PROJECT TECHNICAL REPORT NO. 50

FARMING SYSTEM ECONOMIC ANALYSIS OF EWUP STUDY CASES

By:

Farouk Abdel Al, Donald W. Lybecker

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EGYPT WATER USE AND MANAGEMENT PROJECT

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ABSTRACT

The improvement of the economic and social well-being of the Egyptian farmer through technological change in on-farm water management is a primary objective of the Egypt Water Use and Management Project. Analysis of the use of resources on Egyptian farms is an essential part of assessing the economic efficiency of water use. Irrigation water interacts with other inputs. The best use of these inputs relative to each other, their allocations between alternative enterprises, and between farms, is a primary consideration to improvements in on-farm water management. It is also important to analyze the institutional constraints imposed on the farmers which limit their ability to achieve the most profitable allocation of water and other associated inputs.

The economic analysis in the Egypt Water Use and Management Project revolves around a farm record system. The farm record system was developed as a tool for use in monitoring and planning on-farm water management alternatives. The system provides data to evaluate the relative contributions of alternative enterprises to farm income, to delineate the production activities for each enterprise, and to determine factors which limit operating decisions.

An analysis of the factors which impact on the economic and social well-being of the farmer as a result of the farming system at each of the Project sites indicated that the importance of share rental agreements for land is increasing, cropping patterns are not static, crop productivity has increased over time, and the relative importance of livestock has increased. An analysis of the returns to water has decreased over time and in several cases was negative.

49 pages 12 tables

ملخـــــــص

من أهم اهداف مشروع تطوير الرى بمصر هو تحسين الحالة الاقتصادية والاجتماعية للفلاح المصرى عن طريق ادخال الغييرات التكنولوجيـــة فى ادارة استخدام مياه الرى على مستوى المزرعة .. وقد وجـــد أن تحليل استخدام المصادر المتوفرة فى المزارع المصرية هو أحـــد العوامل الرئيسية فى تقييم الكفاءة الاقتصادية لاستخدام الميـــاد . ان مياه الرى ترتبط بعناصر الانتاج الأخرى ويكون أفضل استخدام لهـذه العناصر بالنسبة لبعضها البعض وتوزيعها على المزارع والمشاريـــع الانتاجية المختلفة داخل المزرعة من أهم الاعتبارات التى يجب أن تراعـى فى تحسين ادارة المياه على المستوى الحقلى . ويجب ايضا تحليـــل المعوقات السلوكية التى يواجهـــا المزارعون والتى تحد من قدرتهم على تحقيق افضل توزيع للمياه بالاضافة الى العناصر الاخرى المرتبطة بها .

هذا ويرتكز التحليل الاقتصادى لمشروع تطوير الرى على محـــور اساسى هو نظام سجل المزرعة . وقد تم عمل هذا النظام كوسيلة لضبـــط وتخطيط البدائل المختلفة لادارة المياه على المستوى الحقلى . ويعطـى نظام سجل المزرعة بيانات لتقييم نسبة مشاركة العمليات المختلفـــة فى دخل المزرعة ، بالاضافة الى تحديد أنشطة الانتاج لكل من هـذه العمليات ومعرفة العوامل التى تحد من قرارات التشغيل .

ويشير تحليل العوامل التى تؤثر على الحالة الاقتصاديـــة والاجتماعية للفلاح كنتيجة لنظام الزراعة السائد فى كل من مناطـق المشروع الى أن اتفاقيات التأجير بالمشاركـــة للأرض تزداد وأن التركيب المحصولى ليس ثابت بالاضافة الى أن الانتاجيـــة المحصولية قد زادت بمرور الوقت ، كما زادت أهمية الانتـــاج الحيوانى وأظهرت التحليلات ايضا الى انه فى بعض الحـــالا ت انخفضت قيمة العائد على المياه بمرور الوقت .

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INTRODUCTION

The Egyptian Water Use and Management Project (EWUP) was initiated in 1977 with the principal goal of providing significant social and economic progress for the Egyptian Farmer. The Project utilized an interdisciplinary team of agronomists, economists, engineers and sociologists to first identify important agricultural production problems (with water management problems receiving emphasis) and second, test potential solutions in the pilot program implementation stage.

The EWUP selected four sites within three areas in Egypt to carry out its program. Abu Raya site in Kafr el-Sheikh governorate was selected in the lower Delta area, Mansuriya site,(divided into the El Hammami and Beni Magdul area), in Giza governorate is in the upper Delta area, and Abyuha site in El-Minya governorate is in Middle Egypt. The four sites were selected to provide a range of conditions and locations for problem identification and pilot program implementation. Hopefully the alternative sites will provide a variety of solutions to improve the economic and social progress of the Egyptian farmer.

The role of the EWUP economist is to (1) provide a unique discipline viewpoint for the interdisciplinary EWUP team, (2) to conduct discipline specific analysis necessary to measure the economic progress of the Egyptian farmer touched by interventions undertaken by the Project and (3) provide other associated economic analysis.

A most important tool developed and used by the economists in the Project is the EWUP Farm Recordbook. The recordbook was develcped to collect information from a selected group of farmers at each of the sites to measure the economic change of the farmer and provide a source for basic technical and economic information. The farm recordbook approach provides for timely collection of data (typically every two weeks an EWUP field staff economist will visit each of his farmers and update their record). This multiple contact approach provides the opportunity to build a trusting relationship between the farmer and the field economist. This trusting relationship helps ensure accurate and complete data collection. The recordbook methodology is also desirable because it provides a whole farm or farm system orientation.

An alternative methodology for collecting farm level data is the farm survey. This approach allows for the collection of data from a larger number of farms because only one or a few farmer visits are undertaken. The farm survey typically provides less detailed data but from

a greater number of farmers. The accuracy of the information collected with the farm survey, eventhough the sample of farmers is determined statistically, is significantly less than that with the recordbook approach because of (1) lack of recorded data and the need to rely on farmer memory, (2) a less developed relationship between the farmer and the enumerator, (3) the mass quantity of data collected per visit, and (4) potential greater communication misunderstandings. In addition, the detail of the data collected is generally less with a farm survey compared to a recordbook because of (1) farmer recall problems, (2) extended questionnaire length required for detail farm survey record collection and (3) the farmer-enumerator confidence required to successfully elicit detailed data can rarely be developed in one or a few visits. Because EWUP desired data accuracy and detail, the recordbook methodology was selected rather than the farm survey approach. However, the EWUP economists conducted several farm surveys to obtain specific complementary data from a larger sample of farms.

This report will first briefly describe each of the Project sites and the principal EWUP intervention packages undertaken at each of the sites. Next a short background of the development of the EWUP Farm Recordbook is presented followed by a description of the base measures to be used in the comparative analysis. The over time comparative analysis by site is then presented. The comparative analysis for each site will include that set of farms for which continuous records are available, the set of all record keeper farms (each year), and finally those farms that are subject to a major EWUP intervention package. The paper concludes with a summary and conclusions section.

DESCRIPTION OF EWUP STUDY AREAS

Abyuha Site--El Minya Governorate

The Abyuha site is 1150 *feddans* of irrigated land served by a single hydraulic unit, the Abyuha canal. The site lies 20 km south of the city of El-Minya, the capital of El-Minya governorate, which is 245 km south of Cairo. About one-fourth of the farm units are fully owned and three-quarters rent at least some of the land they farm. Nearly half the farm units are less than one *feddan* in size and less than 2 percent of them operate more than ten *feddans*. The average farm unit has a land base of 1.5 *feddans*. The area has a cropping intensity ratio (average number of crops harvested per *feddan* per year) of 1.9.

The soils at Abyuha are clay and are in the vertisol soil order. They have an average depth of 8.3 meters, are low in phosphorus and zinc, and are considered generally non-saline. Two-thirds of the *mesqas* use gravity irrigation but with a small hydraulic head. Typically the irrigation is by small basin flooding and the summer irrigation rotation is seven days "on" followed by seven days "off". The winter irrigation rotation is five days on followed by ten days off. The two typical crop rotations are (1) wheat, broadbeans or berseem, followed by corn and (2) broadbeans or berseem followed by cotton. In addition about 15 percent of the area is in sugarcane and a small percentage in tree and/or vineyard crops.

The principal intervention at Abyuha was the raising of *mesqa* 26 which provided an improved gravity system. A farmer organization managed irrigation rotation system was also introduced on the *mesqa* at the time it was raised. The *mesqa* was raised during November to January 1980/81.

Mansuriya Site--Giza Governorate

The Mansuriya Irrigation District includes 24,745 *feddans* and adjoins the Cairo metropolitan area. Because the area is adjacent to Cairo, agricultural land is being converted to other uses and land prices are rising.

The typical farm unit is small and produces maize and vegetables as summer crops and berseem, flax, and vegetables as winter crops. There are also many *feddans* of orchards and/or vineyards. The typical farm will raise many crops, particularly vegetables, during both growing seasons. Farm records are being kept in two areas at the Mansuriya area: Beni Magdul and El-Hammami. The soil at Beni Magdul is similar to the clays at Abyuha and Abu Raya. However, the soil at El-Hammami is sand. The sandy soil at El-Hammami will reduce the irrigation efficiency and on-farm delivery efficiency, thus the water requirements per *feddan* are higher than at the other three sites.

Since the area is next to Cairo, it is exempted from many of the government's agricultural land use policies thus little wheat, rice, or cotton is produced. Only about ten percent of the area is subject to gravity irrigation. Most of the water lifting is done by *saqia* with some *tambours* and few pumps in use. The typical irrigation rotation is four days on water and eight days off. However, the Beni Magdul canal, at the Beni Magdul site, is scheduled as a continuous flow system. A small sample survey of the farmers on two

branch canals in Mansuriya (EWUP PTR No. 1) showed an average farm size of about 4.75 *feddans* and nearly equal number of farmers who owned all of the land they farmed and those who supplemented their owned land with rented fields.

At the Beni Magdul site *Mesqa* 10 was elevated and concrete lined. This intervention was completed during the spring of 1982. At El-Hammami site a low pressure pipeline distribution system is being installed. It is expected that this intervention will be completed during the latter months of 1983.

Abu Raya Site--Kafr el-Sheikh Governorate

The Abu Raya site is located in Kafr el-Sheikh governorate and lies south of El-Brolles Lake in the Lower Delta. The area is reclaimed land which has been farmed for about fifty years. The top 40-60 cm of soil is a heavy clay and the subsoil is loam. The area suffers from soil salinity and sodicity problems but the canal water is of high quality. The water table is relatively close to the surface--40 to 160 cm from the land surface.

Farm holdings by Abu Raya farmers vary in size from less than one *feddan* to more than 20. Nearly 50 percent of the farms are less than three *feddans* in size and less than 4 percent of the farm are more than ten *feddans*. Major winter crops are berseem, wheat, broadbeans, sugarbeets, flax and vegetables while major crops in the summer are cotton, rice, maize and vegetables. Water is primarily lifted by *saqias* into a *marwa* and then distributed into small flat basin with or without furrows. Typically a double or triple irrigation rotation system is used at Abu Raya.

Based upon a 1981 EWUP Farm Survey of Abu Raya (EWUP PTR No. 11), farmers reported using tractors for plowing and seventy-five percent of the surveyed farms own either a buffalo or cow or both since ninety percent of the farmers lift water with animal power. Nearly all (ninety-eight percent) of the farms and ninety percent of the area at Abu Raya are owner-operated.

At Abu Raya, the EWUP interventions focused upon farm irrigation system improvements. The three principal improvements were land leveling, on-farm irrigation system design (length of furrow) and farm irrigation system operation (See EWUP TR No. 35).

FARM RECORDBOOK BACKGROUND

The EWUP farm recordbook system was started with the 1978-1979 crop season. The initial accounting period was one year - October 1 to September 30. The accounting period was changed to the November 1 to October 31 period for the 1979-1980 year and this period has been maintained since then. This change was made to accommodate harvest of cotton and rice.

The accounting entity or firm is basically the farm and farm household. Because some resources, particularly labor, can be employed other than in the farm-household entity, income earned from nonfarm sources is reported to provide for the total productivity of farm-household resources regardless of their employment source. Thus, labor income earned by a household member from nonfarm employment and land rent generated from allowing others to use the land resource are included in the measure "net farm income".

