Mid Project Report
Volume III

Appendix B
Staff Papers

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Staff Paper #1

SUMMARY OF EGYPT WATER USE AND MANAGEMENT PROJECT WITH ITS ACCOMPLISHMENTS

R. H. Brooks and H. Wahby

February, 1980

INTRODUCTION

Egypt Water Use and Management Project is a research and demonstration program designed to assist in improving existing management practices of irrigated agriculture in Egypt. Central to project activities is the accomplishment of significant social and economic progress for the Egyptian farmers. Of specific concern to EWUP is the improved management of water. soil, capital, and human resources used in agricultural production. The second component of the project is to develop and improve a data base concerning quantity and quality of water entering and leaving an irrigation district or its subcatchment areas. This data will be developed to assist in the management decisions regarding water delivery and drainage for the specified areas. The project has been organized to maximize technical input and support to accomplish its objectives. A senior staff of American specialists working with a senior staff of Egyptian specialists provide the necessary technical expertise to carry out the project objectives in three project pilot areas in Egypt.

Even though the Egypt Water Use and Management Project (EWUP) was designed to assist in improving existing water management practices of agriculture in Egypt, it was realized in the formulation of the project that management of resources used in modern irrigated agricultural systems must be considered and accomplished for a permanent agriculture in Egypt. The project is structured to function in an interdisciplinary mode to formulate and demonstrate viable on-farm management alternatives for the typical Egyptian farmer. Thus, the Egypt Water Use and Management Project constitutes a new strategy for irrigation development both in approach to project activities and staffing. The EWUP team includes agronomists, engineers, economists and sociologists from the United States and Egypt. The team works with the Egyptian farmer at the field level to find out what is being done and what viable alternatives exist for improving on-farm management practices. The basic procedure that has been followed is first to identify problems quantitatively, second, search for appropriate solutions and finally to demonstrate by use of large pilot areas the viable solutions that may be defused throughout the country on a large scale basis.

PROJECT ACCOMPLISHMENTS

Problems Identified

The project is obviously concerned about present agronomic practices and water use practices on individual farms. With respect to water use on the farm one of the most significant findings has been with respect to excessive use of water for production. The project has learned that farmers over irrigate for a variety of reasons given below:

Field Geometry - Farmers irrigated by using small basins ranging from sizes of $8m^2$ to 140 m^2. These basins are used irrespective of crop, topography, and size of irrigation stream. Internal channels for distributing water may consume 8 to 14% of the field area.

Infiltration Rate - Quantities of irrigation water are applied without respect to infiltration rate. Early in the irrigation of individual crops, the infiltration rate is higher than later. Therefore excessive applications of water occur early in the season.

Topography or Slope - Small basin units are irrigated as if the slope is zero or level. Water is applied until the highest elevated parts of the fields are unindated. Elevations variations within a basin may range from

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5 cm to 20 cm.

Water Supply Rate - Variable flow rates from the sakia or tambour combined with variable area irrigated limit the farmers ability to apply a specific amount of water to the field. Sakia flow rates range from 10 to 230 m^3/hr while the tambour ranges from 18 to 65 m^3/hr. The maximum flow rate is frequently twice the mean.

Rotation System - The rotation system applied by the Ministry of Irrigation influences the farmer to irrigate at every rotation turn rather than by crop needs or growth stages. The farmer tends to irrigate whenever water is available especially during the summer when he is not sure of crop needs and weather conditions. Often downstream users suffer from lack of water because upstream users control the flow downstream by irrigating when it is not necessary.

Water Table - In many areas, water tables are close or remain within the root zone during the growing season. Water deliveries or irrigations do not take into account the contribution from the water table for plant growth. Irrigation water is applied without respect to the available storage capacity in the root zone.

These factors mentioned above are generally valid for all irrigated regions in Egypt, however there are some additional unique factors related to rice production in the lower delta. Considerable additional quantities of water are required for paddy rice production over that required for most other crops. Much of this additional water is needed for puddling soils and to maintain continuous flood levels in the paddies. Also excessive quantities of water flow directly to the drains from rice fields either because of poor dike construction or because fields are drained periodically. Data from Kafr El Sheikh show that 44% of the irrigations of rice paddys occur every 2 days and 88% did not exceed an irrigation interval of 6 days. The rotation of

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water there is on 4 days and off 4 days.

Excessive Quantities of Water in System

This high occurrence of irrigation frequency for rice mentioned above coupled with the fact that night irrigation seldom if every occurs suggest that excessive quantitites of water are flowing in the irrigation system. Observations show that a high percentage of farmers irrigate during the off-period. Large quantities of water must be delivered to fill over-excavated cross sections of the delivery system. Canal storage is often sufficient to carry on irrigation continuously. The problem of leaky head gates for water control compounds the problem.

Since night irrigation does not occur, this suggests that there is sufficient water during the daylight hours to supply water for all areas inspite of the fact that the system was designed for 24 hour operation.

On the other hand, the tails of meskas and branch canals often suffer because of water shortage due to weeds siltation and seepage in the canals and the lack of cooperation among farmers in the use of water.

Sociological Factors

The lack of social organization among farmers, formal or voluntary, causes communication problems and does not promote cooperation among farmers with respect to water use. The problem mentioned above regarding water shortages at the ends of canals and meskas could largely be overcome with improved communications and improved respect for others.

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Agronomic Problems

Egyptian farmers are intelligent and resourceful but often do not have the benefit of modern research and technology available for improved agronomic practices. Much of the research needed to improve agronomic practices has been done here in Egypt. Because of tradition and poor extension communication the farmer suffers with reduced yields and crop losses.

Some poor agronomic practices include:

Low Density of Plants - The number of plants per unit area is low as percent of optimum. In the case of corn in the Mansouria area, stands were from 24 to 49 percent below optimum. The reason for these low plant stand densities are not particularly clear but may include:

Poor seed bed preparation
Poor irrigation practice during germination
Poor seed quality

Date of Planting - This factor often effects yields of some crops, ie, cotton. For instance, farmers in Minya have a fixed crop rotation where beans are followed by cotton. Beans often yield a higher price than cotton so the farmer delays cotton planting until after the bean harvest.

Soil Nutrients - Some soils are deficient in macro and micro nutrients. The farmers have no means of determining what fertilizers are required and the quantities for optimal production. The micro nutrient, zinc, is often deficient and limits production.

On the other hand, in the Mansouria area the farmers apply nitrogenous fertilizers in amounts that exceed recommended rates. The fertilizer recommendations are based on an area wide recommendations. A soil

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fertility survey revealed that the development of a soil testing program on basin soil sampling must be considered.

Salinity and Sodicity Management - Salinity and Sodicity in Egyptian soils are more or less a constraint to production depending upon the area considered in Egypt. However, the largest area affected lies in the lower delta. Rice production is often used to control salinity. Many farmers are not aware of management practices needed to improve sodicity of their soils. Many soils in the lower delta are being further reclaimed by adding subsoil drainage and subsoil tillage together with the additon of gypsum. This is largely accomplished by the Ministries of Irrigation, Agriculture, and Land Reclamation.

A question that should be addressed by the project during the second phase of "search for solution" deals with the economics of land drainage and reclaiming soils to the depth of newly installed drains in the lower delta regions. By reclaiming the soil profile to the depth of the drains, the soil permeability will increase with a resulting increase in the flow of water to the drains.

During the production of low-land rice, it is likely that the farmers will be unable to maintain ponded conditions on their rice fields unless drains are plugged during the rice growing period. Ofcourse drainage is needed for other crops in rotation, but can the water table during the off-rice growing season be controlled through surface water management? If the answer is yes, installation of drains should perhaps be on a low priority. The answer to this question is urgently needed because of the increased land drainage activity in the lower delta.

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Economic Problems

There are many economic factors that control the Egyptian farmers ability to do a better job in managing his resources such as water and soil. Obviously if a farmer cannot accumulate reserves for improvement and management of his system, it will be difficult for him to make changes that may be suggested to him. Some of the reasons for his present inability to accumulate reserves are the following:

Low Prices for Products - The national policies of the Government of Egypt regarding domestic food prices, import taxes and government finance result in low prices for many crops produced by Egyptian farmers. Although there are compelling reasons for these policies it should be recognized that they starve the agricultural industry of development capital. Egyptian farmers receive only a fraction of the international price for some crops.

Excessive Cost of Lifting Water - The determination of water lifting costs is based upon the assumption that human and animal power has a market value. Our studies indicate that human power has a value of LE 0.15 per hour and animals about LE 0.32 per hour when turning a medium sized sakia. Lifting water with a tambour costs three times more than with a diesel pump or a sakia about two times more.

Excessive Slack Time in Crop Rotation - The average slack time in crop rotation for Mansouria is about 16 percent or 58 days per year. Similar times are observed in other areas. Often this non productive time is due to tradition or non capital intensive methods.

Lack of Data for Farm Planning - Farmers lack the data needed for farm planning and management. They have no farm records and must recall past performance of input-output relationships from memory. Substantial

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increases in productivity and net farm income could result from farm records used for planning and budgeting.

PRESENT PROJECT ACTIVITIES TO SOLVE PROBLEMS

Proper on-farm water management by the farmer will allow Egypt to maximize its water resources and agricultural outputs. But, how to teach and convince the farmer that he must do a better job is difficult, to say the least. It is obvious that he must be convinced through demonstration and through the use of his own hands due to his lack of confidence in officials and cooperative extension personnel. Several demonstrations or field trials have been taking place at the various project sites since the project implementation. These field trials are briefly described below. Most have not been evaluated or selected to solve problems on a large scale basis at this time. But at least, the reader will be appraised of the possible solutions being contemplated.

Improved Farm Layout for Water Distribution

Land leveling has occurred on many field sites for purposes of redesigning the field irrigation system. Small basins have been eliminated and replaced with long borders of width to accomodate stream size. Farmers who have accepted this new farm layout are pleased and satisfied that irrigations can be accomplished more easily and with minimum labor inputs.

Frequency of Irrigation

Some instruments combined with soil sampling have been used as an indicator of "when" to irrigate. Where water is available on a demand basis farmers have less difficulty in accepting this idea than where water is available on a rotation basis only. However, progress is being made

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and it will be proven to the farmers that irrigating according to soil profile storage and plant needs are the most efficient irrigation procedures.

Modified Water Delivery on Rotation and Demand Basis

Since 1977, the Beni Magdoul Canal in the El Mansouria irrigation district has been on a continuous flow basis. Irrigation on selected fields have been monitored since that time in order to compare water used by farmers for two different types of delivery systems.

This canal was lined also to reduce and control its cross section. In addition several "meskas" have been lined to control their cross section and to insure delivery of water at the ends by reducing or eliminating seepage.

Some "meskas" are presently being considered to deliver water on a semi-demand basis. Water scheduling on a "meska" basis is complicated and requires some computer modeling to select the best alternatives. It appears that water scheduling among "meskas" may have greater promise and is also being considered as a method to allow water to be used when it is needed.

Water Delivery by Pipe Line System

In an attempt to eliminate seepage from branch canals in sandy soils and provide water to farmers on a regular basis where it was formerly in short supply, a buried pipe line water delivery system is presently being designed for the El Hammami distributor in the El Mansouria irrigation district. Water scheduling will be tried and operation and maintenance charges will be attempted to be levied against the farmers for this system. The system will operate as a low pressure system and no water lifting by individual farmers is required. Hopefully this trial will answer several

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questions regarding the farmers willingness to change, ie, will he cooperate with others in the use of water?, will he pay for the operation and use of a non-lift system?, and will he use less water on a demand basis compared to his present use?

