semi-log equation to the data..

Table B-5: Nominal Per Capita Value of Production on the Old Lands by Governorate and Region, 1990-1997

(LE)

Governorate/ region	1990	1991	1992	1993	1994	1995	1996	1997	Average Annual Growth Rate (%)[a]
Lower Egypt	302	347	399	408	411	483	536	530	9.7
Behera	419	488	559	563	561	662	714	707	9.4
Gharbia	262	287	332	336	338	407	441	423	8.3
Kafr El Sheikh	456	556	669	673	685	862	944	934	12.8
Dakahlia	318	393	435	469	458	525	600	605	11.4
Damietta	220	262	319	290	311	362	417	412	10.9
Sharkia	306	345	414	421	434	498	565	560	10.3
Menofia	273	281	299	310	324	362	398	389	4.9
Kalyoubia	110	113	131	129	130	150	174	171	6.1
Middle Egypt	244	255	253	275	297	316	370	347	4.9
Giza	111	136	134	120	147	135	152	141	5.7
Beni-Suef	320	344	347	426	444	451	519	492	7.3
Fayoum	386	325	373	366	388	438	513	444	0.3
Menia	306	335	301	357	378	429	515	504	6.1
Upper Egypt	253	280	294	307	323	384	395	401	7.2
Assiut	238	256	254	274	272	318	389	410	5.8
Sohag	223	247	261	283	276	324	357	366	7.4
Qena	309	347	375	364	414	508	437	424	7.2
Aswan	230	260	284	310	354	410	408	426	10.3
Total Old Lands	277	310	341	353	364	420	464	456	8.2

Source: Calculated from data provided by the MALR (1990 - 1997).

a. Average annual growth rate is the exponential growth rate estimated by fitting a semi-log equation to the data..