In 1978-1979, records were kept on six farms at Beni Magdul, five farms at El-Hammami, and seven farms at Abu Raya. The seven farms at Abu Raya have been maintained in the subsequent years, however, changes in the sets of record keepers at Beni Magdul and El-Hammami occurred during the 1979-1980 crop year. Fortunately the 1979-1980 set of record keepers has been basically maintained at the two Mansuriya sites and additional farmers added in 1980-1981. The Abyuha record keeping farms were established in 1979-1980 and eight of the initial nine farms have been retained and others added.

The data from the farm record keepers is <u>not</u> a random sample of operators which can confidently be extended to the entire farm population. Rather, they are the farms of operators willing to cooperate with the EWUP. Thus farm size may be somewhat larger than average but the magnitude and type of changes reported would be representative of the changes at the EWUP sites.

BASE MEASURES OF COMPARATIVE ANALYSIS

The comparative analysis (over time) presented in this report is based upon several measures of input use, costs, and measures of productivity. The data presented and the ratios constructed are defined or computed as follows:

Land

Farm Size is reported as the total area cultivated by the farm unit expressed as *feddans* (1 *feddan* = 24 kerats = 1.038 acres = 0.42 hectares). In addition to total farm size, the *feddans* and percent of land owned, cash rented, and share rented are reported. If land is rented out, it is not reported as contributing to farm size but such area is included in the land and real estate inventory.

Crop Distribution

The crop percentages reported are the number of *feddans* of one or a set of crops times 100 divided by the total *feddans* of harvested crops, regardless of the season grown. Thus a cropping percentage of 15.5 for wheat would indicate that 15.5 percent of the combined total annual *feddans* harvested were wheat. It should be noted that intercropping is computed as the number of *feddans* of each of the crops on the intercropped area. Perennial crops are reported by the number of crops harvested per year.

Crop Intensity Index

The crop itensity index is computed as the *feddans* harvested times 100 divided by the total *feddans* of land cropped. Thus, if both summer and winter crops are grown on all of a farm area, the crop intensity index would be 200. Intercropping is handled in the Crop Intensity Index in the same way as indicated in Crop Distribution.

Crop Productivity

The gross value of crops grown during the accounting period is defined as crop productivity. Crop productivity includes the value of crops sold at market prices and an opportunity cost for home consumed crops and crops used for seed and livestock feed. Both the principal product and residual production (stocks, stover, etc.) are included. Perennial crops (grapes, orchards, and sugarcane) only reflect current crop year production.

Crop Expenses

The cash variable costs of crop production are reported as crop expenses. Included are hired labor, equipment rental, fertilizer, seed, pesticides, and other cash production expenses which are associated with a specific crop. Joint costs--for example irrigation pump fuel and oil, are not included and neither are the fixed costs of crop production (taxes and land rent).

Family Members

The EWUP farm record system reports the number of individuals of all ages directly associated with the farm and farm household. Grown children and their families would only be included if they reside in the farm household.

Working Assets

The average value (the sum of beginning values + ending values divided by two) of all assets except land and real estate is defined as working assets. Thus, working assets include livestock, poultry, equipment, and forage and grain inventories.

Livestock Number

The data presented under livestock numbers are the average number of animals by species per farm during the accounting period. It is the number of animals shown in the beginning inventory plus or minus purchases and sales of animals before June aggregated over the set of farms and this total divided by the number of farms in the set.

Livestock Index

An aggregate measure of the number of livestock based upon the buffalo unit is the livestock index. The index developed by EWUP economists is computed using the average number of animals by species and the following weights:

Buffalo 1.0, cow 0.8, camel 1.1, calf 0.45, donkey 0.6, and goats and sheep 0.1. Thus a set of farms with an average of one buffalo and one donkey would have an index of 1.60.

Livestock Value

Livestock value is the average inventory value (beginning + ending inventory value summed then divided by two) of all livestock and poultry. Changes in livestock value are the result of (1) purchases, (2) sales, (3) home consumption, (4) deaths and births, (5) animals maturity, and (6) price changes.

Livestock Productivity

The gross value of livestock and poultry and their products sold, exchanged, and consumed in the farm household is reported as livestock

productivity. Included are livestock value changes due both to the measuring of animals and to the market price changes. Livestock productivity is computed as value of livestock and poultry products consumed in the farm household plus product sales plus the value of livestock work plus livestock and poultry sales minus livestock purchases plus/minus inventory changes. The value of livestock work is the hours of livestock power provided to transport, turn *saqias*, and do field work. All donkeys are assumed to provide 350 hours of personal transportation to the family in addition to the hours of farm transportation. The opportunity cost per hour of livestock work is assumed as: donkey L.E. 0.15 and buffalo or cow L.E. 0.03. This measure of livestock productivity differs from that reported in the 1978-1979 to 1980-1981 farm record summaries but is nearly consistent with the 1981-1982 data.

Net Farm Income

This is the return to the resources provided by the farmer and the farm household. It includes income generated by farm and farm household resources used off the farm, including wages from nonfarm employment. Intermediate farm inputs (animal feed, animal power and animal transportation) are not included. Land appreciation is excluded but appreciation of the other assets, livestock, poultry, equipment and grain and forage, is included in the net-farm income coefficient reported. To a major extent, net farm income reflects both cash and in-kind income available to the farm-household unit.

Crop Ratios

Three crop ratios are included in the analysis. 1) Crop productivity per L.E. of crop expense shows the importance of changes in the cash crop expenses and crop productivity. 2) Crop productivity per *feddan* presents an aggregate measure of yield, price and enterprise combination impacts. 3) Crop productivity per person is a measure of labor productivity but will be understated because all family members regardless of the time spent in the farming operation are used as the divisor.

Livestock Ratios

Three livestock ratios are presented to track the role of livestock. 1) Livestock productivity per L.E. of crop productivity measures the relative importance of gross livestock productivity compared to gross crop productivity. 2) Livestock productivity per *feddan* measures the importance of the land base in livestock productivity whereas 3)

livestock productivity per person measures the labor efficiency of livestock production. Again, it should be noted that the measure of labor is the number of family members regardless of their involvement in the farming operation.

Asset and Income Ratios

Working assets per L.E. of gross farm production measures the use of nonland and capital in the agricultural production process. Gross farm production is the sum of crop productivity and livestock productivity as defined above and includes the value of intermediate farm inputs such as animal power, farm produced seed, and farm produced livestock feed. Net farm income per *feddan* measures the efficiency of land in generation of income for the farm family. To improve the Egyptian farm family's economic status, this ratio must increase over time and/or the number of *feddans* farmed per family must increase. It should be noted that net farm income includes the income generated by farm and farm household resources outside of the farm. Net farm income per person is a second measure of ecoromic well-being of the farm family and measures per capita net income. Again, increases over time in this measure would reflect an improved economic situation for the Egyptian farm family.

Net Returns per Thousand Cubic Meters of Water

The net returns per thousand cubic meters of water is a measure of the residual return to irrigation water after all other factors of production have been paid. Lacking direct farm unit measurement data (water delivered per farm), an indirect approach was used to estimate the quantity of water delivered to the farm. EWUP enterprise crop budgets (1980-1981 for all sites) report the estimated quantity of water delivered to the farmgate per *feddan* of crop. A weighted average (weighted by the percent of harvested area or crop distribution) for the available crop enterprise budgets was computed to estimate the average water delivered per *feddan*. When more than one budget for a given crop was available, the simple average of the budgets was used. Appendix Table A-1 shows the water delivered and labor requirements (in man hour equivalents) per *feddan* used in the analysis. Crops not included in the set of enterprise budgets were assumed to have delivered water the average of those crops for which budget data was available. Total water delivered per farm was computed by multiplying the land area per farm times the average cubic meters of water delivered per *feddan*.

The net return component of the ratio is the net farm income per farm minus an opportunity cost for all factors of production except water and minus off-farm income. The opportunity costs used were: land capital legal rental rate, nonland capital (working assets) 5 percent, labor L.E. 0.25 per man hour (estimated man hours are derived from the enterprise cost budgets in a way parallel to the water delivered estimate and woman hours are weighted 0.75 and boy/girl hours 0.50 of a man hour), and management L.E. 1.0 per *feddan* per month. Because total labor was charged an opportunity cost, the value of hired labor is added back. Also, the value of off-farm income is subtracted to compute net returns. Thus, net returns per 1,000 m^3 of water is the return to water after all other factors of production have been valued.

If all other factors are paid their opportunity cost, then it is possible for the residual, the return to water, to be negative. In general the ratios presented in this paper will tend to overstate the return to water because of the importance of livestock productivity.

ABYUHA SITE ANALYSIS

The Abyuha site farm records were first kept during the 1979-1980 crop season. Eight of the nine first year farms for which data was collected have continued to provide data for three years. This set of farms is titled, "Eight Continuous Farms". A second set of farms titled "All Record Keeper Farms" is composed of all farms for which data was collected. This second set of farms varies by year even when the number of farms is the same. These two sets of farms will be used as a basis for comparing the farms in *mesqa* 26 where a major intervention took place.

Data was collected on six farms on *mesqa* 26 during the 1980-1981 and 1981-1982 cropping seasons. No farms on *mesqa* 26 provided farm record data prior to the 1980-1981 crop year. During the period November 1980 to February 1981, *mesqa* 26 was elevated to provide improved gravity irrigation, a water delivery schedule was developed and implemented, and selected agronomic trials (long furrows and fertilizer recommendations) were undertaken on some fields. Thus, the farm record data is reflective of the situation after the intervention took place.

Eight Continuous Farms:

Data for eight continuous farms is presented in Table 1. The farms range in size from 0.5 to 14.0 *feddans* and have an average size of

Table 1. Selected statistics for the eight continued farms, Abueha Site 1979/80 to 1981/82.

	Unit	1979/80	1980/81	1981/82
Land Owned	Feddan	2.81	2.25	2.56
	%	55	46	52
Cash Rented	Feddan	2.33	2.64	2.33
	%	45	54	48
Share Rented	Feddan	0.00	0.00	0.00
	%	0	0	0
TOTAL	Feddan	5.14	4.89	4.89
Crop Distribution	% Harv			
Broadbeans	Area	20.6	22.4	28.2
Maize	"	23.4	19.0	12.1
Cotton	"	12.8	11.8	12.3
Wheat	"	14.5	8.8	2.7
Berseem	"	13.8	9.1	14.7
Soybeans	"	0.0	7.9	18.0
Sugarcane	"	11.5	19.6	10.6
Grapes	"	0.8	0.7	0.7
Garden Crops[a]	"	0.6	0.7	0.7
Crop Intensity Index	Index	161	193	189
Crop Productivity	LE/farm	2020.9	2168.8	2456.1
Crop Expenses	"	566.0	721.1	909.6
Family Members	Person	7.25	7.25	7.25
Working Assets	LE/farm	869.6	1105.2	1519.4
Livestock Numbers				
Buffalo	Number	1.00	1.00	0.88
Cow	"	0.38	0.50	0.75
Camel	"	0.13	0.13	0.00
Calf	"	0.13	0.00	0.00
Donkey	"	1.50	1.50	1.25
Sheep & goats	"	3.88	3.38	2.25
Livestock Index	Buf Units	2.79	2.78	2.46
Livestock Value	LE/farm	547.5	755.5	826.9
Livestock Productivity	"	507.0	489.4	856.3
Net Farm Income	"	1710.8	1202.6	2040.5
Crop Prod/LE Crop Exp	LE	3.57	3.01	2.70
Crop Prod/Feddan	"	393.2	444.4	503.3
Crop Prod/Person	"	278.7	299.1	338.8
Livestock Prod/LE Crop Prod	"	0.25	0.23	0.35
Livestock Prod/Feddan	"	98.6	100.3	175.5
Livestock Prod/Person	"	69.9	67.5	118.1
Wkg Assets/LE Gross Farm Prod	"	0.34	0.42	0.46
Net Farm Income/Feddan	"	332.8	246.4	418.1
Net Farm Income/Person	"	236.0	165.9	281.4
Net Returns/1,000 M^3 Water	"	54.47	33.22	74.20

[a] Tomatoes, Potatoes, and Watermelon.

about five *feddans*. Over the three years the average farm size changed from 5.14 to 4.89 *feddans*, a decrease of 0.25 *feddans* or about five percent. About half of the land is owned and the other half is cash rented.