Improved Agronomic Practices

Many field trials have occurred with farmers to improve their agronomic practices by improving seed bed preparation and plant stands by use of agricultural machinery. Considerable efforts have been made in working with the farmers to demonstrate the affects of improved soil fertility and methods of controlling insects. The confidence that is being built between the farmer and project personnel with respect to agronomic practices will have a large payoff when we ask the farmers to cooperate with us on large pilot areas in the future. Because of increased yields and quality of products produced from their farms by following EWUP practices, the farmers are willing to follow our recommendations with respect to the more difficult requests such as scheduling and operation and maintenance cost sharing.

In Kafr El Sheikh, ineffective surface drains have been eliminated to increase land area in production and water application efficiencies have been increased to reduce deep seepage and water table build up. Salinity is being monitored to observe possible build-up due to increased irrigation efficiency and elimination of surface drains.

Irrigation Water Control Structures

To monitor and measure water flowing in subcatchments of irrigation districts, continuous measurements of discharge are being measured at permanent water measuring structures. During winter closure periods, many water measuring structures have been built in the three project areas. Data is being collected to determine the quantities of water delivered to selected areas. Also, measurement of quantities of water dis-

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charged into surface drains is being measured. These measurements when combined with evapotranspiration and groundwater components will provide the project with present water budgets. These data are being compared with the quantities actually needed.

Economic Analysis and Farm Records

Cost enterprise data have been prepared for 15 to 20 different crops. These data show net return after considering all fixed and variable costs. The information is valuable for planning at all levels including the farmer himself.

Farm records are being maintained with the assistance of EWUP staff at all field locations for many farmers. Farmers are beginning to see the value of these records in making future decisions regarding management alternatives.

Draft papers have been prepared on:

1. "Procedures for Calculating the Cost of Lifting Water for Irrigation in Egypt"
2. "Calculation of Machinery Costs for Egyptian Conditions"
3. "Economic Costs of Water Shortage Along Branch Canals"

Sociological Factors

Data have been accumulated and reports written regarding the Egyptian farmers perceptions of alternative extension strategies and their cooperation in rural development. Other documents dealing with the social dimensions of Egyptian irrigation patterns is also in progress.

Training

Considerable project time and effort is being made in training project and ministry personnel in water management. For the past three summers, 1977-1979, short courses have been held in Fort Collins, Colorado, at

Colorado Sate Univeristy dealing with on-farm water management. For the summer of 1980, the short course will be held in Egypt for the first time. Project and ministry personnel have benefited also from field tours in the U.S. designed to acquaint the participants with modern water delivery systems and management practices in the U.S. More than 50 selected persons have participated in both types of training.

CONCLUSIONS

The Egyptian Water Use and Management Project has identified many constraints in Egyptian Irrigated Agriculture. Many of these are presently being addressed by implementing field trials to solve some of the problems identified. In the final phase of project activity, the most appropriate solutions that have been tried will be assembled for inclusion into a large pilot project in each of the field locations. The analysis and evaluation of such pilot projects will serve as a basis for national improvement and policy making regarding irrigated agriculture in Egypt.

Staff Paper #2

A PRELIMINARY COMPARISON OF TWO CROPPING SCHEMES AT ABUEHA, MINYA GOVERNORATE BROADBEANS - FENUGREEK - COTTON VS BERSEEM - COTTON

Elia Sorial and Gene Quenemoen

March, 1980

The area served by the Abueha Cooperative has an annual cotton allotment of 575 feddans. Technically the farmers are required to plant cotton seeds before March 10. Those who comply with this requirement usually raise berseem as a winter crop. They take the last cutting in February and prepare the land for planting cotton before March 10.

Many farmers plant broadbeans, often intercropped with fenugreek, in place of berseem. Broadbeans mature in April consequently delaying the planting date for cotton.

It is generally believed the yield of cotton is retarded if its planting date is delayed past March 10. Some studies show planting cotton in April reduces yields as much as 33 percent. Farmers at Abueha do not believe this. They say the yield of cotton is higher after broadbeans than after berseem.

The following crop enterprise budgets are based on production cost data reported by farmers at Abueha. Cotton yields are reduced from 6 kentars per feddan following berseem to 4.9 kentars per feddan following broadbeans-fenugreek to account for the later seeding date.

The costs are intended to represent the amount paid by the farmers for machines, materials and labor. Inputs supplied by a farmer such as his own labor, management, and land are charged at their estimated opportunity cost rate. Therefore the income available to a farmer for either cropping scheme may exceed "income above all costs," if a farmer supplied his own labor, management and capital.

The items listed under "variable costs" reflect the technology employed in producing each crop. They also reflect the market rate for labor at the season during which they are employed. For example the labor cost for picking early cotton, in September, is lower than for late cotton which is picked in October. Peak labor demands occur in October which causes the market wage rate to increase.

The difference in "return above all costs" is L.E. 23.07 in favor of broadbeans-fenugreek-cotton. If the farmers are right about yields on late cotton being as good as early cotton, then the difference in income will be more than L.E. 60 per feddan in favor of broadbeans-fenugreek-cotton.

The estimated water requirements for the two alternative schemes are based on data from experiments at Malawi Research Station, 35 kilometers south of Abueha. Careful measurement should be done in order to verify these estimates. If they can be verified it appears the most profitable crop is also the least demanding of water.

CROP ENTERPRISE COST STUDY *

COTTON-BERSEEM, ABUEHA, MINYA CUT

Prepared by: Elia Serial & Quenemeen
Identifier Code: [illegible]
Date Prepared: February 28,1980

EGYPT WATER USE MANAGEMENT PROJECT

Item	Unit	Number of Units	Price or Value per unit L.E.	Total income or Costs L.E.
Income				
Berseem, 1st cut (1)	kerat cut(2)	24.0	2.000	48.00
Berseem, 2nd cut	kerat cut	24.0	2.500	60.00
Cotton, unginned	kantar	6.0	38.000	228.00
Cotton stalks	camel load	4.0	1.500	6.00
Total Income				342.00
Variable Costs				
BERSEEM		0.0	0.000	0.00
Berseem seed (3)	kilo	2.0	5.000	10.00
Labor to spread seeds	man hour	1.0	0.100	0.10
Irrigation by gravity 6x	man hour	30.0	0.100	3.00
Super-phos (0-15-0) free mkt	kg	150.0	0.050	7.50
Spread super-phosphate	man hour	2.0	0.100	0.20
COTTON		0.0	0.000	0.00
Organic fertilizer (4)	cubic meter	20.0	0.600	12.00
Labor to spread organic fert	man hour	10.0	0.100	1.00
Plowing by tractor 2x	feddan	1.0	6.000	6.00
Leveling by tractor	feddan	1.0	1.000	1.00
Furrowing by animal, 12/kasaba	feddan	1.0	2.500	2.50
Make ditches & ridges	man hour	20.0	0.100	2.00
Irrigation before planting	man hour	5.0	0.100	0.50
Irrigation by gravity 10x	man hour	50.0	0.100	5.00
Hoeing before planting	man hour	50.0	0.100	5.00
Plant cotton (5)	man hour	20.0	0.100	2.00
Cotton seeds	kilo	6.0	0.255	1.53
Hoeing 3x	man hour	150.0	0.100	15.00
Thinning	boy hour	50.0	0.050	2.50
Super phos.(0-15-0) from coop.	kg	100.0	0.027	2.70
Ammonium nitrate (31-0-0)	kg	200.0	0.051	10.20
Spread fertilizer	man hour	5.0	0.100	0.50
Insect control by coop	feddan	1.0	21.800	21.80
Gather cotton (6)	pound	2126.0	0.007	14.88
Transport cotton to village	camel load	3.0	0.700	2.10
Cut stalks	man hour	25.0	0.100	2.50
Transport stalks to village	camel load	4.0	0.500	2.00
Total Variable Costs				133.51
Return Above Variable Costs				208.49
Fixed Costs				
Rent	month	12.0	5.630	67.56
Management	month	12.0	1.000	12.00
Total Fixed Costs				79.56
Grand Total Costs				213.07
Return Above All Costs				128.93

FOOTNOTES:

* This study for an area of one feddan
(1) Previous crop maize or sunflower.
(2) Berseem is priced standing in the field.
(3) Planting date is October 1. Harvest will end February 15.
(4) Organic fertilizer is transported from the village. Cost includes labor and animals for transport.
(5) Planting date is March 10. Harvesting will begin September 5.
(6) Picking labor is paid L.E. 0.007 per pound. Labor cost increases later in September.

	LABOR DISTRIBUTION			WATER DISTRIBUTION, CU METERS			
	Man Hours	Woman Hours	Boy/Girl Hours	First Irrig.	Second Irrig.	Third Irrig.	Fourth Irrig.
October	13	0	0	300	200	0	0
November	10	0	0	200	200	0	0
December	5	0	0	200	0	0	0
January	0	0	0	0	0	0	0
February	18	0	40	200	0	0	0
March	103	0	0	400	0	0	0
April	57	0	50	350	0	0	0
May	110	0	90	350	350	0	0
June	10	0	180	350	350	0	0
July	13	0	150	350	350	0	0
August	10	0	0	350	350	0	0
September	32	212	212	0	0	0	0
Total	381	212	722	Total Water Applied=	4850 cu meters		

FOOTNOTES:

(1) Water requirements estimated from Malawi Agricultural Research Station data. The amounts have not been measured by EWUP.

CROP ENTERPRISE COST STUDY *

COTTON-BROADBEAN-FENUGREEK, ABUEHA, MINYA GOV

Prepared by: Elie Serial & Quenemeen
Identifier Code: [illegible]
Date Prepared: February 28, 1980

EGYPT WATER USE & MANAGEMENT PROJECT

Item	Unit	Number of Units	Price or Value per unit L.E.	Total Income or Costs L.E.
Income				
Broadbeans (govt.)	ardob	2.5	20.000	50.00
" " (market)	ardob	4.0	24.000	96.00
Fenugreek	kela	6.0	2.000	12.00
Cotton, unginned	kantar	4.9	38.000	184.30
Cotton Stk &Bean Stw	feddan	1.0	44.880	44.88
Total Income				387.18
Variable Costs				
Plow & level by tractor 2x (1)	feddan	1.0	7.000	7.00
Furrow by animals	feddan	1.0	2.500	2.50
Make ditches and ridges	man hour	20.0	0.100	2.00
Broadbean seed	kela	6.0	2.500	15.00
Fenugreek seed	kela	0.3	2.000	0.50
Broadcast seeds (2)	man hour	1.0	0.250	0.25
Organic fertilizer	cubic meter	20.0	0.600	12.00
Spread fertilizer	man hour	10.0	0.100	1.00
Super phosphate (0-15-0)	kg	150.0	0.027	4.05
Ammonium nitrate (31-0-0)	kg	25.0	0.051	1.28
Spread chemical fertilizer	man hour	2.0	0.120	0.24
Hoeing	man hour	50.0	0.100	5.00
Irrigation by gravity 4x	man hour	20.0	0.100	2.00
Cut beans & fenugreek	man hour	60.0	0.100	6.00
Threshing by machine	machine hour	2.0	1.500	3.00
Labor for threshing	man hour	6.0	0.500	3.00
Winnowing by contract	feddan	1.0	3.500	3.50
Transportaion, seeds & straw	feddan	1.0	4.400	4.40
Plant cotton on bean furrows	man hour	20.0	0.100	2.00
Cotton seeds (3)	kela	6.0	0.255	1.53
Hoeing 3x	man hour	150.0	0.100	15.00
Thinning	boy hour	50.0	0.050	2.50
Super phosphate (0-15-0)	kg	100.0	0.027	2.70
Ammonium nitrate (31-0-0)	kg	200.0	0.051	10.20
Spread fertilizer	man hour	4.0	0.120	0.48
Insect control by cooperative	feddan	1.0	21.800	21.80
Irrigation by gravity 9x	man hour	45.0	0.100	4.50
Gather cotton (4)	pound	1718.0	0.010	17.18
Transport cotton to village	camel load	2.0	0.700	1.40
Cut stalks	man hour	20.0	0.100	2.00
Transport stalks to village	camel load	3.0	0.540	1.62
Total Variable Costs				155.63
Return Above Variable Costs				231.56
Fixed Costs				
Rent	month	12.0	5.630	67.56
Management	month	12.0	1.000	12.00
Total Fixed Costs				79.56
Grand Total Costs				235.19
Return Above All Costs				152.00

FOOTNOTES:

* This study for an area of one feddan.
(1) Previous crop maize or sunflower.
(2) Planting date November 1. Most farmers put seed by axe and hand.
(3) Planting date April 20. Harvesting will begin September 25.
(4) Picking labor is paid L.E. 0.01 per pound.