The principal crops grown are broadbeans, maize, cotton, wheat, berseem, and sugarcane. In the 1981-1982 crop year, broadbeans accounted for 28.2 percent of the harvested *feddans*. This is an increase of over one-third compared to the 1979-1980 level. Soybean area also increased significantly from zero percent of the harvested area in 1980-1981 to 18.0 percent in 1981-1982. To offset these increases the area of maize dropped from 23.4 to 12.1 percent in the three years and wheat area decreased from 14.5 percent in 1979-1980 to 2.7 percent in 1981-1982. The other crops remained at about the same level during the three cropping seasons.

The crop intensity index increased from 161 in 1979-1980 to 193 in 1980-1981 and decreased to 189 in 1981-1982. Thus, nearly two crops are harvested from each *feddan*, including the perennial crops. Crop productivity, the gross value of crops produced per farm, increased from L.E. 2021 in 1979-1980 to L.E. 2169 in 1980-1981 and was L.E. 2456 in 1981-1982. Similarly, crop expenses per farm have also increased each year, from L.E. 566 in 1979-1980 to L.E. 721 in 1980-1981 to L.E. 910 in 1981-1982. Hence both the gross value of crop production and crop expenses increased each year.

The eight continuous farms averaged 7.25 male and female family members (combined) of all ages. The working assets controlled by the average farm were L.E. 870 in 1979-1980 and increased to nearly L.E. 1500 in 1981-1982.

Livestock numbers on the eight continuous farms over the three - year period show small declines in the number of buffalo and donkeys and a larger drop, nearly 1.5 animals, in the number of sheep and goats on the farms. In terms of buffalo units, the livestock index dropped about 0.30 in 1981-1982 compared to its level in the first two years. The value of livestock assets has steadily increased from L.E. 548 in 1979-1980 to L.E. 756 in 1980-1981 and was L.E. 827 in 1981-1982. This increase is because of higher prices rather than increased livestock numbers. The value of livestock production was about constant the first two years but jumped from L.E. 489 to L.E. 856, an increase of 75 percent, in 1981-1982.

Average net farm income per farm dropped in 1980-1981 nearly L.E. 500 but recovered in 1981-1982. The 1981-1982 net farm income was L.E.

2040. About half of the 1981-1982 increase in net farm income is attributable to livestock production, a little to crop production when the increase in crop expenses is considered and the rest is from other sources including nonfarm income.

Crop productivity per L.E. of crop expense has decreased steadily over the three years dropping from L.E. 3.57 in 1979-1980 to L.E. 2.70 in 1981-1982. This suggests that cash costs of crop production are increasing more rapidly than the total value of crops produced.

Crop productivity per *feddan* has increased steadily during the three years of data collection. It rose from L.E. 393.2 in 1979-1980 to L.E. 503.3 in 1981-1982. This suggests that crop yields, crop prices, and/or the enterprise combination has changed. Because the number of family members per farm remained at 7.25 over the three years, the consistent increases in crop production per person are attributable to the increase in crop productivity rather than a decrease in the number of family members per farm.

Livestock productivity per L.E. of crop productivity indicates the relative importance of these two sources of production. For the eight continuous farms at Abyuha, livestock productivity per L.E. of crop productivity has increased from L.E. 0.25 to L.E. 0.35 over the three years. The 1980-1981 data showed a slight drop in the ratio but the 1981-1982 level was considerably higher. Although livestock productivity is increasing, it is substantially less important than crop productivity.

Livestock productivity per *feddan* increased more than 75 percent in 1981-1982 after remaining nearly equal the previous two years. Similarly, livestock productivity per person increased in 1981-1982 after two years at a nearly equal level. The change in both of these measures is because of the increase in livestock productivity in 1981-1982 rather than a decrease in *feddans* farmed or family members per farm.

Working assets per L.E. gross farm production increased from L.E. 0.34 to L.E. 0.46 during the three years of records. Some of this increase is the result of the 51 percent increase in livestock assets over the three years compared to a 31 percent increase in gross farm production. However, the livestock share of working assets has decreased from 62 percent to 54 percent indicating that non livestock assets have grown more rapidly and caused most of the increase in working assets per L.E. of gross farm production.

Net farm income per *feddan* decreased in 1980-1981 by more than L.E. 85 but increased about twice the decrease the following year. A similar pattern was followed by net farm income per person. Again, these changes are primarily because of changes in net farm income rather than decreases in farm size or family members.

Net returns per 1,000 m^3 water is positive in all three years and closely follows the pattern of net farm income. In 1979-1980, the ratio was L.E. 54.47 and it increased to L.E. 74.2 in 1981-1982 after dropping by nearly L.E. 20 the previous year.

Significant changes in the eight continuous farms from 1979-1980 to 1981-1982 include: (1) a changing cropping pattern with increased production of broadbeans and soybeans and reduced areas of wheat and maize, (2) the cropping intensity index increased moderately, (3) steady increases over the three years in working assets, livestock value, crop expenses and crop productivity, (4) a decline in 1980-1981 followed by a substantial rise in 1981-1982 in livestock productivity, net farm income, and net returns per 1,000 m^3 of water, and (5) steady decreases in the ratio of crop productivity per L.E. of crop expense.

All Record Keeper Farms

The second set of farms includes all farms for which farm record data was collected. This set includes the eight continuous farms and is supplemented by other operations. Because different sets of farms are used each year, the over time changes reported in Table 2 will need to be interpreted carefully. If the data from all record keeper farms supports the changes reported from the eight continuous farms, greater reliability can be afforded to the initial trends reported.

The average farm size declined from 6.20 *feddans* in 1979-1980 to 3.79 *feddans* in 1981-1982. In 1979-1980 and 1981-1982 about two-thirds of the land was owned and one-third was cash rented. In 1989-1981 the land area was about equally divided between land owned and land cash rented. No land was share rented in any of the three years.

The cropping patterns for the all record keeper farms over the three years includes decreases in maize, wheat, and cotton area and increases in the areas of soybeans, berseem, and garden crops. Cotton and wheat areas are reduced about 50 percent and maize about one-third. Berseem area increased 80 percent and soybeans have increased from zero to 17.7 percent of the harvested area over the three years. Garden crops, although small in area, increased 225 percent from 0.4 to 1.3 *feddans*.

Table 2. Selected statistics for all record keeper farms, Abueha Site 1979/80 to 1981/82.

	Unit	1979/80	1980/81	1981/82
Land Owned	Feddan	3.91	2.22	2.56
	%	63	51	68
Cash Rented	Feddan	2.29	2.17	2.33
	%	37	49	32
Share Rented	Feddan	0.00	0.00	0.00
	%	0	0	0
TOTAL	Feddan	6.20	4.39	3.79
Crop Distribution	% Harv			
Broadbeans	Area	25.2	20.3[a]	26.0
Maize	"	28.9	24.3[a]	14.7
Cotton	"	13.9	14.1[a]	8.8
Wheat	"	13.3	14.0[a]	6.7
Berseem	"	9.8	9.0[a]	17.7
Soybeans	"	0.0	4.9[a]	17.7
Sugarcane	"	8.0	12.1[a]	6.7
Grapes	"	0.5	0.4[a]	0.4
Garden Crops[b]	"	0.4	0.9[a]	1.3
Crop Intensity Index	Index	170	186[a]	208
Crop Productivity	LE/farm	2248.2	1759.5	1917.5
Crop Expenses	"	662.0	586.3	705.1
Family Members	Number	7.00	6.40	6.67
Working Assets	LE/farm	887.0	1024.0	1249.4
Livestock Numbers				
Buffalo	Number	0.89	0.80	0.87
Cow	"	0.33	0.47	0.40
Camel	"	0.11	0.07	0.00
Calf	"	0.11	0.07	0.00
Donkey	"	1.56	1.27	1.07
Sheep & goats	"	3.78	4.47	3.07
Livestock Index	Buf Units	2.64	2.49	2.14
Livestock Value	LE/farm	509.6	708.7	733.9
Livestock Productivity	"	466.5	466.9	641.0
Net Farm Income	"	1886.0	1092.4	1418.9
Crop Prod/LE Crop Exp	LE	3.40	3.00	2.72
Crop Prod/Feddan	"	362.6	400.8	507.3
Crop Prod/Person	"	321.2	274.9	287.5
Livestock Prod/LE Crop Prod	"	0.21	0.26	0.33
Livestock Prod/Feddan	"	75.2	106.4	169.6
Livestock Prod/Person	"	66.6	73.0	96.1
Wkg Assets/LE Gross Farm Prod	"	0.33	0.46	0.49
Net Farm Income/Feddan	"	304.2	248.8	375.4
Net Farm Income/Person	"	269.4	170.7	212.7
Net Returns/1,000 M^3 Water	"	42.97	27.48	70.60

[a] Includes one farm that rented out 6.41 feddans for summer corn crop.
[b] Artichokes, tomatoes, watermelon, etc.

The crop intensity index increased from 170 to 208 over the three years. Crop productivity dropped between 1979-1980 and 1980-1981 by nearly L.E. 490 but increased nearly L.E. 60 between 1980-1981 and 1981-1982. Crop expenses also declined between the first two years but increased to L.E. 705 in 1981-1982 to the highest level in the three years of data collected.

The number of family members per farm decreased from 7.00 in 1979-1980 to 6.40 in 1980-1981 and was 6.67 in 1981-1982. Working assets showed steady growth over the three year period, increasing about L.E. 200 each year. In 1981-1982 working assets were L.E. 1249.4. Livestock value, a component of working assets, also increased each year, but the growth did not equal that of working assets during the third year.

Livestock numbers showed a small decline in camels, calves, donkeys, and sheep and goats over the three years. The livestock index dropped from 2.64 in 1979-1980 to 2.14 in 1981-1982.

Livestock productivity stayed at about L.E. 470 per farm in 1979-1980 and 1980-1981 but increased to L.E. 640 in 1981-1982. Net farm income per farm dropped nearly L.E. 800 between 1979-1980 and 1980-1981 but increased more than L.E. 300 in the third year to L.E. 1418.9 per farm.

Crop productivity per L.E. of crop expense decreased over the three years from L.E. 3.40 to L.E. 3.00 to L.E. 2.72. Crop productivity per *feddan* increased from L.E. 362.6 to L.E. 507.3, however, per person crop productivity decreased from L.E. 321.2 in 1979-1980 to L.E. 274.9 in 1980-1981 and only increased moderately the following year.

Livestock productivity per L.E. of crop productivity, per *feddan,* and per person, all increased over the three years of record collection. These changes all reflect smaller ratio divisors the first two years and increases in livestock productivity during the last year.

Working assets per L.E. of gross farm production increased steadily reflecting a faster growth in working assets than crop and livestock productivity combined. Net farm income per *feddan* decreased from L.E. 304.2 to L.E. 248.8 between years one and two but increased to L.E. 375.4 in 1981-1982. Net farm income per person also declined between the first two years but increased L.E. 42 during 1981-1982 to L.E. 212.7.

Net returns per thousand cubic meters of water decreased from L.E. 42.97 to L.E. 27.48 during the first two years and then rose to L.E. 70.60. The increase in the third year is greater than the increase in

net farm income but is reflective of a lower quantity of water delivered because of a different crop enterprise combination.

The analysis of the all record keeper farms confirmed the declines identified by the analysis of the eight continuous farms in maize and wheat production and the increase in soybean area at the Abyuha site. The increase in working assets, and livestock value, and the steady decrease in crop productivity per L.E. of crop expense were consistent between the two data sets as was the decline in net farm income and net returns per 1,000 m^3 of water during 1980-1981. The increase in livestock and crop productivity found in the eight continuous farms is not supported by the changes found in these variables in the all record keeper farms data, thus the level of confidence that increases in crop and livestock productivity are typical for the area is weakened.

Mesqa 26 Record Keeper Farms

Two years of data are shown in Table 3 for six farms on *mesqa* 26 after the intervention was undertaken. It should be noted, however, that only 1981/82 reflects a full - crop year after the intervention was completed. The average size of farm operated was 2.31 *feddans* in 1980-1981 and this increased 0.06 *feddans* in 1981-1982 to 2.37 *feddans*. Ninety percent of the area is cash rented, ten percent is owned and none is share rented.