	LABOR DISTRIBUTION			WATER DISTRIBUTION, CU METERS			
	Man Hours	Woman Hours	Boy/Girl Hours	First Irrig.	Second Irrig.	Third Irrig.	Fourth Irrig.
October	52	105	105	0	0	0	0
November	18	0	40	400	0	0	0
December	55	0	0	300	0	0	0
January	0	0	0	0	0	0	0
February	5	0	0	300	0	0	0
March	5	0	0	300	0	0	0
April	113	0	0	350	0	0	0
May	107	0	80	350	0	0	0
June	62	0	180	350	350	0	0
July	60	0	150	350	350	0	0
August	10	0	0	350	350	0	0
September	5	65	65	350	0	0	0
Total	492	178	620	Total Water Applied=		4450 cu meters	

FOOTNOTES:

(1) Water requirements estimated from Mulawi Agricultural Research Station data. The amounts have not been measured by EWUP.

Staff Paper #3

CORN INSECTS

Dr. Elwy Atalla

May, 1980

INTRODUCTION

Corn is one of the most important cereal crops in Egypt. It is the main crop used for bread-making in most rural areas. Furthermore, green corn plants are used as a forage crop for cattle. This crop, however, is susceptible to a large number of pests which cause an average reduction to its yield amounting to 25%.

The most important corn pests are:

1. Corn Borers:

Three borers are known to attack corn in Egypt. They are destructive to the corn crop, particularly in Lower Egypt and in the northern part of the country. Their damage differs greatly according to the date of sowing, to the prevailing borer where the corn is sown, and the environmental conditions. Corn borer are:

a. The Pink Borer:

The pink borer, Sesamia cretica Led., is common all over the country. Besides corn it attacks sugar cane and some other graminour weeds.

Life Cycle and Nature of Infestation:

Female moths lay their egges in masses of 15 to 20 eggs each on young corn when it reaches 15 days old. No eggs are laid on corn older than 35 days, except late in the season when eggs of the last generation are laid on older corn. Larvae from the particular eggs undergo hibernation. Eggs masses are laid on the inner surface of the leaf-sheath of the first three leaves on the plants. Eggs of one cluster are separated and are arranged mostly in two irregular longitudinal rows. The egg is nearly round in shape and slightly less than 1 mm in diameter.

The incubation period varies between 3 to 7 days, depending upon the temperature. The newly hatched larvae first feeds on the egg shell, then bore directly through the stem which, at that time, is composed of rolled leaves surrounding the growing point. Up to this stage infestation does not show to the outside, but a few days later , small holes can be seen on the leaf blades in the form of transverse rows. On examining an infested plant showing these symptoms, the holes through which young larvae entered the stem are first seen and lead to the larvae feeding in tunnels made in the folded leaves which form the stem. The larvae may continue to feed upwards destroying on its way the growing point of the plant which withers and can be easily detached. This phenomenon is known as "dead heart".

Infested older plants show external holes which lead to big tunnels in the internodes of corn stems. These plants are infested by larvae migrating from younger plants since no eggs are laid on old plants. The borer may also attack the ear feed on the kernels or bore into the ear cob.

The larvae becomes fully developed within 3 to 4 weeks and reaches about 3.5 cm in length having a pinkish colour. Pupation takes place inside the plant. The moths emerge 7 to 10 days later and leave the plant to infest other plants.

Life History:

The number of generations of Sesamia cretica under field conditions in this country is not definitely known, although there are some indications that 4 to 5 generations may be presented every year.

The fully grown larvae of the last generation hibernate inside the corn stalks or below the soil level inside corn roots. The larvae may also overwinter in galleries between kernel rows or within the cob-core.

b. The Purple Lined Borer:

The purple lined borer, chilo agamennon Bles. (sometimes called the rice stem borer) is considered the most injurious pest of corn in Egypt. It is quite common in lower and middle Egypt. However, in 1967, this borer was reported to attack sugar cane and corn at Sohag Governorate, and recently it reached the northern districts of Quena Governorate in Upper Egypt. It is thought that certain climatic factors, mainly humidity and temperature, have probably changed in Upper Egypt in the last few years to favour the borer. Changes in the climatic factors are mainly due to changing of basin lands to regular cultivation with summer irrigation through the use of the reserved water behind the High Dam.

Life Cycle and Nature of Infestation:

The female moth normally lays its eggs on corn plants ranging between 1 and 2.5 months old and rarely at an earlier or a later stage. Eggs are mainly deposited on the upper side of the leaf blades, preferably those near the growing point of the plant. The eggs are flat, oval, pearl-whitish in colour with light shades of yellow green overlapping and 15 eggs on the average are found in one egg mass.

Eggs hatch 3 to 6 days after deposition. The newly hatched larvae crawl towards the stem to invade and feed on the leaf sheaths of the lower leaves and frequently in the plant wherl. After 3 to 5 days, the larvae in the 2nd or 3rd instar bores through the stem. It normally invades an internode at a point near the node. It then burrows downwards and before reaching the lower node, it starts feeding in a circular manner around the inner periphery of the stem. This girdling phenomenon is a characteristic feature of Chilo infestation, which may cause the plant to break at this weak point by the action of wind or any other mechanical means.

The loss in crop yield due to girdling reaches its maximum when girdling takes place in a point below the ear and before it is formed.

This borer may attack the ears, tunnelling between kernel rows or through the cob, the size of the ear is greatly reduced if the larvae bores through the ear shank. Larval tunnels also are common at the lower instar nodes of the plant or inside the roots.

The mature larvae is creamy in colour with 5 purple longtudinal strips on its dorsal surface. The larval stage may be completed in 15 days and pupation takes place inside the stem. The pupal stage lasts for 5 to 8 days after which the moth emerges.

Seasonal History:

The number of generations is not yet known with certainty, but we may get 4 to 6 generations a year. The full grown larvae of the last generations hibernate in the same overwintering sites as Sesamia cretica

c. The European Corn Borer:

The European corn borer, Ostrinig hubilalis (Hbn) is common in Lower and Middle Egypt up to Beni-Suef Governorate. The northern regions of the Delta are seriously infested, and a gradual decrease in the degree of infestation is exhibited as we go southwards.

Life Cycle and Nature of Infestation:

This insect attacks corn when it is at least two feet high or 35 days after planting. The eggs are normally deposited near the middle rib on the under side of corn leaves in clusters of 15 to 25 overlaping like scale of a fish.

Clusters are flat and measure approximately 6 mm in diameter. They are white waxy in colour but eggs that are about to hatch have distinct black centers caused by the black heads of the larvae visible through the translucent shell.

The eggs hatch in 3 to 7 days, depending upon weather conditions. Young larvae then move mainly to the plant whorls and frequently to the leaf sheath. After a few days leaf feeding can be seen at the base of the leaf blades surrounding the plant whorl. As the larvae reach the instar they burrow into the stalk of corn plant.

Larvae mostly invade the upper parts of the corn stalks making tunnels full of sawdust like frass. Stalk tunnelling results in destruction of food conducting channels. This weakens the plant and reduces the yield.

They may also tunnel in the ear shank and thus preventing the proper development of the ear. Larvae feed also on the kernels or bore into the ear cob. Tunnelling in the stalks carrying the tassels cause them to break or bend down. The lower internodes of the corn plant and the roots are frequently free of insect invasion.

The larvae has greyish or pinkish colour characterized by having dark spots on the dorsal surface of its body (6 on each body segment).

Seasonal History:

It is believed that Oscrinig nubilalis has 3 to 4 generations a year in our country. This insect overwinters as a full grown larvae inside corn stalks, in galleries between kernel rows or inside the cob.

Control Measures of Corn Borers:

Mechanical, chemical, cultural or other means of control are based upon several aspects, including behaviour of injurious stages and the overwintering sites. Measures practiced in controlling corn borers are:

1. Date of Sowing:

Stuides on the relationship between the date of corn sowing and infestation with corn borers in Egypt indicate that:

a. Corn planted as early as late March or during April is subjected to high infestation with Sesamia cretica. In most cases such plantations need insecticidal treatments to control this borer. Corn sown at Lower Egypt during March is moderately attacked with ostrinia nubilalis. Mostly the infestation by this pest doesn't reach the economic level.

b. Corn planted during May until mid-June is slightly infested with corn borers and normally such plantations do not receive any chemical treatments.

c. Corn sown during July or early August is severly attacked by Chilo agamemnon and ostrinia nubilalis and insecticidal applications should be applied to control these insects. Infestation with S. cretica on corn sown during this period is mostly low and does not require any control measures. It is suggested, therefore, that farmers should plant their corn during May and early June to avoid high infestation with borers and consequently get high yield of corn. Corn observation fields are usually sown at certain districts in the delta and Middle Egypt to regulate the chemical control of corn borers and to limit insecticidal treatments to corn subjected to economic infestation.

2. Eradication of the Overwintering Larval:

It has previously been mentioned that larval overwinter inside the corn stalks and in corn roots left in the field after harvest. Moths of Sesamia developing from the hibernating larval emerge during March and April, while Chilo moths appear during May and ostrinia moths emerge late in April and early in May. Corn stalks used as fuel by the farmers should, therefore, be consumed before March to get rid of the overwintering larval inside these stalks. Corn roots left in the fields should also be collected and burned when preparing the field for the following crop.

3. Chemical Control:

Four applications are necessary to obtain good control when high infestations with corn borers are expected. The first two applications are mainly done for Sesamia control. The first is carried out when corn is 20 days old (or about one foot high) while the second is done 10 days later. Seiving 85% wettable powder at the rate of kg. per feddan is 150 liters of water is recommended in these applications. The third and fourth appications are carried out when corn is 45 and 60 days old, respectively and are done mainly to control Chilo and Ostrinia. DDT 50% wettable powder at the rate of 3 kg. per feddan in 300 to 400 liters of water is recommended in these two applications.

It has to be noticed that insecticidal application in corn fields is very much easier when corn is planted in rows. It is also of great importance to mention that corn plants treated with recommended chemicals should not be used as food for cattle.

4. Through the Development of Resistant Corn Varieties:

None of the corn varieties in commercial use now in Egypt shows any tendency to resist corn borers. A program is proposed to develop new varieties which resist the borers' attack beside the other good qualities. A team consists of the plant-breeder, the entomologist and the plant pathologist; then should work side by side to carry out such a project.