During the two years the production of soybeans, berseem, and broadbeans increased nearly 30 percent in aggregate and cotton declined over 20 percent. Small declines are also reported in wheat, maize, and garden crops. The crop intensity index increased 50 points from 194 to 244, crop productivity increased nearly L.E. 200 and crop expenses increased from L.E. 264.4 to L.E. 394.7.

Family members per farm remained constant at 5.50 over the two years but working assets increased nearly L.E. 140 per farm. Livestock numbers remained relatively stable in total but the number of sheep and goats declined two heads per farm. The livestock index, livestock value and livestock productivity all declined slightly. Net farm income declined almost L.E. 120 per farm during the two-year period.

Crop productivity per L.E. of crop expenses decreased from L.E. 3.46 to L.E. 2.98 or 14 percent. Crop productivity per person and per *feddan* both increased, again because of the increased crop productivity rather than decreases in farm size or family members per farm. The importance of livestock productivity relative to crop productivity as

Table 3. Selected statistics for six mesqa 26 farm record keepers, Abueha Site, 1980/81 and 1981/82.

	Unit	1980/81	1981/82
Land Owned	Feddan	0.23	0.23
	%	10	10
Cash Rented	Feddan	2.08	2.14
	%	90	90
Share Rented	Feddan	0.00	0.00
	%	0	0
TOTAL	Feddan	2.31	2.37
Crop Distribution	% Harv		
Broadbeans	Area	14.5	18.7
Maize	"	24.2	22.0
Cotton	"	25.4	3.6
Wheat	"	18.9	15.7
Berseem	"	14.8	24.6
Soybeans	"	0.0	15.5
Garden Crops[a]	"	2.2	0.0
Crop Intensity Index	Index	194	244
Crop Productivity	LE/farm	985.0	1176.2
Crop Expenses	"	284.4	394.7
Family Members	Number	5.50	5.50
Working Assets	LE/farm	898.4	1036.3
Livestock Numbers			
Buffalo	Number	0.67	1.00
Cow	"	0.50	0.17
Calf	"	0.17	0.00
Donkey	"	0.83	0.83
Sheep & goats	"	6.67	4.67
Livestock Index	Index	2.31	2.10
Livestock Value	LE/farm	735.5	725.7
Livestock Productivity	"	479.6	449.4
Net Farm Income	"	792.5	674.1
Crop Prod/LE Crop Exp	LE	3.46	2.98
Crop Prod/Feddan	"	426.4	496.3
Crop Prod/Person	"	179.1	213.9
Livestock Prod/LE Crop Prod	"	0.49	0.38
Livestock Prod/Feddan	"	207.6	189.6
Livestock Prod/Person	"	87.2	81.7
Wkg Assets/LE Gross Farm Prod	"	0.61	0.64
Net Farm Income/Feddan	"	343.1	284.4
Net Farm Income/Person	"	144.1	122.6
Net Returns/1,000 M^3 Water	"	56.22	52.66

[a]Artichokes, tomatoes, watermelon, etc.

shown in the ratio of livestock productivity per L.E. of crop productivity decreased from 0.49 to 0.38 over the two years. Both livestock productivity per *feddan* and per person declined slightly. Working assets per L.E. of gross farm production stayed essentially the same, but both net farm income per *feddan* and per person declined. Net returns/1,000 m^3 of water decreased L.E. 3.56 from L.E. 56.22 to L.E. 52.66.

In contrast to the eight continuous farms and the all record keeper farms, the farms on *mesqa* 26 show several differences. First, the farms are smaller and have a greater proportion of cash rented land. Second, the cropping pattern trends are consistent with those in the other two sets but the base levels are higher for declining area crops (maize, cotton and wheat) and lower for increasing area crops (broad beans, soybeans and berseem). Third, crop productivity per L.E. of crop expenses is higher due primarily to lower crop expenses per *feddan*. Fourth, livestock productivity relative to crop productivity has declined on the *mesqa* 26 farms compared to the increase on the other two sets of farms during the last year. Net farm income on *mesqa* 26 declined during the last year in total L.E., L.E. per *feddan*, and L.E. per person while all of these measures increased on the other sets of Abyuha farms. Finally, the increase in net returns/1,000 m^3 of water declined between 1980-1981 and 1981-1982 compared to increases in the other two sets of farms.

MANSURIYA SITE ANALYSIS

El-Hammami Area

Data is available on four continuous farms for three years, 1979-1980 to 1981-1982, and for all record keeper farms for four years. Data on five farms was collected in 1978-1979 and on four farms in 1979-1980, but these four farms are all different from those used the previous year. Data from 14 farms was recorded in 1980-1981 and 11 farms in 1981-1982 including one new record keeper.

Four Continuous Farms

The data presented in Table 4 shows the statistics for the same four farms for three years. The farmers own over ninety percent of the land and cash rent the residual. The average farm grew from 4.53 *feddans* in 1979-1980 to 4.84 *feddans* in 1981-1982.

Table 4. Selected statistics for four continued farms, El Hammami Site, 1979/80 to 1981/82.

	Unit	1979/80	1980/81	1981/82
Land Owned	Feddan	4.14	4.17	4.52
	%	91	91	93
Cash Rented	Feddan	0.39	0.39	0.32
	%	9	9	7
Share Rented	Feddan	0.00	0.00	0.00
	%	0	0	0
TOTAL	Feddan	4.53	4.56	4.84
Crop Distribution	% Harv			
Broadbeans	Area	5.8	1.4	0.9
Maize	"	7.6	8.0	9.1
Wheat	"	6.0	6.1	2.6
Berseem	"	14.8	13.3	16.0
Maize Forage	"	3.2	6.1	4.6
Peanuts	"	2.1	3.5	4.2
Sesame & Sunflower	"	4.8	5.0	2.6
Garden Crops[a]	"	55.7	56.6	60.0
Crop Intensity Index	Index	340	387	327
Crop Productivity	LE/farm	2154.5	2324.7	2856.7
Crop Expenses	"	593.5	804.4	1023.8
Family Members	Number	8.75	8.75	9.25
Working Assets	LE/farm	2008.1	2727.8	3294.5
Livestock Numbers				
Buffalo	Number	1.00	0.50	1.00
Cow	"	0.75	1.50	1.50
Camel	"	0.25	0.00	0.00
Calf	"	0.00	0.25	0.75
Donkey	"	1.50	1.50	1.25
Sheep & goats	"	1.25	0.00	0.00
Livestock Index	Buf Units	2.90	2.71	3.29
Livestock Value	LE/farm	712.2	847.0	1167.0
Livestock Productivity	"	974.4	886.2	1612.6
Net Farm Income	"	2042.9	2099.6	2528.9
Crop Prod/LE Crop Exp	LE	3.63	2.88	2.79
Crop Prod/Feddan	"	477.7	509.8	637.7
Crop Prod/Person	"	246.2	265.7	378.1
Livestock Prod/LE Crop Prod	"	0.45	0.38	0.56
Livestock Prod/Feddan	"	216.1	194.3	360.0
Livestock Prod/Person	"	111.4	101.3	174.3
Wkg Assets/LE Gross Farm Prod	"	0.64	0.85	0.74
Net Farm Income/Feddan	"	453.0	460.4	564.5
Net Farm Income/Person	"	233.5	240.0	273.4
Net Returns/1,000 M^3 Water	"	-27.21	-53.16	-29.01

[a]Artichokes, tomatoes, watermelon, etc.

Because of the proximity to Cairo, farms in El-Hammami area are not required to produce rice or cotton and typically none is produced. Over the three years the enterprise combinations have changed. The area of broadbeans has declined from 5.8 percent of the harvested area to 0.9 percent. Declines over the three years are also shown in Table 4 for the areas of wheat, sesame and sunflowers. During the same three years the area in peanuts has doubled from 2.1 to 4.2 percent, maize area has increased slightly, forage production represented by the combined area of berseem and maize forage, has increased from 18.0 to 20.6 percent and the percent of harvested area in garden crops has increased from 55.7 to 60.0 percent in three years.

The crop intensity index increased from 340 to 387 between 1979-1980 and 1980-1981 but dropped to 327 in 1981-1982. Crop productivity increased steadily from L.E. 2154.5 to L.E. 2856.7 per farm over the three years and crop expenses also increased but at about twice this rate.

The number of family members per farm was constant at 8.75 the first two years but then rose to 9.25. Working assets increased from L.E. 2009 in 1979-1980 to L.E. 3294 in 1981-1982, an increase of more than sixty percent which was about equal for both the livestock and the non-livestock components of working assets. Livestock value increased steadily over the three years. The livestock index and livestock productivity, however, declined between the first two years then increased to levels substantially above the first year's level in 1981-1982. Net farm income increased from L.E. 2043 to L.E. 2100 between 1979-1980 and 1980-1981. The next year, net farm income increased L.E. 529 to L.E. 2529.

The ratio of crop productivity per L.E. of crop expense declined steadily over the three years. In 1979-1980, this ratio was L.E. 3.63 and in 1981-1982 it had declined to L.E. 2.79. The decline is the result of crop expenses rising more rapidly than crop productivity. Both crop productivity per feddan and per person increased over the three years due to increases in crop productivity.

The three livestock ratios, livestock productivity per L.E. of crop expense, per *feddan*, and per person all declined during the second year but all increased during the third year to levels higher than the initial year. The ratio of working assets per L.E. of gross farm production increased substantially between the first two years (0.64 to 0.85) because of the large increase in working assets. The decrease in this ratio the third year was because of the relatively larger increase in gross farm production. Both net farm income per *feddan*

and per person increased slightly between 1979-1980 and 1980-1961 and a substantially greater increase is shown 1981-1982.

Net return per thousand cubic meters of water are negative in all three years. Water returns were L.E. - 27.21 in 1979-1980 and declined the following year to L.E. - 55.16. In 1981-1982, water returns recovered and were only L.E. - 29.01. The negative returns to water suggest that farm income was not sufficient to pay the factors other than water all of their opportunity costs.

The major changes and characteristics of the four continuous farms over the three years are: (1) a modest increase in farm size, (2) increased production of broadbeans, wheat, sesame, and sunflowers and increases in the percent of harvested area of berseem, peanuts, and garden crops, (3) crop productivity increased, (4) crop expenses increased 7½ percent, (5) working assets increased 63 percent, (6) livestock productivity dropped in 1980-1961, but increased substantially in 1961-1962, (7) net farm income increased by L.E. 500, (8) crop productivity per L.E. of crop expense declined 24 percent , (9) crop productivity per *feddan* increased by one-third and (10) net returns/1,000 m^3 water were negative in all three years.

All Record Keeper Farms

The set of all record keeper farms varies substantially over the four years. Thus, much of the change in the statistics over time may be due to this factor. Patterns and trends consistent with the four continued farms, however, would be supportive of the analysis of the four continued farms. Table 5 presents data for the four years 1978-1979 through 1981-1982.

A majority of the farmland was owned by the all record keeper farms. The percentage varies between 63 percent in 1978-1979 and 91 percent in 1979-1960. A small percentage, less than 6 percent, was share rented during the last two years and the residual was cash rented. Average farm size was 4.53 *feddans* in 1979-1980 and declined to a low for the four years of 2.63 in 1961-1982.

Principal crop enterprise trends include a steady decline in the percent of harvested area in wheat and a consistent increase in the production of garden crops. Crop production patterns similar to those of the four continuous farms for the 1979-1980 to 1981-1962 crop years include declines in broadbeans, sesame, and sunflower and an increase in the peanut area. The pattern of change in the crop intensity index and crop productivity are inconsistent with the four continued farms

Table 5. Selected statistics for all record keepers, El Hammami Site, 1978/79 to 1981/82.