5. Biological Control:

A survey of predators and parasites which attack corn borers in Egypt is not yet completed. However, the following is a list of parasites known to attack corn borers:

Trichogramma Evanescens	On egg parasite
Pimpla sp	On larvae and pupae
Microbracon brevicornis	On larvae and pupae
Apantelels sp	On larvae of *Sesamia*
Platytelenomus hylas	On eggs of *Sesamia*
Cononorium esemita	On pupae of *Sesamia*

CORN APHID

Corn is infested by the corn aphid *Repalosiphum maidis* at any time, but the infestation mostly occurs immediately after tasseling. Infested corn shows numerous greenish or greenish-blue aphids on the tassel and upper leaves. Infested corn leaves are frequently mottled with yellowish patches. They soon turn black as a result of heavy fungoid growth following the excretion of honey-dew. Under favouralbe conditions the aphid will multiply rapidly, and infestation may seriously interfere with the pollination of corn. This insect is most common on corn planted during July and August. It appears in these fields late in August and during September.

Control Measures:

1. Early Planting

   Corn planted during May or early in June is less subject to severe infestation than corn planted during July and August.

2. Cutting the infested tassels as soon as they show infestation and burning them outside the field. This method can be practiced to control light or moderate infestations. No more than 25% of the tassels should be removed.

3. In case of heavy infestation, spray infested corn with melathion 97% at the rate of 1½ liters per feddan.

Staff Paper #4

RICE INSECTS

Dr. Elwy Atalla

May, 1980

INTRODUCTION

Rice is a very important cereal crop in Egypt. It is the second export crop in this country. Its yearly cultivated area has increased recently to reach about 1.2 million acres. Furthermore, rice grows well in newly reclaimed lands where certain salinity exists in the soil which prevents successful growth of most other crops.

The Major Insect Problems of Rice in Egypt Are:

The Blood Worms; Chironomus Sp.

Larvae of a certain species of *Chironomus*, commonly named as the blood-worms, occur in rice fields in saline soils or if irrigated from draining canals. Such conditions prevail in newly reclaimed land at the northern region of the country.

Chironomus larvae cut and destroy the rootlets of young seedlings in rice nurseries. The affected seedlings lose their attachment to the soil, float on water surface and are drifted to the corners of rice plots. Larvae may also feed on the starchy contents of the rice grain.

Life Cycle and Seasonal History - Eggs of this insect embedded in gelatenous material are laid by flying female flies into water. They attach themselves to any floating stratum until hatching. They may be swept away along with running water into draining ditches and may fail to hatch if rested on dry sites.

The incubation period of eggs ranges between 2.2 and 4.5 days according to weather conditions. At the end of the incubation period, the small larvae escapes out by bursting the egg-shell and begins its swimming close to the water surface.

The larval stage lasts between 12 and 18 days. Shortly before pupation, the thoracic region of the larvae becomes swollen and its segments loose their distinction. Larval cuticle is then retracted and is replaced by the pupal cuticle. The pupae lies half burried in the mud at the bottom of water with therax and respizatory filaments projecting outwards. The pupal stage lasts between 4 and 8 days according to weather conditions.

As the pupal development comes to an end, the pupa floats to the water surface. A longitudinal split occurs along the theracic dorsum through with the fly can make her escape. The female flies live for 2 to 3 9 days while males live from 0.4 to 1.5 days.

Mating does not occur in captivity. It occurs while flies are on the wing in swarms hevering near the water surface at dusk.

The insect overwinters as full grown larvae buried in the mud at the bottom of deep pools or water streams.

Hibernation starts around mid-December and ends in early March. The number of generations per year is hard to figure out because of overlapping in the field. However, duration of the life cycles suggested that under normal conditions there might be 9 generations per year.

Control Measure:

1. Do not plant rice nurseries in saline soils.
2. Try to sow year seeds on the same day you fill your field for rice nursery with water. This will help rice seedlings to fix themselves in the soil before the attack of larvae.

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3. Rice sown with seeds previously soaked in water for 48 hours and left for another 48 hours until the emergence of rice rootlets has a better chance to escape infestation.
4. Do not irrigate rice nurseries from draining canals.
5. Draining of water from rice nurseries for one or two days is effective in reducing the insect population without seriously affecting the rice seddlings.
6. The application of 5% granular Diazinon or 10% granular sevin each at the rate of 6 kg per acre gives a satisfactory control of this insect in rice nurseries.

The Rice - Stem Borer

Rice in Egypt is subjected to rather severe infestations by the rice stem borer chilo agamemnon bles. Before the 1965 season, rice infestation by this borer was too low to be considered of economic importance. However, it was found recently that the infestation has increased considerably and approximately 10% of the rice yield has been lost in certain years due to the borer attack.

Losses in rice yield due to the borer attach differ greatly in different localities with different rice varieties and according to the rates of nitrogen fertilizers.

Nature of Infestation - Eggs of this borer are laid in clusters of about 20 eggs each on rice leaves or on the green stem. After hatching larvae feed for few days on the leaf sheaths and then invade the stem mostly from below. They tunnel into the stem and cause one of the following symptoms:

1. Destroying the growing point of plants before heads are

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developed, causing what is termed "dead hearts". Such plants yield nothing.

2. If heads are developed, rice borer may feed into the head stem detaching it from the main stem of the plant. Such heads wither and die before seeds are formed.

   No yield is expected from such plants. This phenomenon is termed "white heads". Infected heads look white while sound heads are still green.

3. Stems may be infested, but sound heads containing seeds are developed. In this case, the yield is slightly affected.

Life and Seasonal History - Life history of this insect is previously described on corn. The insect passes about 3 generations on rice in the field and full grown larvae overwinter in rice stubble and in rice straw.

Control Measure:

1. Rice variety Nahda is less subjected to infestation than other commercial varieties cultivated in Egypt.
2. Rice planted early in the season (up to May 15) is less subjected to infestation by the borer than late rice plantings.
3. The infestation increases with increasing the rate of nitrogen fertilizers.
4. Lindane or Diazinon both in granular form are two effective insecticides against this pest.

Staff Paper #5

MAJOR FIELD CROP INSECTS AND THEIR CONTROL

Elwy Atalla

May, 1980

INTRODUCTION

Cotton, corn, rice, wheat, barley and sugar-cane can be considered the major field crops in Egypt. These crops, however, are subject to infestation by a good number of pests which if not put under control cause considerable damage to their yields. The major insect problems of these problems are reviewed here with the different measures practiced in their control.

COTTON INSECTS

Cotton is the most important agricultural crop in Egypt. The cotton area, during the last few years, has varied between 1.4 and 1.6 million acres per year. It is still considered the backbone of the national economy in spite of the recent attempts at industrialization and crop diversification.

This crop is highly susceptible to arthropod infestations which are reported to attack all parts of the plant at all times of the growing season.

The important pests of cotton in Egypt are classified as follows:

a. Early season pests;

1. Cutworms

2. Cotton thrips.
3. Cotton aphids.
4. Spider mites.

B. Mid season pests:

5. The cotton leaf worm
6. The lesser cotton leaf worm

C. Late season pests:

7. The pink bollworm
8. The sping bollworm
9. Spider mites.

Practically, the cotton leaf worm and the pink bollworm are considered as key pests of cotton in Egypt, the following is a brief account of cotton pests.

I. Cutworms:

Several species of cutworm are found in Egypt. The greasy cutworm *Agrotis ypsilon* is the most common.

The greasy cutworm is a cosmopolitan species which is known to cut off seedlings of many plants while satisfying its appetite. This insect cuts in two young cotton plants at or near the surface of the soil.

The female moth of this insect lays its eggs singly or a few together on the leaves or stems of cotton seedlings or on the weeds in the cotton fields. One female may lay as much as 2000 eggs.

Eggs hatch within 3 to 7 days. Young larvae feed on the plant foliage and reach maturity after 3-5 weeks depending on weather conditions. Full-grown larvae are greasy grey to brown above with faint lighter stripes. They reach about 5 cm. long and are found in the day time in the soil. They often curl their bodies when disturbed. They pupate in the soil in a mud cell few centimeters below the soil surface. Pupal duration lasts between 2 and 3 weeks in summer and a wide host range among field and truck crops.

Control Measures:

1. Early ploughing of cotton fields in order to expose the soil to sun for a reasonable time for it to dry off before cotton is sown.

2. Spraying of infested fields by insecticides. A list of the recommended chemicals for all cotton insects control for the 1979 season in Egypt is given at the end of this review.

II. The Cotton Thrips: *Thrips tabaci* Lind

Thrips attack the leaves and terminal buds of cotton seedlings. Infestation may be slight in scattered areas or it may spread over the whole field of cotton. Severely infested plants may be stunted and the stand of cotton may be reduced to such a level that resowing is necessary.

Larvae and adult thrips attack the cotton plant by piercing the tissue of the leaves and feeding on the cell sap.

Heavy infestation gives the plants a silvery appearance. Later the leaves become dark olive or brown in colour, shrivel and fall off. Early sowing cotton is less subjected to infestation than late sowing. Proper irrigation and fertilization allow the plant to tolerate infestation.

Control:

Spraying of cotton infested fields by the recommended insecticides.

III. The Cotton Aphid, *Aphis gossypii* Glover

Cotton seedlings are subjected to infestation with the cotton aphid during April and May. However, infestation on developed cotton plants with this pest is not uncommon.

Aphids are seen in good numbers at the lower surfaces of cotton leaves. They are relatively big in size and green or olive green in colour. Having a piercing sucking mouthpart the insect sucks the plant sap. As a result, infested leaves of cotton seedlings show curling symptoms. When cotton is attacked by aphids in late summer, the pest usually infests the leaves and growing tops. With heavy infestation, leaves become reddish and then yellowish and may fall off. Fungus growth associated with honey-dew excretion of the aphids is usually seen covering the infested plant parts.

As a result of the aphid infestation the developed bolls are relatively smaller and cotton yield is decreased.

Control:

Spraying of infested cotton fields by the recommended insecticides.

IV. Cotton Spider Mites:

Spider mites on different crops, including cotton, will be reviewed in a separate lecture.

V. The Cotton Leaf Worm: *Spodoptera littoralis* Bois

The cotton leaf worm is the most serious cotton pest in Egypt. It is extremely phytophagous having a very wide host range among field and truck crops.

Eggs of S. Littoralis are laid in masses on the underside of cotton leaves. The number of eggs in one mass varies between 250 and 350 eggs and one female may lay between 1000 and 2000 eggs.

Eggs hatch after a period of 2 to 4 days and newly hatched larvae feed first on the leaf where the egg mass is deposited. After a few days, larvae are scattered to attack the leaves of the whole plant. Larvae devour the leaves completely and make their way into young shoots and flower buds.

Growth of infested plants is retarded, and as a result the crop yield is affected, particularly if flower buds or bolls are infested.

The larval duration lasts about 15 to 20 days. Full grown larvae leave the plant and burrow into the soil to a depth of 2 to 3 cm. in order to pupate. The pupal stage lasts between 7 and 15 days.

The cotton leaf worm is active allover the year. However, winter generations develop very slowly when compared with summer generations. In general the insect has 7 generations a year, three of them are found on cotton

Control measures:

1. Hand picking of egg masses is generally practiced with reasonable efficiency during June and July. This method, although laborious, saves to a great extent the troubles of using chemicals against this pest.
2. The Chemical control is used when larvae of different ages are seen scattered on cotton leaves in the field.

VI. The Lesser Cotton Leaf Worm, Spodoptera exiqua.

This insect is very similar in feeding habits to the cotton leafworm except that it is less harmful to cotton plants It appears in cotton fields early in in the season. It lays its eggs either on the lower surfaces of plant leaves or on the leaves of certain weeds in the cotton fields. Eggs are laid in masses of 20 to 70 eggs each. One female moth may lay as much as 500 eggs.