	Unit	1978/79	1979/80	1980/81	1981/82
Number of Farms	Number	5	4	14	11
Land Owned	Feddan	2.58	4.14	1.96	2.26
	%	63	91	75	84
Cash Rented	Feddan	1.49	0.39	0.51	0.39
	%	37	9	19	14
Share Rented	Feddan	0.00	0.00	0.16	0.05
	%	0	0	6	2
TOTAL	Feddan	4.07	4.53	2.63	2.70
Crop Distribution	% Harv				
Broadbeans	Area	0.0	5.8	1.0	0.6
Maize	"	9.4	7.6	8.8	7.5
Wheat	"	8.2	6.0	5.1	1.9
Berseem	"	17.3	14.8	13.2	16.3
Maize Forage	"	15.8	3.2	4.7	5.0
Peanuts	"	2.1	2.1	3.6	4.5
Sesame & Sunflower	"	1.0	4.8	4.1	2.2
Garden Crops[a]	"	46.2	55.7	59.5	62.0
Crop Intensity Index	Index	160	340	371	335
Crop Productivity	LE/farm	1209.7	2154.5	1502.0	1826.0
Crop Expenses	"	498.7	593.5	662.7	728.1
Family Members	Number	14.80	8.75	6.71	7.36
Working Assets	LE/farm	1120.0	2008.1	1563.1	2035.8
Livestock Numbers					
Buffalo	Number	0.40	1.00	0.43	0.82
Cow	"	1.20	0.75	0.86	1.00
Camel	"	0.40	0.25	0.00	0.00
Calf	"	1.20	0.00	0.07	0.55
Donkey	"	1.20	1.50	1.29	1.27
Sheep & goats	"	1.00	1.25	0.43	0.64
Livestock Index	Buf Units	3.16	2.90	1.96	2.49
Livestock Value	LE/farm	578.2	712.2	568.4	824.3
Livestock Productivity	"	520.3	974.4	559.6	1314.2
Net Farm Income	"	669.4	2042.9	1301.6	2184.8
Crop Prod/LE Crop Exp	LE	2.43	3.63	2.27	2.51
Crop Prod/Feddan	"	279.2	477.7	571.1	676.3
Crop Prod/Person	"	81.7	246.2	223.8	248.1
Livestock Prod/LE Crop Prod	"	0.43	0.45	0.37	0.72
Livestock Prod/Feddan	"	127.8	216.1	212.8	486.7
Livestock Prod/Person	"	35.2	111.4	83.4	178.6
Wkg Assets/LE Gross Farm Prod	"	0.65	0.64	0.76	0.65
Net Farm Income/Feddan	"	164.5	453.0	494.9	809.2
Net Farm Income/Person	"	45.2	233.5	194.0	296.8
Net Returns/1,000 M^3 Water	"	nc	-27.21	-15.62	70.78

[a] Artichokes, tomatoes, watermelon, etc.
nc = not computed

but crop expenses per farm increased each year. No consistent trends are shown in the number of family members, working assets, livestock numbers (except camels which declined from 0.04 to 0.00 during the first three years and remained at zero in 1981-1982), livestock index, livestock value, livestock productivity, and net farm income per farm. The pattern of livestock productivity and livestock index, however, paralleled that of the four continuous farms for the last three years.

Only three of the ratios computed for all record keeper farms showed a trend. Crop productivity per *feddan* consistently increased each year from L.E. 279.2 per *feddan* in 1978-1979 to L.E. 676.3 per *feddan* in 1981-1982. A similar pattern was reflected for net farm income per *feddan* and nearly a consistent yearly increase was reported for livestock productivity per *feddan*.

The other six ratios did not show consistent trends over the four years. Patterns parallel to those shown in the four continued farms for the period 1979-1980 to 1981-1982 were present in the three livestock ratios and working assets per L.E. of gross farm production.

Net returns per thousand cubic meters of water showed increases in each of the last two years although both 1979-1980 and 1980-1981 are negative. The water return is L.E. 70.76 in 1981-1982 in part because of the L.E. 800 increase in net farm income.

Data from the all record keeper farms set that supports the patterns of the four continued farms include: (1) a majority of the land was owned, (2) there was increased percentages of harvested area in peanuts and garden crops and decreased percentages of wheat and during the last three years, decreases in broadbeans, sesame, and sunflowers, (3) crop expenses per farm consistently increased, (4) declines in the livestock index, livestock value, and livestock productivity in 1980-1981 were followed by a rise in 1981-1982, (5) increases in crop productivity per *feddan*, and (6) increases in net farm income per person.

Beni Magdul Area

The Beni Magdul area has five farms which provide continuous records since 1978-1979. In 1978-1979 and 1979-1980, records were kept on six farms and the next two years records were kept on 15 farms. Two principal interventions were implemented in the area. *Mesqa* 10 was elevated and lined to provide an improved gravity irrigation system.

Mesqa 6 was renovated to improve its gravity irrigation system. Data will be presented for the five continuous farms, all record keepers, farms on *mesqa* 10, and farms on *mesqa* 6.

Five Continuous Farms

Table 6 presents four years of data for five continuous farms at the Beni Magdul area. Farm size increased during the first three years from 1.85 *feddans* to 2.20 *feddans* but declined in 1981-1982 to 2.10 *feddans*. The owned land varied between 24 and 34 percent during the four years. Cash rented land was at least two-thirds of the total the first two years but dropped to about 30 percent the last two years. At least 40 percent of the land area was share rented the last two years but only a very small quantity of land was share rented in 1978-1979 and 1979-1980.

Enterprise crop trends include notable decreases in the percent of harvested area of maize, forage and other crops (flax, sesame, cowpeas, and grapes). Maize production dropped from 16.3 percent in 1978-1979 to 10.2 percent in 1981-1982. The combined production of berseem and maize forage declined 6.8 percent over the four years and other crops declined 6.1 percent. Small declines over the four years are also shown in wheat and sunflowers. The major increase in percent of harvested *feddans* is in garden crops which increased from 17.2 percent to 41.0 percent in 1981-1982.

The crop intensity index increased from 226 in 1978-1979 to 328 in 1980-1981 but declined to 313 in 1981-1982. Crop productivity followed a similar pattern increasing L.E. 1120.5 from L.E. 794.3 in 1978-1979 to L.E. 1914.8 in 1980-1981 but then declined to L.E. 1720.6 in 1981-1982. Crop expenses per farm increased from L.E. 223.4 to L.E. 274.9 during the four years. The increase was essentially steady except for a slight decline in 1980-1981.

The number of family members per farm has increased over the four years from 7.60 to 8.20. Working assets increased steadily from L.E. 1940.4 in 1981-1982. Livestock numbers show a moderate switch from buffalo to cows over the four years and an increase in the number of donkeys from 1.00 head per farm in 1978-1979 to 1.60 head per farm in 1981-1982. The livestock index increased slightly in 1981-1982 after remaining about constant the previous three years. Livestock value per farm has increased steadily over the four years rising from L.E. 607.8 to L.E. 1149.0. Livestock productivity rose rapidly the first three years from L.E. 674.2 to L.E. 1568.4 and dropped to L.E. 1364.7

Table 6. Selected statistics for five continued farms, Beni Magdul Site, 1978/79 to 1981/82.

	Unit	1978/79	1979/80	1980/81	1981/82
Land Owned	Feddan	0.62	0.47	0.58	0.63
	%	34	24	26	30
Cash Rented	Feddan	1.23	1.38	0.69	0.61
	%	66	72	31	29
Share Rented	Feddan	0.00	0.08	0.93	0.86
	%	0	4	43	41
TOTAL	Feddan	1.85	1.93	2.20	2.10
Crop Distribution	% Harv				
Broadbeans	Area	0.0	1.2	0.0	0.0
Maize	"	16.3	11.7	11.2	10.2
Wheat	"	4.2	2.1	2.8	2.8
Berseem	"	35.3	45.3	38.5	33.4
Maize Forage	"	13.1	3.2	7.0	8.2
Sunflower	"	7.6	8.2	5.0	4.2
Garden Crops[a]	"	17.2	27.5	35.2	41.0
Others[b]	"	6.3	0.8	0.3	0.2
Crop Intensity Index	Index	226	286	328	313
Crop Productivity	LE/farm	794.3	1327.1	1914.8	1720.6
Crop Expenses	"	223.4	247.1	235.8	274.9
Family Members	Number	7.60	8.00	8.20	8.20
Working Assets	LE/farm	863.2	1015.2	1426.0	1940.4
Livestock Numbers					
Buffalo	Number	1.60	1.60	1.20	1.20
Cow	"	0.40	0.20	0.40	0.60
Calf	"	0.00	0.20	0.00	0.20
Donkey	"	1.00	1.20	1.40	1.60
Sheep & goats	"	0.60	0.40	0.40	0.40
Livestock Index	Buf Units	2.58	2.61	2.40	3.04
Livestock Value	LE/farm	607.8	827.0	1099.1	1149.0
Livestock Productivity	"	674.2	934.3	1568.4	1364.7
Net Farm Income	"	650.0	1560.2	2142.5	2602.9
Crop Prod/LE Crop Exp	LE	3.56	5.37	8.12	6.26
Crop Prod/Feddan	"	429.4	687.6	870.4	819.3
Crop Prod/Person	"	104.5	165.9	233.5	209.8
Livestock Prod/LE Crop Prod	"	0.85	0.70	0.82	0.79
Livestock Prod/Feddan	"	364.4	484.1	712.9	649.7
Livestock Prod/Person	"	88.7	116.8	191.3	166.4
Wkg Assets/LE Gross Farm Prod	"	0.59	0.45	0.41	0.68
Net Farm Income/Feddan	"	351.4	808.4	973.9	1239.5
Net Farm Income/Person	"	85.5	195.2	261.3	317.4
Net Returns/1,000 M^3 Water	"	nc	90.96	51.38	6.93

[a] Artichokes, tomatoes, watermelon, etc.
[b] Flax, sesame, cowpeas and grapes.

nc = not computed.

in 1981-1982. Net farm income per farm increased each year rising from L.E. 650.0 in 1978-1979 to L.E. 2602.9 in 1981-1982, an increase of 400 percent.

Crop productivity per L.E. of crop expense increased steadily from L.E. 3.56 in 1978-1979 to L.E. 8.12 in 1980-1981 then declined to L.E. 6.26 in 1981-1982. The increase reflected more rapidly rising crop productivity while the decline was the result of a decline in crop productivity and an increase in crop expenses. Crop productivity per *feddan* and per person both increased until 1980-1981 but declined in 1981-1982. The decline in the last year was due to a L.E. 200 decrease in crop productivity per farm.

The livestock productivity per L.E. of crop productivity ranged between 0.70 and 0.85. Thus crop productivity was always more important than livestock productivity. The four years, however, provided no consistent trend. Livestock productivity per *feddan* increased each year except in 1981-1982, thus it followed the pattern of livestock productivity because farm size remained relatively constant. Livestock productivity per person reflects the increase in livestock productivity increasing until the last year when it showed a modest decline.

Working assets per L.E. of gross farm production declined each year except the last year. The declines were because gross farm production increased more rapidly than working assets. Net farm income per *feddan* and per person increased each year basically because of growth in net farm income. Net returns/1,000 m^3 of water declined each year but remained positive. Returns to water were L.E. 90.96 in 1979-1980 but only L.E. 6.93 in 1981-1982.

The key changes in the five continuous farms over the four years at Beni Magdul are: (1) increased use of share rental agreements during the last two years, (2) increased production of garden crops with decreases in the production of maize, forage, and other crops, (3) an increase of about 100 points in the crop intensity index, (4) nearly a L.E. 1000 increase per farm in crop productivity, (5) more than a doubling of working assets per farm, (6) livestock productivity doubled during the four years, (7) net farm income increasing from L.E. 650 in 1978-1979 to L.E. 2600 in 1981-1982, and (8) a rapidly declining return to water.

All Farm Record Keeper Farms

The data for all record keeper farms at Beni Magdul are presented in Table 7. In most of the years the farmers owned less land then they

Table 7. Selected statistics for all record keepers, Beni Magdul Site, 1978/79 to 1981/82.