Eggs hatch after 2 to 4 days and young larvae feed first on the lower leaf epidermis. When they grow up they pierce the leaves and sometimes devour the whole leaf except the riks.

Larvae reach maturity after 10 to 15 days. They pupate in the soil and moths emerge after about a week.

Control Measures:

This insect is controlled by the same way described for the cotton leaf worm; egg masses are hand picked when picking egg masses of the cotton leaf worm, and the chemicals used are effective on both insects.

VII. The Pink Bollwom, Pectinophora gassyptèlla

Larvae of the pink bollworm feed upon cotton squares, blooms and seeds within the growing boll. In addition to the destruction of lint and seeds, the quality of the picked lint in heavily infested fields is also lowered. As a result of infestation, fungus find an easy entry to the bolls through the holes made by the larvae and causes rottening of the whole boll or one of the locules.

In some cases, squares are completely destroyed and shed. If the infested square does not shed, a rosette bloom results. Such blooms have petals tied together with silken threads. They do not open normally. The rosette bloom is a typical sign of the pink bollworm infestation.

Infestation by the first generation of the pink bollworm starts as early as May or June and increases gradually with the advancement of the cotton season and the development of the plant. The peak of abundance of this insect in Egypt occurs during September. Percentages of infestation ranges from about 1% in June to 90% in September if no control mesures are followed.

Female moths of the pink bollworm lays from 50 to 300 eggs over a period of 8 days. Eggs hatch in 4 to 5 days. The larvae feed inside cotton squares, blooms or bolls for 10 to 14 days and then pupate in the soil. Normally 8 days are required for pupal development. Larvae of the pink bollworm pass a period of diapause of varying lengths in a full fed state. This period is termed the "resting stage". Most of the diapausing larvae pass the winter in the bolls in which they have developed. However, some may pass the winter in the cotton seeds, in the trash in fields or at gins or in cracks in the soil. A larva may hibernate in a single seed or it may pull two hollowed out seeds together and unite them by spinning or continuous cocoon and remain within the cavity of the two seeds.

Some diapausing larvae may not pupate until in their second year of life.

Control Measures:

A. Cultural Methods:

1. Early maturing varieties of cotton escape high infestation late in the season.

2. Early sowing, for early maturity.

3. Collecting and burning infested bolls after the cotton season is over helps in reducing the source of infestation for the following year.

4. Seeds of cotton are heated for 5 minutes in cotton gins to a temperature of 56 to 59 ^{o}C. The ginning season should also end before April.

B. Chemical Control:

Cotton is sprayed periodically for 3 to 4 times to control both the pink and the spiny bollworms. The first application starts when the infestation reaches 10% in green bolls in the field (about mid July). More than one insecticide is used in one field to avoid or delay the insect resistance to the the insecticides used. Certain chemicals, effective also on the cotton leaf worm are used when cotton is infested with the latter insect late in the season. The recommended insecticides are listed later in this review.

VIII. The Spring Bollworm, Earias insulane Bois

In its youger stages, the spiny bollworm commonly attacks the terminal growing points feeding on the unexpanded leaflets and tiny squares. More developed larva attacks the well-developed squares, larger flower buds and small bolls.

The spiny bollworm tends to foul a boll more than a pink bollworm does. This is perhaps due to the fact that the spiny worm is more bigger in size and feeds rather more on the unripe cotton fibres. Furthermore, it attacks more than one boll when completing its development while the pink bollworm feeds and develops in one boll only. The presence of dirty excrement inside and outside the bolls and the large irregular entrance holes make it easy to identify the work of this pest.

In spite of the fact that the individual spiny worm is more destructive than the individual pink worm, the economy of the pink. The population of the spiny bollworm is very much less than the population of the pink bollworm. However, the density of the spiny bollworm population increases considerably in South Egypt and the ration of both insects might be in the favour of the spiny bollworm south of Quena Governorate.

Eggs of the spiny bollworm are usually deposited on the bolls and small leaves and buds at the growing points of the main stem and branches. Eggs are laid singly and possibly in pairs.

One female may lay about 200 eggs. During summer eggs hatch within 3 to 4 days. The larva complete its development in two weeks during summer and in more longer time under colder conditions

The full-grown spiny bollworm leaves the bolls and seekd a site where it spins its cocoon. This may occur anywhere on the plant or among fallen leaves below the plant. The pupal duration lasts between 9 and 11 days. It is suggested that the insect has from 5 to 6 generations a year.

INSECTICIDES RECOMMENDED FOR COTTON INSECTS

FOR THE 1979 SEASON IN EGYPT

Insect	Insecticides
Cutworm	Endrin 50% W.P., 1 kg/fed or Endrin 19.5% e.c., 2.5 lt/fed.
Cutworms & Aphid and Thrips	Endrin/Bedrin., 1.5 lt/fed
Aphid + Spider mites	Kalthane S, 1 lt/fed Golecron 50%, 0.5 lt/fed or Folimat 80%, 0.5 lt/fed or Kelval 40%, 0.5 lt/fed or Zolon 30% W.P., 0.5 kg/fed
Thrips	Novacron 40%, 400 cm^3/fed or Tamaron 50%, 500 cm^3/fed or Folimat 80%,250 cm^3/fed or Endrin/Bedrin 20:20, 1.5 lt/fed or Azodrin 40%, 500 cm^3/fed or Kalthane S, 1 lt/fed
Cotton Leafworm or lesser leafworm.	Cyolane,1.5 lt/fed
Bollworms and late infestation of cotton leaf-worm	Cytrolane, 1.75 lt/fed or Dursban 40.8% e.c., 1 lt/fed or Endrin/Bedrin, 2.5 lt/fed or Tamaron/Gusathion, 2 lt/fed or Novacron 40%, 1.5 lt/fed or Gusathion 20%, 3 lt/fed.

SECTION 2

WHEAT AND BARLEY INSECTS

By Dr. Elwy Attalla

Wheat and barley are attacked by several insects, none of these however, causes severe loss to their yields. The most important wheat and barley insects are:

1. The Black Cut-Worm

The cut-worm *Agrotis ipsilon* is a pest of wheat and barley in certain regions in Egypt.

Larvae feed on the lower part of the stem just above the soil surface. The infested plant is cut off, falls and dies. The infestation is mostly light and tillers of these crops usually cover this infestation.

2. Wheat Stem Sawfly

Wheat stem sawfly *Cephus tabidus* is common in wheat fields planted all-over the country. However, the losses caused by this insect to this crop do not exceed 1%. The adult females lay their egg by thrusting them into the plant tissues on the upper parts of the wheat stem. The larvae feed within the stem, boring down through the joints until they reach the lower parts of the plant close to the soil surface. Here it cuts right around the stem causing the plant to break off before the kernelas are formed. The larvae then plugs itself into the base of the plant forming a chamber in which it estivates.

Control Measures:

Ploughing under inpested stubble after harvest is the best method of control. Solid stemmed varieties of wheat are more resistant.

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3. Cnephasia sp. (Fam. Tortricidae)

This insect is common on wheat & barley in the Delta and Middle Egypt as far as Beni-Suef. It is most common in Sharqiya province, where considerable damage is observed.

Young larvae of the first and second instars mine into wheat and barley leaves. When they grow up they leave the mines and attack the plant itself. They feed on the stem below the ear and before kernels are formed. The ears dry off while free ears are still green. Larvae may also feed on the kernels causing partial damage to the ear. This insect attacks also flax and some graminous weeds. No control measures are recommended.

SECTION 3

SUGAR-CANE INSECTS

By Dr. Elwy Attalla

Sugar-cane is the only crop planted in Egypt for sugar production. Molasses, alcohol, vinegar and some other materials are by-products of the sugar industry. The area planted with sugar-cane has been increased recently to reach about 210,000 feddans and is increasing steadily. Around 90% of this area is located in Upper Egypt at Quena and Aswan Governorates, while the rest is cultivated in Middle Egypt in Minya Governorate.

The most important sugar-cane pests are:

1. Sugar-cane Borers

Out of the three borers mentioned on corn, two are known to attack sugar-cane. These are the pink borer and the purple lined borer.

A- The Pink Borer

This insect is common on sugar-cane allover the country. Eggs are laid in clusters on the inner surface of the lower leaf sheath of young sugar-cane plants and sometimes on the gramineous weeds in sugar-cane fields. The nature of infestation of this insect on sugar-cane is very similar to that described on corn. "Dead hearts" caused by this insect are very common in infested sugar-cane fields. However, infesting the growing points in young sugar-cane plants might accelerate the development of new shoots.

B- The Purple Lined Borer:

This insect is more destructive to sugar-cane plants and cause considerable losses to this crop.

Eggs of this insect are laid in clusters on both sides of leaf blades.

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After hatching, larvae move towards the stem. They usually feed on the leaf sheaths for a few days before they invade the stem. The nature of infestation to sugar-cane stems is similar to that described for this insect to corn stalks. However, tunnelling in sugar-cane stems is a direct loss to the yield. The amount of juice and sugar obtained from infested joints are less than that obtained from free joints.

Occurence of this insect was limited to the Delta and Middle Egypt. However, this insect invaded sugar-cane at Assuit, Sohag and north of Quena Governorates just recently. It is feared, however, that the insect might extend southward to cover Quena and Aswan Governorates where most sugar-cane is cultivated.

Recent survey of this borer indicates that the infestation has reached an average of 12% (expressed as infested joints to the total number of joints examined) in Middle Egypt while it averaged 5% at the north of Quena Governorate.

The infestation by the borer differs with different varieties and in different localities. As the insect is very sensitive to the relative humidity in the environment sugar-cane grown in heavy soils or in areas where no draining takes place is more infested than sugar-cane grown in light soils or when a draining system is found. For the same reason, sugar-cane planted on wide row distance is less subjected to infestation than that planted on narrow rows.

The life cycle of the borer has been mentioned before. The nature of infestation in sugar-cane is almost the same as in corn.

Control Measures:

The following are the different means of control practiced against sugar-cane borers:

1) Planting of relatively resistant varieties of sugar-cane particularly in areas where high infestations with the borers are expected.

.../...

2) Elimination of weeds from sugar-cane fields decreases the borers infestation. Borer eggs are sometimes laid on the gramineous weeds in sugar-cane fields. The developing larvae feed on the weeds for a short time before they attack sugar-cane plants.

3) Borer larvae over-wintering in corn stalks, corn roots and rice and sugar-cane stubbles are sources of borers infestation to sugar-cane. Eradication of these larvae decreases the borers' infestation in sugar-cane fields.

4) Improvement of the draining system in sugar-cane beside proper irrigation decreases the infestation by the borer.

5) Borers control by chemicals in sugar-cane fields is a hard task. On one hand, sugar-cane plants become very crowded in the field after the month of July due to narrow rowing, and applying any insecticide after July becomes almost impossible. Most of the borer's activities in sugar-cane fields occur during July through October. Experiments were conducted, however, to test several insecticides against the borers on sugar-cane planted on wider rows and satisfying control was obtained.

2. Sugar-cane Aphid

The sugar-cane aphid, Rhopalocephum maidis, is not considered a serious pest on sugar-cane as far as the damage done by this insect to cane plants is concerned. However, this insect is known to be a vector of the sugar-cane virus disease.

No control measures are recommended for this pest on sugar-cane.

3. Sugar-cane Mealybug

The sugar-cane mealybug, is a small oval pink insect covered with a thin layer of powdery wax. It is common on sugar-cane stalks, particularly around the nodes and under the leaf sheaths. It is more common on stubble

.../...

cane than on plant cane.

Its damage to cane plants is not only confined to sucking the plant juice, but it also interferes with sugar crystalization.