	Unit	1978/79	1979/80	1980/81	1981/82
Number of Farms	Number	6	6	15	15
Land Owned	Feddan	0.83	0.39	0.83	0.98
	%	40	22	48	56
Cash Rented	Feddan	1.25	1.32	0.44	0.42
	%	60	75	25	24
Share Rented	Feddan	0.00	0.06	0.47	0.35
	%	0	3	27	20
TOTAL	Feddan	2.08	1.77	1.74	1.75
Crop Distribution	% Harv				
Broadbeans	Area	0.0	1.1	0.0	0.0
Maize	"	14.8	12.1	10.1	9.8
Wheat	"	6.8	1.9	4.2	3.1
Berseem	"	34.6	43.4	34.7	32.7
Maize Forage	"	11.7	2.9	5.2	6.6
Sunflower	"	5.9	7.4	4.7	3.8
Garden Crops[a]	"	21.3	30.4	40.8	39.9
Others[b]	"	4.9	0.8	0.3	0.1
Crop Intensity Index	Index	214	285	337	336
Crop Productivity	LE/farm	843.9	1239.1	1449.1	1388.6
Crop Expenses	"	251.5	247.4	250.1	299.9
Family Members	Number	7.50	8.17	7.87	8.47
Working Assets	LE/farm	856.5	891.9	1433.4	1738.3
Livestock Numbers					
Buffalo	Number	1.50	1.33	0.93	1.07
Cow	"	0.50	0.17	0.53	0.53
Calf	"	0.00	0.17	0.00	0.20
Donkey	"	1.17	1.17	1.07	1.33
Sheep & goats	"	0.50	0.33	0.60	1.13
Livestock Index	Buf Units	2.65	2.28	2.05	2.50
Livestock Value	LE/farm	609.8	714.7	711.2	1068.3
Livestock Productivity	"	704.3	779.4	1099.9	1122.2
Net Farm Income	"	679.0	1383.3	1700.6	1720.4
Crop Prod/LE Crop Exp	LE	3.36	5.01	5.79	4.63
Crop Prod/Feddan	"	405.7	700.1	832.8	793.5
Crop Prod/Person	"	112.5	151.7	184.1	163.9
Livestock Prod/LE Crop Prod	"	0.84	0.63	0.76	0.81
Livestock Prod/Feddan	"	338.6	440.3	632.1	641.3
Livestock Prod/Person	"	93.9	95.4	139.8	132.5
Wkg Assets/LE Gross Farm Prod	"	0.55	0.44	0.56	0.69
Net Farm Income/Feddan	"	326.4	781.5	977.4	983.1
Net Farm Income/Person	"	90.5	169.3	216.1	203.1
Net Returns/1,000 M^3 Water	"	nc	89.01	-77.65	-232.54

[a] Artichokes, tomatoes, watermelon, etc.
[b] Flax, sesame, cowpeas and grapes.

nc = not computed.

rented. During 1978-1979 and 1979-1980, land was primarily cash rented but during the last two years about half of the rented land was share rented. During the last three years the farm size remained nearly constant at about 1.75

Principal changes in the cropping patterns over the four years include decreases in the percent of harvested area in maize, forage, and other crops and the area of harvested garden crops increased from 21.3 percent in 1978-1979 to nearly 44 percent in 1981-1982. The crop intensity index rose from 214 in 1978-1979 to 336 in 1981-1982. Crop productivity increased the first three years by over L.E. 600 per farm but dropped from L.E. 1449.1 in 1980-1981 to L.E. 1368.6 in 1981-1982. Crop expenses were nearly constant the first three years at about L.E. 250 per farm but increased to L.E. 300 per farm in 1981-1982.

The number of family members per farm changed each year. The high was 8.47 in 1981-1982 and the low was 7.50 in 1978-1979. Working assets per farm, however, increased each year rising from L.E. 856.5 in 1978-1979 to L.E. 1736.3 in 1981-1982.

Livestock numbers show a reduction of about one-half buffalo per farm over the four years and a slight increase in the number of cows. The number of donkeys and sheep and goats also increased modestly. The livestock index varied between 2.65 and 2.85 during the four years but showed no consistent trend. Livestock value, livestock productivity, and net farm income all showed increasing trends over the four years. Livestock productivity increased 60 percent between 1978-1979 and 1981-1982 and net farm income increased from L.E. 679 to L.E. 1720 over the same four years.

Crop productivity per L.E. of crop expense increased from L.E. 3.36 in 1978-1979 to L.E. 5.79 in 1980-1981. These increases were associated with increases in crop productivity. In 1981-1982, this ratio declined to L.E. 4.63 because crop productivity declined and crop expenses increased. Crop productivity per and per person both increased through 1980-1981 because of increase in crop productivity but declined in 1981-1982 primarily because of a decrease in crop productivity.

Livestock production per L.E. of crop productivity declined in 1979-1980 because crop productivity increased more than livestock productivity. The increase in 1980-1981 was due to a relatively larger increase in livestock productivity and the 1981-1982 increase was associated with the decrease in crop productivity and the small

increase in livestock productivity. The steady increase in livestock productivity per *feddan* was because of increases in livestock productivity. The increases in livestock productivity per person through 1980-1981 was the result of increased livestock productivity and the decline in 1981-1982 was because of the increase in the number of family members per farm that year.

The decrease in working assets per L.E. of gross farm production in 1979-1980 was because of a relatively larger increase in livestock and crop productivity compared to working assets. The reverse situation was the case in 1980-1981 and 1981-1982 causing increases in the ratio.

Net farm income per *feddan* increased each year because of increases in net farm income and no increases in farm size. The similar pattern for net farm income per person was broken in 1981-1982 because of the substantial increase in the number of family members per farm. The net returns per thousand cubic meters of water declined each year going from L.E. 89.01 in 1979-1980 to L.E. -232.54 in 1981-1982.

The data in Table 7 supports the analysis of the five continuous farms in several important ways. The increase in share rent in 1980-1981 and 1981-1982 is consistent between the two sets of farms. The trends and patterns of all the crops grown is similar. The increase in the crop intensity index, L.E. of working assets per farm, and crop productivity follow very similar patterns compared to the five continuous farms. The pattern of livestock value and livestock productivity changes were essentially the same. Although the net farm income per farm increased for both data sets, the set of all farm record keepers shows a slower rate of increase. Most of the ratios also showed the same basic patterns. Net returns/1000 m^3 water declined significantly for both sets of farms over the four years. Thus, most of the analysis of all record keeper farms supports the analysis of the five continuous farms.

Meaqa 10 Record Keeper Farms

Meaqa 10 in Beni Magdul was elevated and lined to provide an improved gravity irrigation system. Data from record keeper farms located on *meaqa* 10 have been collected since 1978-1979 and are presented in Table 8. However, records from only one farm are available the first year and only two farms the second year. In 1980-1981 and 1981-1982 data from seven farms are reported. The extremely small number of farms is a definite weakness of the data presented for the first two years, but the larger number of farms the last two years should enhance the data reliability.

Table 8. Selected statistics for mesqa 10 farms, Beni Magdul Site, 1978/79 to 1981/82.

	Unit	1978/79	1979/80	1980/81	1981/82
Number of Farms	Number	1	2	7	7
Land Owned	Feddan	0.00	0.00	0.75	0.65
	%	0	0	51	47
Cash Rented	Feddan	1.50	1.25	0.64	0.64
	%	100	100	44	47
Share Rented	Feddan	0.00	0.00	0.07	0.08
	%	0	0	5	6
TOTAL	Feddan	1.50	1.25	1.46	1.37
Crop Distribution	% Harv				
Broadbeans	Area	0.0	4.6	0.0	0.0
Maize	"	10.3	14.2	8.9	10.8
Wheat	"	0.0	0.0	3.4	2.6
Berseem	"	36.2	28.8	24.0	21.8
Maize Forage	"	7.0	5.3	5.4	5.0
Sunflower	"	0.0	0.0	1.4	0.0
Garden Crops[a]	"	46.5	47.1	56.9	59.8
Crop Intensity Index	Index	162	288	361	378
Crop Productivity	LE/farm	630.5	865.8	1102.3	1141.3
Crop Expenses	"	276.0	249.6	300.6	300.8
Family Members	Number	8.00	8.50	7.57	7.57
Working Assets	LE/farm	348.0	386.0	1066.6	1274.0
Livestock Numbers					
Buffalo	Number	1.00	0.50	0.67	0.67
Cow	"	0.00	0.00	0.50	0.71
Calf	"	0.00	0.00	0.00	0.00
Donkey	"	1.00	1.00	1.00	1.29
Sheep & goats	"	0.00	0.00	0.33	0.57
Livestock Index	Buf Units	1.60	1.10	1.70	2.04
Livestock Value	LE/farm	320.0	244.0	495.0	1078.6
Livestock Productivity	"	419.7	254.6	1017.2	1464.3
Net Farm Income	"	540.0	650.7	1222.6	709.2
Crop Prod/LE Crop Exp	LE	2.28	3.47	3.67	3.79
Crop Prod/Feddan	"	420.3	692.6	755.0	833.1
Crop Prod/Person	"	78.8	101.9	145.6	150.8
Livestock Prod/LE Crop Prod	"	0.67	0.29	0.92	1.10
Livestock Prod/Feddan	"	279.8	203.7	696.7	915.2
Livestock Prod/Person	"	52.5	30.0	134.4	165.8
Wkg Assets/LE Gross Farm Prod	"	0.33	0.34	0.50	0.49
Net Farm Income/Feddan	"	360.0	520.6	837.4	517.7
Net Farm Income/Person	"	67.5	76.6	161.5	93.7
Net Returns/1,000 M^3 Water	"	nc	81.11	-41.99	-200.48

[a]Artichokes, tomatoes, watermelon, etc. nc = not computed.

Average farm size for the record keepers on *mesqa* 10 over the four years ranges from 1.35 to 10.21 *feddans*. The first two years of data show only cash rented land. In 1980-1981 and 1981-1982 about half of the land was owned and half was cash rented.

The cropping pattern the first two years was about 47 percent garden crops, more than one-third of the harvest area was in forage (berseem and maize forage) and the residual is maize and broadbeans. During the last two years the percentage of harvested area in garden crops increased to nearly 60 percent, forage production in between 25 to 30 percent, and the remainder was in maize, wheat, and sunflowers.

The crop intensity index increased each year, rising from 162 in 1978-1979 to 378 in 1981-1982. This was reflective of the increase in the production of garden crops. Crop productivity followed a similar pattern increasing from L.E. 630 in 1978-1979 to L.E. 1141 in 1981-1982. Crop expenses rose each year increasing from L.E. 276 in the first year to L.E. 300 in 1981-1982.

The number of family members per farm ranged from 7.57 in 1980-1981 to a maximum of 8.50 in 1981-1982. Working assets per farm increased steadily each year. In 1978-1979 working assets were L.E. 348 but in 1981-1982 working assets increased to more than L.E. 1274, an increase of 366 percent.

Livestock numbers reflect the typical pattern of each farm having a donkey plus either a buffalo or cow. Some increase in livestock numbers is shown during the final year when the livestock index rose from 1.70 to 2.04. This was the result of increased numbers in most classes of livestock during 1981-1982. The livestock value decreased L.E. 60 in 1979-1980 but increased in both of the two following years. In 1981-1982 livestock value had risen to L.E. 1078.

Livestock productivity decreased in 1979-1980 by L.E. 165 to L.E. 255 but in 1980-1981 it increased to L.E. 1017 and continued to increase the following year to L.E. 1464. Net farm income increased from L.E. 540 the first year to L.E. 1223 in 1980-1981 and then declined to L.E. 709 in 1981-1982.

During the four years, crop productivity per L.E. of crop expense increased each year rising from L.E. 2.28 in 1978-1979 to L.E. 3.79 in 1981-1982. This rise was because the increases in crop productivity were greater than the increases in crop expenses. Crop productivity per *feddan* and per person also increased each year, again because of the annual rises in crop productivity compared to the relatively stable land base and number of persons per farm.

The three livestock ratios all declined in 1979-1980 but showed sizable gains the last two years. Livestock productivity exceeded crop productivity during 1981-1982 reflecting the relatively greater importance of livestock. Livestock productivity per *feddan* increased from L.E. 280 in 1978-1979 to L.E. 915 in 1981-1982 and livestock productivity per person increased more than three times during the four years. Working assets per L.E. of gross farm production increased the first three years reflecting the more rapid increase in working assets. In 1981-1982, the ratio was about the level of the previous year. Net farm income per person and per *feddan* increased during the first three years but declined during 1981-1982. This follows the pattern of net farm income per farm because of the relatively stable levels of persons per farm and land base per farm. Net returns/1,000 m^3 of water declined each year. In 1979-1980, water returns were L.E. 81.11 but in 1981-1982 they had declined to L.E. -200.48.