Control Measures:

1) Plant free cane seed pieces.
2) Clean fields thoroughly from weeds.
3) Burn sugar-cane dry leaves in the field after harvest.
4) Using a four-year rotation; plant cane and two stubbles followed by one-year legumes.

4. The Field Rat

The field rat, Arvicanthis niloticus, is a rodent animal with a body length of 17-19 cm. and a tail length of 12-15 cm. It is common in Egyptian fields but most common in Upper Egypt particularly in sugar-cane fields.

The rat multiplies rapidly, its pregnancy period ranges between 18 and 20 days, 5 to 6 young are laid at a time and these reach maturisation in 75 days. The female lays 3 to 7 times a year and the rats live 35 to 70 months.

Sugar-cane fields are good shelters for the rates. They make their holes in the fields and live by feeding on cane plants. They chew the plants, preferring the lower joints, causing damage to this crop estimated at 8%. Wounds in cane plants made by rates are also easy entrances for fungi and bacteria.

Control Measures:

Rate control should be continuous all through the year and not confined to sugar-cane fields. It should also be done on a large scale basis covering the whole infested areas.

.../...

1. Rat Traps:

Rat traps are a good method of controlling rats in houses or small gardens, but it is not practical under field conditions and when large numbers of rats are found. Different kinds of baits for the trap should be used, and these should be renewed periodically. Traps are put where rats are most common.

2. Poison Baits:

A poison bait of zinc phosphide is recommended for rat control, using corn seeds, lentils or water-melon seeds as a carrier. Zinc phosphide is used at the rate of 30 gr. per one k . of seeds. When water-melon seeds are used, they are soaked in water for 18-24 hours. Corn and lentils seeds are boiled in water until they are nearly cooked. The water is drained and the chemical is added and mixed thoroughly. Oil is then added to the bait at the rate of 10 cc. per kg.

Poison baits are prepared and delivered in the field just before sunset. Zinc phosphide is a very poisonous chemical. Preparing and handling the bait should be done with great care.

A new chemical named "Warfarin" has proved to be effective against the rat. This chemical is less poisonous than zinc phosphide and has no repellent odour. It kills the rats after 4 days by causing internal haemorrhage.

5. White Grubs:

White grubs of the beetle Pentoden bispinosus are known to attack sugar-cane plants in Egypt. Larvae feed on the underground parts of the cane plants. They attack the seed pieces making big tunnels inside the joints. Poor cane stand and less shooting is expected in the infested areas. Cane seedlings are affected also by larvae feeding on their roots.

.../...

Infestation by the grubs is more common when the soil is rich in organic matter or when excess of manure is added.

Control Measures:

1) Deep ploughing and exposing the soil to the sun for a long period to dry off and cleaning the field from any plant residues kill many of the larvae in the soil.

2) Mixing the soil with aldrin, dieldrin or chlordane just before planting is also very effective against grub infestation.

Staff Paper #6

CUTTHROAT FLUME METRIC EQUATIONS

M. Helal

May, 1980

INTRODUCTION

The general equations for the head discharge relationships for cutthroat flumes are presented in metric form in this paper. Also equations are given for determining the values of the coefficient and exponents in the flow equations.

The bulletin[1/] describing the cutthroat flume presents the flow equations and rating tables in the English system. Thus the bulletin cannot be used directly whenever the metric system is standard and conversion from the English system is required. Since the flow equations are empirical and lack dimensional integrity the conversion is not a simple one and must be done with care list errors result. The work presented here was undertaken to meet the need for metric equations.

The coefficient and exponents in the flow equations are a function of the length of the flume. The bulletin 120 presents these functional relationships in graphical form. Figure 1 shows coefficient and exponents for free flow and Figure 2 for submerged flow. These graphs cannot be used by digital computers. So equations which can be used have been fit to the curves which show the relationship between coefficient or exponent and the flume length. With these equations direct calculation of flume discharge without resort to table look up or graph reading is possible.

The derivation of the equations is described in this bulletin. A program for discharge computation by Hewlett-Packard No. 9825 computer is presented.

The Metric Equations

The equation given in Bulletin 120 for free flow through a cutthroat flume is:

$$Q = K_1 \; W^{1.025} \; ha^{n1} \;........(1)$$

[1/] Selection and installation of cutthroat flumes for measuring irrigation and drainage water. Technical Bulletin 120, Colorado State University.

Values for K_1 are given for use with English units so equation (1) will be referred to as the English form equation.

Where Q is the discharge rate
W is the flume width
h_a is the upstream head

To convert to the metric system each length dimension must be multiplied by 3.281, the number of feet in a meter. Thus:

$$Q_M(3.281)^3 = K_1(W_M \times 3.281)^{1.025}(ha * 3.281)^{n_1} \ldots (2)$$

where m is a subscript denoting metric units

$$Q_M = (3.281)^{(1.025 + n_1 - 3.0)} K_1 \; W_M^{1.025} h_{am}^{n_1} \ldots (3)$$

For the smaller flumes it is sometimes convenient to express the discharge in liters per second and the head in centimeters. In these units equation 2 becomes:

$$Q = 1000(3.281)^{n_1 - 1.975} \; k_1 W^{1.025} \left(\frac{H_a}{100}\right)^{n_1} \ldots\ldots (4)$$

where Q is discharge in liters per second
H_a is the upstream head in centimeters

The equation given in Bulletin 120 for submerged flow through a cut-throat flume is:

$$Q = \frac{K_2 \; W^{1.025}(h_a - h_b)^{n_1}}{\left(- \log \frac{h_b}{h_a}\right)^{n_2}} \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

where h_b is the downstream head

Other terms are as previously defned equation (5) will be termed the "English equation for the same reason given for equation (1). The metric form of this equation is:

$$Q = \frac{(3.281)^{n_1 - 1.975} \; K_2 \; W^{1.025}(h_a - h_b)^{n_1}}{\left(- \log \frac{h_b}{h_a}\right)^{n_2}} \ldots (6)$$

Equations for the relationships between n_1, n_2, K_1 or K_2 and flume length were derived to supplant the curves provided in Bulletin 120. The procedure for the derivation was to pick two pairs of values from the curve and to substitute them into the general form of the equation. Simultaneous solution of the two equations thus obtained yielded the desired relationship.

For example for K_1:

L		K_1
feet	meters	
4	1.219	4.15
8	2.438	3.558

The general equation best describing the relationship between K_1 and L is:

$$K_1 = A + \frac{B}{L}$$

The substitution and solution yield the following equation:

$$K_1 = 2.962 + \frac{1.448}{L} \quad \text{..............................(7)}$$

where L is flume length in meters

The equation for n_1 is of the same general form as for K_1. A similar solution yields:

$$n_1 = 1.418 + \frac{0.405}{L} \quad \text{..............................(8)}$$

The equation for K_2 and n_2 are of different form. Solution yields:

$$K_2 = 2.51 - 0.801 \ln L \quad \text{............................(9)}$$

$$\frac{1}{n_2} = 0.748 - \frac{0.064}{L} \quad \text{..............................(10)}$$

For equations 7,8,9 and 10 the limits of applicability are:

$0.46 \leq L \leq 2.74$ meters.

Equations 7,8,9 and 10 will yield values for coefficient or exponents which are within 1% of the chart values for flumes 1 meter or longer. For flumes 0.5 meter long the error is larger, the error being:

Coefficient or Exponent	Error %
K_1	+ 4.6*
n_1	+ 7.3
K_2	− 1.8
n_2	− 2.2

* Positive indicates that the calculated value is larger than the chart value.

Equations (3) and (6) are for free flow and submerged flow respectively the submergence ratio $\left(\frac{H_b}{H_a}\right)$ at which the flow changes from free to submerged is the transition submergence, S_t. CSU Technical Bulletin provides a curve showing S_t as a function of flume length. Equations defining this relationship have been derived in this study. For the two systems of units they are:

In English units

$$S_t = o.485 + .0575L - .0025\ L^2 + \frac{.11}{L_2} \qquad (11)$$

where L is flume length in feet

In Metric units

$$S_t = .485 + .1887\ L - .0269\ L^2 + \frac{.0102}{L_2} \qquad (12)$$

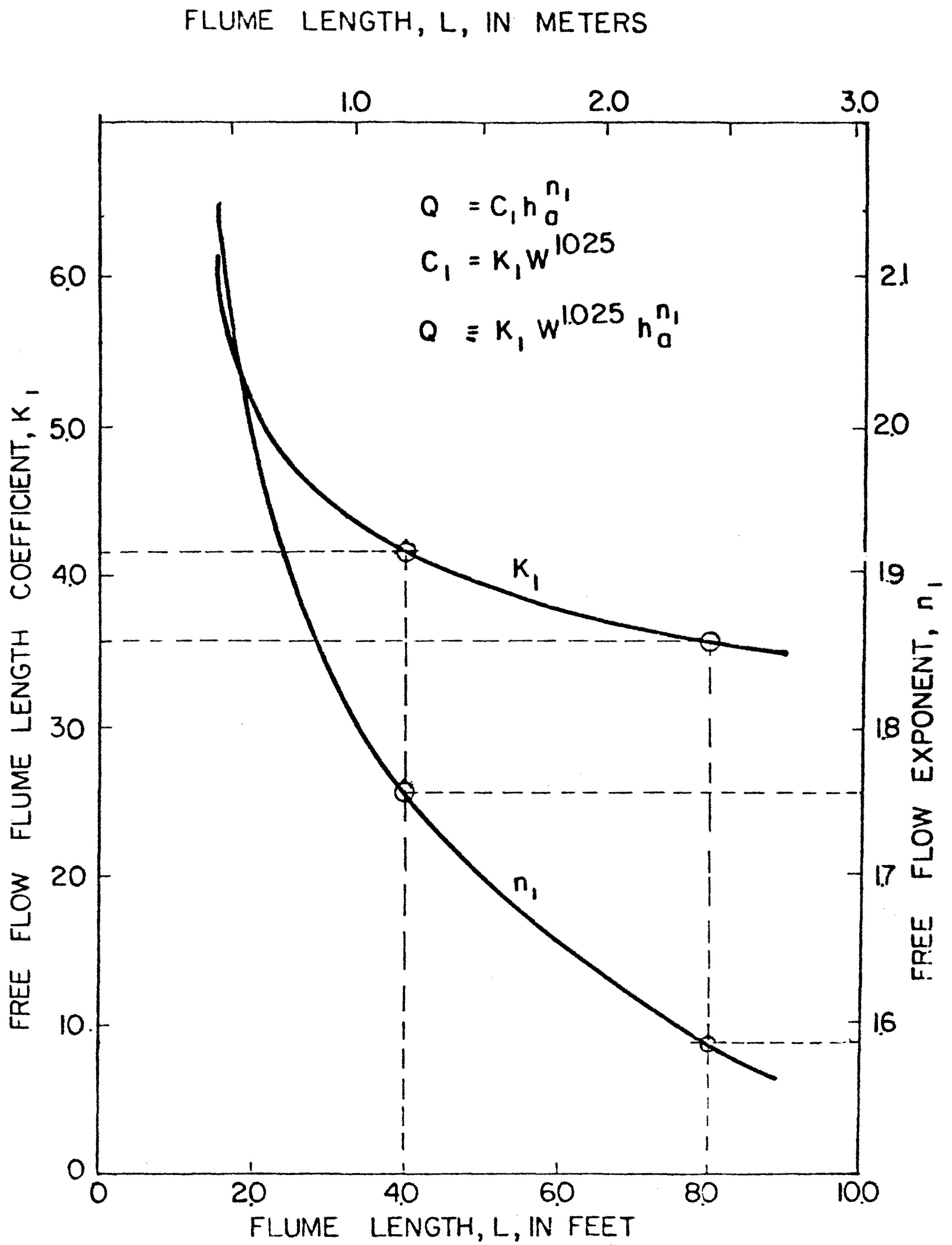
where L is flume length in meters

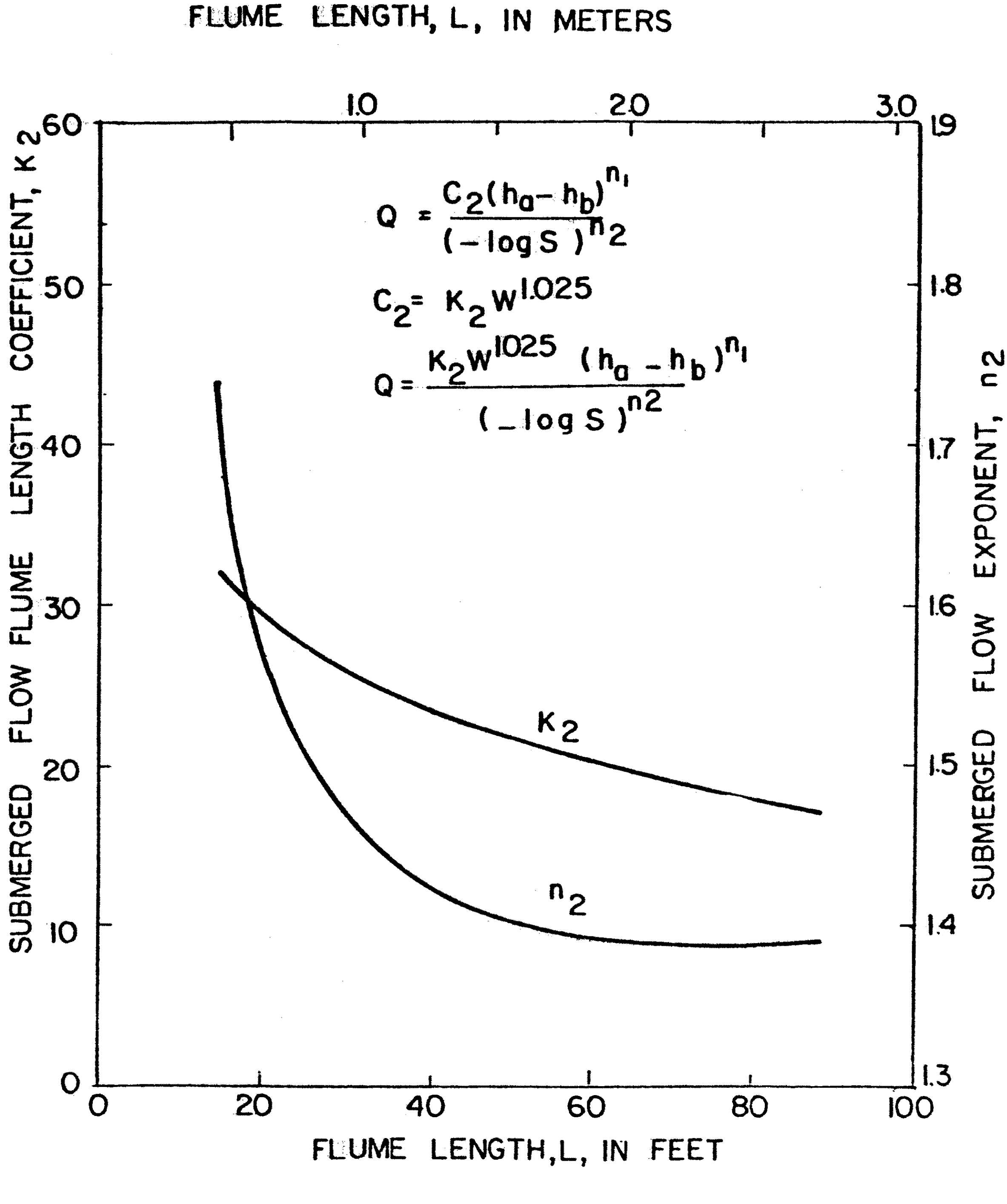
The limits of applicability of equation (12) are the same as given for equations (7) tc (10).

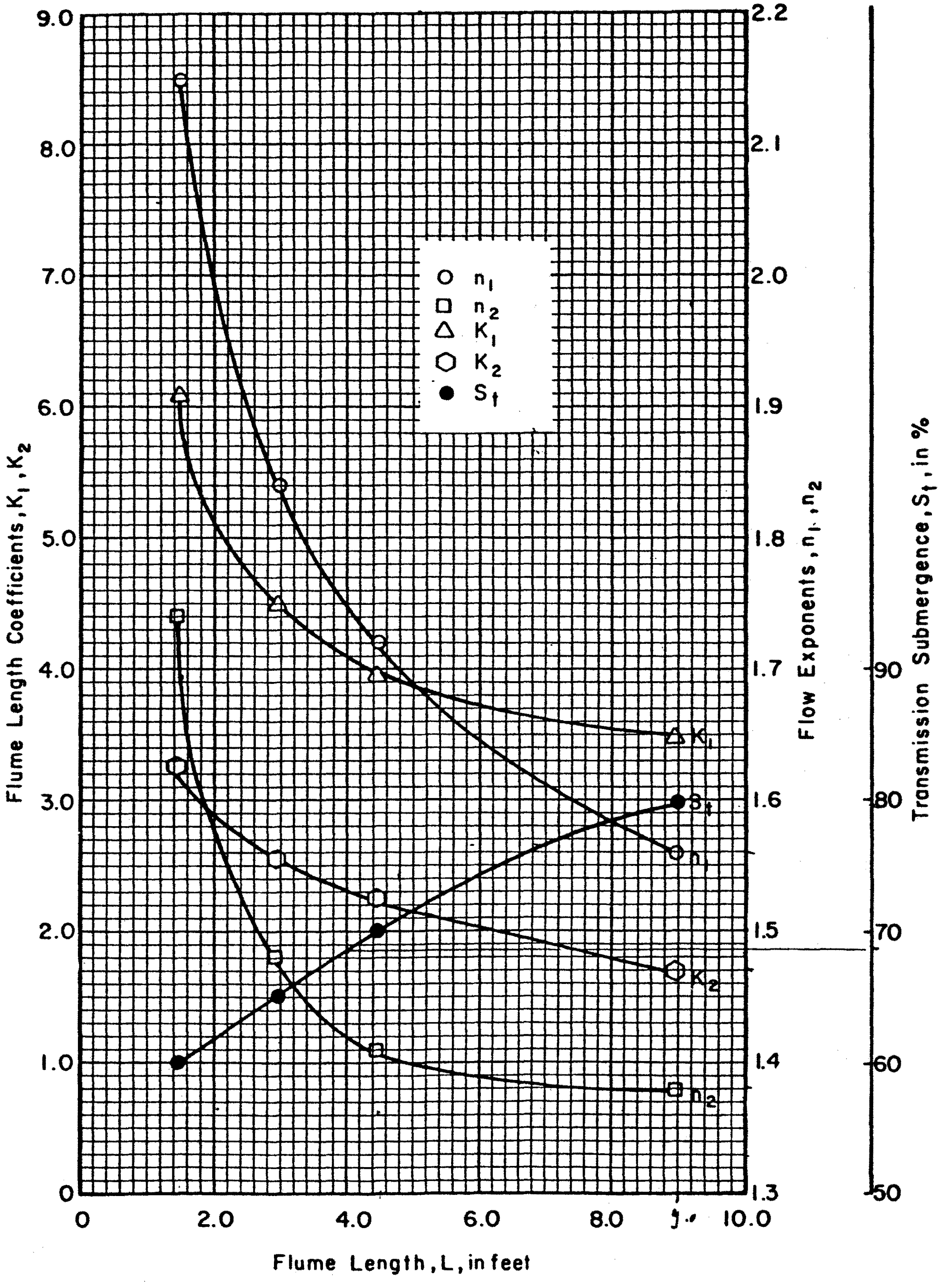
The S_t values calculated by equation (12) are within 2% of values given by the curve or tabulation in Bulletin 120. The comparison of the values is given in the following table:

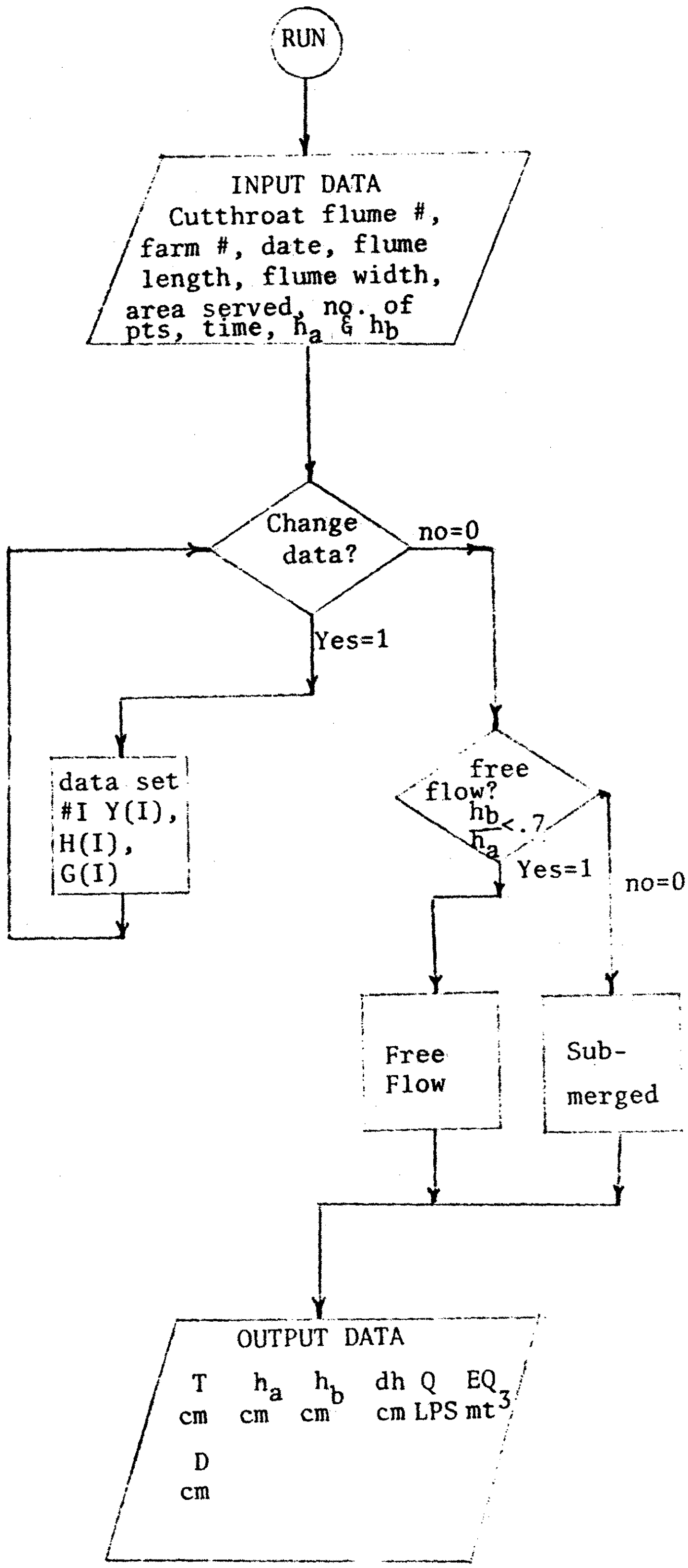
Length L		Bulletin Curve Values	Calculated Values
ft	mt	S_t	S_t
1.5	.457	.600	.6145
2	.610	.618	.6175
3	.914	.650	.6472
4	1.219	.685	.6819
5	1.524	.715	.7144
6	1.829	.742	.7431
7	2.133	.765	.7672
8	2.438	.785	.7867
9	2.743	.799	.8014

.../...