Several differences are noted between the farms on *mesqa* 10 and the previous two sets of farms which are used as a standard of comparison. The *mesqa* 10 farms are about 20 percent smaller and share rent a smaller percentage of their land. The *mesqa* 10 farms have maintained their production of maize, the production of forage has declined more rapidly, and the percentage increase in the production of garden crops is less (although at a higher initial level) than the standard of comparison farms in Beni Magdul. A key comparison is the lack of net farm income growth on *mesqa* 10 during the last year compared to the standard farms. From the data presented it is not obvious why net farm income declined for *mesqa* 10 farmers but rose for the other Beni Magdul farmers. However, reduced farm size and off farm income are part of the answer.

Mesqa 6 Record Keeper Farms

Mesqa 6 in Beni Magdul also underwent interventions to enhance its irrigation system. Table 9 presents data for 1980-1981 and 1981-1982, the only years farms on *mesqa* 6 were included in the set of farms recording data. The EWUP farm recordbook was kept for three farms in 1980-1981 and four farms in 1981-1982.

Farm size increased during the two years from 1.48 to 1.92 *feddans* per farm mostly because of a change in the set of farms analyzed. More than 85 percent of the land was owned by the farmers on *mesqa* 6 with a small percentage of the land cash and share rented.

The cropping pattern made only moderate changes during the two years. The area of forage stayed nearly the same but more maize forage and

Table 9. Selected statistics for mesqa 6 farms, Beni Magdul Site, 1980/81 to 1981/82.

	Unit	1980/81	1981/82
Number of Farms	Number	3	4
Land Owned	Feddan	1.28	1.77
	%	86	92
Cash Rented	Feddan	0.06	0.04
	%	4	2
Share Rented	Feddan	0.14	0.11
	%	10	6
TOTAL	Feddan	1.48	1.92
Crop Distribution	% Harv		
Broadbeans	Area	0.0	0.0
Maize	"	11.0	7.9
Wheat	"	3.3	3.8
Berseem	"	54.2	47.7
Maize Forage	"	2.6	9.0
Sunflower	"	11.0	8.4
Garden Crops[a]	"	17.9	23.2
Crop Intensity Index	Index	343	301
Crop Productivity	LE/farm	1180.4	1337.1
Crop Expenses	"	198.9	307.8
Family Members	Number	8.00	10.25
Working Assets	LE/farm	2028.9	2244.6
Livestock Numbers			
Buffalo	Number	0.67	1.25
Cow	"	0.00	0.25
Calf	"	0.00	0.50
Donkey	"	0.67	1.00
Sheep & goats	"	0.67	2.75
Livestock Index	Buf Units	1.14	2.55
Livestock Value	LE/farm	710.7	957.5
Livestock Productivity	"	549.6	1142.5
Net Farm Income	"	1861.6	2207.4
Crop Prod/LE Crop Exp	LE	5.94	4.34
Crop Prod/Feddan	"	797.6	696.4
Crop Prod/Person	"	147.6	130.4
Livestock Prod/LE Crop Prod	"	0.47	0.85
Livestock Prod/Feddan	"	371.4	595.1
Livestock Prod/Person	"	68.7	111.5
Wkg Assets/LE Gross Farm Prod	"	1.17	0.91
Net Farm Income/Feddan	"	1257.8	1149.7
Net Farm Income/Person	"	232.7	215.4
Net Returns/1,000 M^3 Water	"	-434.39	-448.27

[a]Artichokes, tomatoes, watermelon, etc.

less berseem was produced in 1981-1982 compared to the previous year. The small decreases in the production of maize and sunflowers were reflected in 5.3 percent increase in garden crops. The percentage of garden crops in both years is relatively low compared to other Beni Magdul farms but the production of berseem and maize forage is higher. Thus, the farmers for which farm records were kept on *mesqa* 6 prefer to grow forage rather than garden crops.

The crop intensity index decreased in 1981-1982 but crop productivity and crop expenses increased. The level of crop intensity was high, exceeding 300 in both years. There was a L.E. 150 increase in crop productivity, and crop expenses increased nearly L.E. 110 to L.E. 308 in 1981-1982.

Family members per farm varied between 8.00 and 10.25 persons. Working assets were L.E. 2029 in 1980-1981 and increased nearly L.E. 215 in 1981-1982. This relatively high level of working assets was because of large investments in machinery and equipment by the *mesqa* 6 farmers.

The higher livestock numb and livestock index in 1981-1982 was primarily because of the addition of the fourth farm. Livestock value increased nearly L.E. 250 but livestock productivity more than doubled to L.E. 1142. Net farm income rose from L.E. 1662 in 1980-1981 to L.E. 2007 in 1981-1982, primarily because of the increased livestock productivity.

Crop productivity per L.E. of crop expense decreased from nearly L.E. 6.00 to L.E. 4.34 because of the relatively larger increase in crop expenses. The increases in crop productivity per farm were more than offset by the increases in number of family members per farm and land base per farm thus crop productivity per *feddan* and per person both declined.

Livestock productivity per L.E. of crop productivity increased from L.E. 0.45 in 1980-1981 to L.E. 0.85 in 1981/1982. Hence the relative importance of livestock productivity nearly doubled in 1981-1982. This is primarily due, however, to the large livestock holdings of the fourth farm which was added in 1981-1982. The large increase in livestock productivity per farm in 1981-1982 is reflected in higher livestock productivity per person and per *feddan* ratios in 1981-1982.

The major increase in livestock productivity in 1981-1982 combined with the smaller increase in crop productivity resulted in a lowering of working assets per L.E. of gross farm production from L.E. 1.17 to L.E. 0.91 even though working assets increased L.E. 200.

The gain in net farm income per farm in 1981-1982 failed to increase the net farm income per *feddan* and per person due to the increase of over 25 percent in the average farm size and the two additional family members per farm. Net returns/1,000 m^3 of water stayed nearly constant at about L.E. -400.

Some key contrasts between the farms on *mesqa* 6 and the set of five continuous farms are: (1) fifteen percent higher forage production and a 15 percent lower production of garden crops, (2) an increase in crop productivity compared to a decrease in the five continuous farms during the last two years, (3) a more rapid increase in crop expenses, (4) a higher level of working assets on *mesqa* 6 farms, (5) an increase in livestock productivity compared to a decrease for the same years on the five continuous farms, (6) substantially higher crop productivity per L.E. of crop expense, and (7) nearly constant compared to sharply declining water returns.

ABU RAYA SITE ANALYSIS

Farm records have been kept at Abu Raya for four years. Seven farms have provided continuous records since 1978-1979 and from 7 to 21 farms have kept records in any given year. During the first two years the seven continuous farms are also the seven farms in the set of all record keeper farms.

Seven Continuous Farms

Data for the seven continuous farms at Abu Raya is presented in Table 10. During the four years farm size declined from 6.56 to 5.87 *feddans* per farm. In all years at least 90 percent of the land farmed was owned by the farmers and only a small percentage was rented. The type of rental agreement has shifted from cash rent to share rent during the 1978-1979 to 1981-1982 time period.

The principal cropping pattern change has been the introduction of sugarbeets in 1980-1981. The area of sugar crops (primarily sugarbeets) increased to 7.1 percent of the harvested area in 1981-1982. The production of flax and cowpeas declined nearly an equivalent amount during the four years. Some increase in the production of garden crops is also shown between 1978-1979 and 1981-1982.

The crop intensity index remained stable between 201 and 211, but both crop productivity and crop expenses increased each year. Crop produc-

Table 10. Selected statistics for seven continued farms, Abu Raya Site, 1978/79 to 1981/82.

	Unit	1978/79	1979/80	1980/81	1981/82
Land Owned	Feddan	6.06	6.06	5.66	5.66
	%	92	94	96	96
Cash Rented	Feddan	0.50	0.42	0.21	0.00
	%	8	6	4	0
Share Rented	Feddan	0.00	0.00	0.00	0.21
	%	0	0	0	4
TOTAL	Feddan	6.56	6.48	5.87	5.87
Crop Distribution	% Harv				
Broadbeans	Area	1.2	2.0	1.0	3.2
Maize	"	5.8	7.3	5.2	6.2
Cotton	"	15.8	13.5	14.4	10.6
Wheat	"	13.3	13.4	12.2	12.8
Berseem	"	25.2	30.7	28.5	27.9
Maize Forage	"	3.2	0.9	2.1	0.6
Rice	"	24.9	22.5	24.2	26.7
Flax & Cowpeas	"	9.2	3.1	2.1	0.0
Sugarbeets & Sugarcane	"	0.0	0.0	3.7	7.1
Garden Crops[a]	"	1.4	6.6	6.6	4.9
Crop Intensity Index	Index	201	204	211	206
Crop Productivity	LE/farm	1989.7	2105.8	2641.6	2867.4
Crop Expenses	"	496.6	557.3	635.4	731.4
Family Members	Number	9.14	9.00	8.43	6.71
Working Assets	LE/farm	1505.9	1638.2	2020.2	2527.9
Livestock Numbers					
Buffalo	Number	1.43	1.57	1.43	1.29
Cow	"	1.29	1.57	1.14	1.71
Calf	"	1.71	1.57	1.86	1.14
Donkey	"	1.71	2.29	1.86	1.57
Sheep & goats	"	0.00	0.14	0.29	0.14
Livestock Index	Buf Units	4.26	4.92	4.32	4.13
Livestock Value	LE/farm	804.7	1166.7	1126.3	1624.1
Livestock Productivity	"	828.2	924.4	919.6	1045.5
Net Farm Income	"	1462.9	1950.2	2224.8	2460.9
Crop Prod/LE Crop Exp	LE	4.01	3.78	4.16	3.92
Crop Prod/Feddan	"	303.3	325.0	450.0	488.5
Crop Prod/Person	"	217.7	234.0	313.4	427.3
Livestock Prod/LE Crop Prod	"	0.42	0.44	0.35	0.36
Livestock Prod/Feddan	"	126.2	142.7	156.7	178.1
Livestock Prod/Person	"	90.6	102.7	109.1	155.8
Wkg Assets/LE Gross Farm Prod	"	0.53	0.54	0.57	0.65
Net Farm Income/Feddan	"	223.0	301.0	379.0	419.2
Net Farm Income/Person	"	160.1	216.7	263.9	366.8
Net Returns/1,000 M^3 Water	"	nc	31.66	34.33	26.08

[a] Artichokes, tomatoes, watermelon, etc. nc = not computed.

tivity increased from L.E. 1990 to L.E. 2867 over the four years while crop expenses increased over L.E. 200 from L.E. 497 to L.E. 731 during the same period.

The number of family members on the seven continuous farms decreased each year, dropping from 9.14 in 1978-1979 to 8.71 persons per farm in 1981-1982. It should be noted, however, that two-thirds of this decrease occurred on one farm in 1981-1982. Thus, the per person ratios must be carefully interpreted. Working assets per farm increased over L.E. 1000 during the four years to L.E. 2528 in 1981-1982. Livestock value per farm doubled during the four years but livestock productivity only increased L.E. 218 going from L.E. 828 to L.E. 1046 in four years. Net farm income increased steadily during the four years reaching L.E. 2461 in 1981-1982. Crop productivity per L.E. of crop expense remained nearly constant over the four years because both crop productivity and crop expenses increased at about the same rate. Crop productivity per *feddan* increased each year rising from L.E. 303 to L.E. 488 during the four years. Crop productivity per person followed the pattern of growth shown by crop productivity per *feddan*.

Although livestock productivity per L.E. of crop productivity showed no trend, both livestock productivity per person and per *feddan* increased steadily. Working assets per L.E. of gross farm production increased each year rising from 0.53 in 1978-1979 to 0.65 in 1981-1982. Net farm income per person and per *feddan* both increased steadily and consistently over the four year reflecting the consistent increase in net farm income per farm. Net returns/1,000 m^3 of water was relatively constant varying from L.E. 26.08 in 1981-1982 to L.E. 34.33 in 1980-1981.

All Record Keeper Farms

During the first two years the seven continuous farms were also the set of all record keeper farms at Abu Raya. In 1980-1981 the number of farm records was increased to 15 and 21 farm - kept records in 1981-1982. Data from the set of all record keeper farms is presented in Table 11.

From 92 to 97 percent of the land base was owned with a small percent of the land cash or share rented. Farm size compared closely to the seven continued farms and was always at least six *feddans*.

The changes in the cropping pattern are supportive of those shown by the seven continuous farms. Small decreases in the percent of harvested area for cotton, wheat, and flax and cowpeas are shown.

Table 11. Selected statistics for all record keepers, Abu Raya Site, 1978/79 to 1981/82.

	Unit	1978/79	1979/80	1980/81	1981/82
Number of Farms	Number	7	7	15	21
Land Owned	Feddan	6.06	6.06	5.69	6.00
	%	92	94	94	97
Cash Rented	Feddan	0.50	0.42	0.22	0.09
	%	8	6	4	1
Share Rented	Feddan	0.00	0.00	0.13	0.12
	%	0	0	2	2
TOTAL	Feddan	6.56	6.48	6.04	6.21
Crop Distribution	% Harv				
Broadbeans	Area	1.2	2.0	2.2	1.6
Maize	"	5.8	7.3	5.0	5.8
Cotton	"	15.8	13.5	13.7	10.4
Wheat	"	13.3	13.4	12.9	11.5
Berseem	"	25.2	30.7	28.7	27.4
Maize Forage	"	3.2	0.9	1.7	0.8
Rice	"	24.9	22.5	25.1	25.3
Flax & Cowpeas	"	9.2	3.1	0.9	2.7
Sugarbeets & Sugarcane	"	0.0	0.0	5.6	9.0
Garden Crops[a]	"	1.4	6.6	4.2	5.5
Crop Intensity Index	Index	201	201	213	182
Crop Productivity	LE/farm	1989.7	2105.8	2510.0	2550.5
Crop Expenses	"	496.6	557.3	679.5	633.1
Family Members	Number	9.14	9.00	8.53	7.81
Working Assets	LE/farm	1505.9	1638.2	2240.5	2653.9
Livestock Numbers					
Buffalo	Number	1.43	1.57	1.07	1.33
Cow	"	1.29	1.57	1.07	1.43
Calf	"	1.71	1.57	2.00	1.05
Donkey	"	1.71	2.29	1.47	1.48
Sheep & goats	"	0.00	0.14	0.60	0.43
Livestock Index	Buf Units	4.26	4.92	3.77	3.88
Livestock Value	LE/farm	804.7	1166.7	1182.8	1582.8
Livestock Productivity	"	828.2	924.4	1039.6	1070.3
Net Farm Income	"	1462.9	1950.2	1861.0	2326.2
Crop Prod/LE Crop Exp	LE	4.01	3.78	3.69	4.03
Crop Prod/Feddan	"	303.3	325.0	415.6	410.7
Crop Prod/Person	"	217.7	234.0	294.3	326.6
Livestock Prod/LE Crop Prod	"	0.42	0.44	0.41	0.42
Livestock Prod/Feddan	"	126.2	142.7	172.1	172.4
Livestock Prod/Person	"	90.6	102.7	121.9	137.0
Wkg Assets/LE Gross Farm Prod	"	0.53	0.54	0.63	0.73
Net Farm Income/Feddan	"	223.0	301.6	308.1	374.6
Net Farm Income/Person	"	160.1	216.7	218.2	297.8
Net Returns/1,000 M^3 Water	"	nc	31.66	18.76	-0.27

[a]Artichokes, tomatoes, watermelon, etc. nc = not computed.

Increases in the production of sugar crops, particularly since the establishment of the sugarbeet factory in 1980-1981, is also shown. The other crops have very similar harvested area patterns when compared to the seven continuous farms.

The crop intensity index for all record keeper farms was somewhat lower in 1981-1982 (182 vs. 206) compared to the seven continuous farms. Crop productivity and crop expenses were also somewhat lower in the last year compared to the seven continuous farms. In fact, crop expenses actually declined in 1981-1982 compared to the previous year for the set of all record keeper farms compared to an increase for the seven continuous farms.

The trend in family members per farm is consistent between the two sets of farms at Abu Raya, both show declines over the four years. The decline in 1981-1982 for the set of all record keeper farms, however, was about one person less than for the seven continued farms. Working assets per farm show consistent increases over the four years for both sets of farms.

Livestock numbers for the set of all record keeper farms are a little lower than those for the seven continued farms. Specifically the larger animals were fewer for the set of all record keepers and the numbers of sheep and goats were a little higher when compared to the set of seven continuous farms.

The livestock index is somewhat lower the last two years for the set of all record keeper farms, about one-third of a buffalo unit lower. Livestock value consistently increased over the four years for both farm sets and livestock productivity followed a similar pattern. Net farm income increased from L.E. 1463 to L.E. 2326 over the four years for the set of all record keeper farms and a similar increase of nearly L.E. 1100 is reported for the seven continuous farms.

The pattern over the four years of crop productivity per L.E. of crop expense and crop productivity per person was similar for the two sets of farms. However, crop productivity per person for the set of all record keeper farms was about L.E. 100 lower in 1981-1982. Crop productivity per *feddan* for the set of all record keeper farms was lower in both of the last two years because of larger farm size and less rapid crop productivity growth.

Livestock productivity per L.E. of crop productivity, per *feddan* and per person were all higher in 1980-1981 for the set of all record keeper farms compared to the seven continuous farms. The set of all

record keeper farms also shows nearly no growth during the last year whereas the seven continuous farms show increases in these ratios bringing them nearly equal or above the level of all record keeper farms.

Working assets per L.E. of gross farm production increased more rapidly for the set of all record keeper farms during the last two years. Net farm income per *feddan* and per person both varied less rapidly during 1980-1981 and 1981-1982 when compared to the set of seven continuous farms. The slower growth in the net farm income ratios is primarily because of the lack of a decrease in farm size for the set of all record keeper farms and the fewer family members per farm in 1981-1982 for the set of all record keeper farms. Net returns/1,000 m^3 of water consistently declined for the set of all record keepers declining from L.E. 31.66 in 1979-1980 to L.E. -0.27 in 1981-1982. Water returns for the seven continued farms remained stable at about L.E. 30.00.

The data from all record keeper farms confirm the analysis of the seven continuous farms in several important ways. Farm size and proportion of land owned is consistent. The cropping patterns are similar but crop expenses are shown not to increase in 1981-1982 for the set of all record keeper farms. The numbers of livestock and the livestock index is somewhat smaller for the set of all record keeper farms. The set of all record keeper farms does not confirm the growth in crop productivity per *feddan* shown in 1981-1982 by the seven continuous farms. Net farm income increases per *feddan* and per person shown in the seven continuous farms are confirmed by the set of all record keeper farms, but not at the levels reported by the seven continuous farms. Finally, water returns show more downward pressure for the set of all farm record keepers.

SUMMARY AND CONCLUSIONS

The purpose of this report is to summarize the EWUP farm records for the period 1978-1979 through 1981-1982. Data is presented for each of the three sites for (1) that set of farms which have provided data through this time period, (2) the set of all record keeper farms available each year, and (3) farms that are directly associated with a major EWUP intervention. Information on farm size and tenure, cropping patterns, crop intensity, crop productivity and crop expenses are presented. Also shown are data on number of family members, working assets, livestock numbers by species, a livestock index,

livestock value, livestock productivity, and net farm income. Ratios are developed for crop productivity, livestock productivity, working assets, net farm income and net returns/1,000 m^3 water.

The report has focused upon a descriptive analysis, thus the role of the factors that have caused the changes during the record keeping period has not been emphasized. Neither has there been a focus upon comparing the farms of the different EWUP sites.

Some consistent trends in the analysis are: (1) the importance of share rental agreements for land is increasing, (2) cropping patterns are not static (in the Mansuriya area the production of garden crops is high and increasing, sugarbeets have entered the crop rotation of the Abu Raya farmers since the opening of the sugarbeet factory in 1980-1981, and the soybean area is increasing at Abyuha), (3) typically crop productivity and livestock productivity have increased over time but the source of this increase is most likely a combination of price increases, enterprise changes, and more intensive input use, (4) working assets, livestock value and net farm income have typically increased but a majority of this rise may be because of price inflation, (5) in most cases the relative importance of livestock has increased, and (5) net returns/1,000 m^3 of water typically has decreased and in several situations is negative.

It must be noted, however, that water returns are computed as a residual factor payment and negative water returns may be caused by (1) "over-paying" other resource factors or (2) low farm incomes. The negative returns to water should not be interpreted as meaning that water has a negative value in the production process.

REFERENCES

Egyptian and American Field Team, "Problem Identification Report for Mansuriya Study Area, October 1977 to October 1978". EWUP Tech. Kept. No.1, Cairo, A.R.E. 1979.

Haider, M. and Farouk Abdel Al. "Kafr El-Sheikh Farm Management Survey, crop enterprise Budgets, and Profitability Analysis". EWUP Tech. Kept. No. 11, Cairo, A.R.E. 1982.

Abdel Al, Farouk and Melvin D. Skold, "Farm Record Summary and Analysis for Study Cases at Abu Raya and Mansuriya Sites: 1978-1979", EWUP Technical Report No. 8, Egypt Water Use and Management Project, Cairo, A.R.E., July 1981.

Abdel Al, Farouk and Melvin D. Skold, "Farm Record Summary and Analysis for Study Cases at Abyuha, Mansuriya and Abu Raya Sites, 1979-1980", EWUP Technical Report No. 23, Egypt Water Use and Management Project, Cairo, A.E.R., April 1982.

EWUP Economics Team, "Farm Record Summary and Analysis for Study Cases at Abyuha, Mansuriya and Abu Raya Sites: 1980-1981", EWUP DWP No. 96, June 1982, Unpublished.

EWUP Economics Team, "Farm Record Summary and Analysis for Study cases at Abyuha, Mansuriya and Abu Raya Sites: 1981-1982", EWUP DWP No. 102, March 1983, Unpublished.

Abdel Al, Farouk and David R. Martella, "The Role of Farm Records in the Egypt Water Use and Management Project" EWUP Technical Report No. 30, Egypt Water Use and Management Project, Cairo, A.R.E., August 1982.

Egyptian and American Field Team, "Problem Identification Report for Kafr El Sheikh Study Area, July, 1980", EWUP Technical Report No.6, Egypt Water Use and Management Project, Cairo, A.R.E., July 1980.

APPENDICES

APPENDIX A

Appendix Table 1. Average water delivered per feddan and labor requirement per feddan by crop and by EWUP site.

Site	Crop	Water Delivered (Cubic Meters)	Labor (Man Hours)
Abueha	Berseem	3300	261
	Wheat	2650	211
	Broadbeans	2827	338
	Cotton	3740	540
	Maize	3474	258
	Soybean	2500	375
El Hammami	Maize	2103	212
	Wheat	2520	301
	Berseem	4943	460
	Peanuts	3150	245
	Sesame	2200	321
	Sunflower	2478	235
	Garden Crops[a]	3242	544
Beni Magdul	Maize	2417	253
	Wheat	1270	84
	Berseem	4054	685
	Garden Crops[b]	2695	501
Abu Raya[c]	Wheat	2233	98
	Berseem	4033	106
	Broadbeans	2373	153
	Maize	3164	184
	Cotton	5763	345
	Rice	6594	226
	Flax	2878	167
	Sugarbeets	3051	210

[a]Limited to eggplant, cabbage and squash.

[b]Limited to eggplant and cabbage.

[c]1979/80 enterprise budget study, all other data is 1980/81.

APPENDIX B

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

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

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

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

EGYPTIAN UNITS OF FIELD CROPS

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

EGYPTIAN FARMING AND IRRIGATION TERMS

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

EGYPT WATER USE AND MANAGEMENT PROJECT

PROJECT TECHNICAL REPORTS

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

NO.	TITLE	AUTHOR
PTR#13	The Role of Rural Sociologists in an Interdisciplinary, Action-Oriented Project: An Egyptian Case Study.	J. Layton and M. Sallam
PTR#14	Administering an Interdisciplinary Project: Some Fundamental Assumptions Upon Which to Build.	J. B. Mayfield & M. Naguib
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