FLUME LENGTH, L, IN METERS
1.0
2.0
3.0
Q = C₁ h_a^n₁
C₁ = K₁ W^1.025
Q = K₁ W^1.025 h_a^n₁
6.0
5.0
4.0
3.0
2.0
1.0
0
2.1
2.0
1.9
1.8
1.7
1.6
K₁
n₁
FREE FLOW FLUME LENGTH COEFFICIENT, K₁
FREE FLOW EXPONENT, n₁
0
2.0
4.0
6.0
8.0
10.0
FLUME LENGTH, L, IN FEET


FLUME LENGTH, L, IN METERS
1.0
2.0
3.0
SUBMERGED FLOW FLUME LENGTH COEFFICIENT, K2
60
50
40
30
20
10
0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
SUBMERGED FLOW EXPONENT, n2
$Q = \frac{C_2(h_a - h_b)^{n_1}}{(-\log S)^{n_2}}$
$C_2 = K_2 W^{1.025}$
$Q = \frac{K_2 W^{1.025} (h_a - h_b)^{n_1}}{(-\log S)^{n_2}}$
K_2
n_2
0
20
40
60
80
100
FLUME LENGTH, L, IN FEET


Flume Length Coefficients, K_1, K_2
Flow Exponents, n_1, n_2
Transmission Submergence, S_t, in %
Flume Length, L, in feet
n_1
n_2
K_1
K_2
S_t
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
2.2
50
60
70
80
90
0
2.0
4.0
6.0
8.0
10.0


RUN
INPUT DATA
Cutthroat flume #, farm #, date, flume length, flume width, area served, no. of pts, time, h_a & h_b
Change data?
no=0
Yes=1
data set #I Y(I), H(I), G(I)
free flow? $\frac{h_b}{h_a} < .7$
Yes=1
no=0
Free Flow
Sub-merged
OUTPUT DATA
T cm
h_a cm
h_b cm
dh cm
Q LPS
EQ mt^3
D cm

```
0: dim L,W,V,T[200],H[200],G[200],Q[200],D[200],L[200],P,S,J[5]
1: dim X[200],Y[200]
2: enp "CUTTHROAT FLUME NUMBER",V
3: enp "Farm No.",N
4: enp "Date DDMMYY",K
5: 0)P
6: enp "flume length in meters",L;if flg13+(L<.45)+(L>2.75);cfg 13;jmp 0
7: enp "flume throat width in meters",W
8: enp "area served in square meters",S
9: enp "number of additional data points",Q
10: 2.944+1.448/L)B;1.418+.405/L)C;.740-.064/L)D;1/D)D
11: 2.51-.3011n(L))E;.485+.1007L-.0267L^2+.0102/L^2)F
12: 1)H
13: for I=H to Q;prt I;enp "Time",Y[I];enp "ha",H[I];enp "hb",G[I];next I
14: ent "changes ?,1=Yes,0=NO",J[2];if J[2]=0;gto 17
15: enp "data set no I",I;enp Y[I],H[I],G[I]
16: gto 14
17: for I=H to Q
18: I-1)J
19: if I=1;0)A)T[1];next I
20: if frc(Y[I])-frc(Y[J])<0;100(Y[I]-Y[J]-.4)+A)A)T[I];gto +2
21: 100(Y[I]-Y[J])+A)A)T[I]
22: next I
23: for I=H to Q;G[I]/H[I])X[I];prt X[I];next I
24: spc ;prt F;dsp " yes=1 , FREE FLOW hb/ha<",F;enp "",G
25: for I=H to Q
26: if G[I]/H[I]<F;1000B3.281^(C-1.975)W^1.025(H[I]/100)^C)Q[I];gto 28
27: 1000E2.381^(C-1.975)W^1.025((H[I]-G[I])/100)^C/(-log(G[I]/H[I]))^D)Q[I]
28: if I=1;jmp 3
29: 0)E[1]
30: E[I-1]+(6/100)((Q[I]+Q[I-1])/2)(T[I]-T[I-1]))E[I];100L[I]/S)D[I]
31: next I
32: Q)P
33: fmt 8,/,/;wrt 701.8
34: wrt 701.8;wrt 701.8
35: conv 124,27
36: wrt 701,"|n|&k1S"
37: if G=1;fmt 9,2x,"FREE FLOW CUTTHROAT FLUME DATA",/;wrt 701.9;gto 39
38: fmt 2,3x,"SUBMERGED CUTTHROAT FLUME DATA",/;wrt 701.2
39: wrt 701,"|&k0S"
40: fmt 1,30x,f6.0;wrt 701.1,"Date",K
41: fmt 9,22x,"Farm No.",f3.1,4x,"Area",2x,f9.3,"mt2";wrt 701.9,N,S
42: fmt 8,/,/;wrt 701.8
43: fmt 3,30x,"for flume number";wrt 701.3
44: fmt 7,35x,f2.0
45: wrt 701.7,V
46: fmt 8,/,/;wrt 701.8
47: fmt 4,5x,"T",9x,"ha",9x,"hb",9x,"dh",9x,"Q",9x,"SQ",9x,"D";wrt 701.4
48: wrt 701,"|&dD"
49: fmt 6,4x,"min",9x,"cm",9x,"cm",9x,"cm",8x,"lps",8x,"m3",9x,"cm";wrt 701.6
50: wrt 701,"|&d@"
51: fmt 5,2x,f5.1,f10.1,f12.2,f10.2,f13.2,f10.2,f11.2
52: 1)H
53: for I=M to Q
54: wrt 701.5,T[I],H[I],G[I],H[I]-G[I],Q[I],L[I],D[I]
55: next I
56: fmt 2,40x,"(design & analysis by M.Helal)";wrt 701.2
57: stp
*23354
```

A Computer Program

A computer program has been prepared for the HP 9825. The details are presented in this section.

USER INSTRUCTIONS

* Tape #Ø
* [rew]
* [Load] [Ø] [EX]
* [RUN]

1. When "CUTTHROAT FLUME NUMBER" is displayed:

    a. Enter desired flume number

    b. Press CONTINUE

2. When "Farm No." is displayed:

    a. Enter desired Farm Number

    b. Press CONTINUE

3. When "Date DDMMYY" is displayed:

    a. Enter desired Date D is day, M is month and Y is year

    b. Press CONTINUE

4. When "flume length in meters" is displayed:

    a. Enter desired flume length

    b. Press CONTINUE

5. When "flume threat width in meters" is displayed:

   a. Enter desired threat width

   b. Press CONTINUE

6. When "area served in square meters" is displayed:

   a. Enter the desired area

   b. Press CONTINUE

7. When "number of additional data points" is displayed:

   a. Enter desired the number of points

   b. Press CONTINUE

8.I. When "Time" is displayed:

   a. Enter desired the time "if the time 10 and 35 mints. a.m. enter 10.35.
      if the time 2 and 45 p.m. enter 14.45

   b. Press CONTINUE

II. When "ha" is displayed:

   a. Enter desired the U.S.L.

   b. Press CONTINUE

III. When "hb" is displayed:

   a. Enter desired the D.S.L.

   b. Press CONTINUE

9. If "Time" is displayed; repeat step #8.

10. When "Changes ?, 1=Yes, 0=No" is displayed:

Yes a- Enter 1

b- CONTINUE

c- displayed "data set no. I ; Enter set #

d- displayed Y(#)? ;Enter Time hr. sec.
displayed H(#)? ;Enter U.S.L. ha
displayed G(#)? ;Enter D.S.L. hb

No a- Enter 0

b- CONTINUE

11. When "free flow (hb/ha<.7) yes=1, no=0" is displayed

check on the output result on the tape printer

a- if <.7 ;Enter 1
   if >.7 ;Enter 0

b- CONTINUE

HEWLETT - PAKARD Programming

HP 33E and HP 25

L cm	45	60	90	120	150	180
K_1	6.17978	5.3753	4.57089	4.1687	3.9273	3.7664
n_1	2.31800	2.0930	1.86800	1.7999	1.688	1.643
K_2	3.14960	2.9192	2.59439	2.364	2.1852	2.0392
n_2	1.65077	1.5593	1.47735	1.4395	1.4178	1.4036
S	.6148	.6169	.6456	.6798	.7121	.7407

For used HP 25 or HP 33E Calculators, will be helping with table before or calculate the coefficient by using functions 7, 8, 9, 10 and 12, also calculate

$(3.281)^{n_1 - 1.975} W^{1.025} = K$

and K K_1 [STO] [0]
n_1 STO [1]
K K_2 STO [2]
n_2 STO [3]

H_b [ENTER]
H_a INPUT

```
00
01    STO  4
02    R↓
03    STO  5
```

.../...

```
04        RCL  4
05        ÷
06        .  }
07           } S
08           }
09        f -    (X≤Y)    or    (X<Y)
10        GTO 35
11        RCL  4
12        RCL  1
13        f3
14        RCL  0
15        x
16        STO  4
17        R/S  (the number dispear = Q discharge mt³/sec) ← no. of pt
18        2   (1 if used HP 33E or 2 if used HP 25)
19        f -    (X>Y)    X≥Y
20        GTO  24
21        RCL  4
22        STO  6
23        GTO  00
24        RCL  4
25        RCL  6
26        +
27        2
28        ÷
29        R/S    ← Time (Second) (diff. time bet. 2 pts)
30        x
31        STO + 7
32        RCL  4
33        STO  6
34        GTO  00
35        X≶Y
36        f  2 or 8 (log) 2 if used 33E or 8 if used 25
```

.../...

```
37      CHS
38      RCL  3
39      f  3  (Y^X)
40      g  3 or R↓ (1/X)  3 if used 33E or R↓ if used 25
41      RCL  4
42      RCL  5
43      -
44      RCL  1
45      f 3  (Y^X)
46      x
47      RCL  2
48      x
49      GTO 16
```

1. STRUCTURE

   $K K_1$ STO 0

   n_1 STO 1

   $K K_2$ STO 2

   n_2 STO 3

2. H_a ENTER

   H_b

   R/S
3. # of points

   R/S
4. if # of points = 1

   repeat 2.
5. Time in sec. R/S
6. repeat 2

.../...

at the end RCL 7 will get on total discharge mt^3 if multiplied by 100 and division on area in square meter will get on depth in centimeters.

HEWLETT-PAKARD Program

For HP 67 & HP 97

	HP 67	HP 97
001	f LBL A	LBL· A
002	STO 8	STO 8
003	h R↓	R↓
004	STO 9	STO 9
005	DSP 5	DSP 5
006	2	2
007	.	.
008	9	9
009	6	6
010	2	2
011	STO 0	STO 0
012	1	1
013	.	.
014	4	4
015	1	1
016	8	8
017	STO 1	STO 2
018	2	2
019	.	.
020	5	5
021	1	1
022	STO 2	STO 2
023	.	.
024	7	7

.../...

	HP 67	HP 97
025	4	4
026	8	8
027	STO 3	STO 3
028	1	1
029	.	.
030	4	4
031	4	4
032	8	8
033	RCL 9	RCL 9
034	÷	÷
035	STO + 0	STO + 0
036	.	.
037	4	4
038	0	0
039	5	5
040	RCL 9	RCL 9
041	÷	÷
042	STO + 1	STO + 1
043	RCL 9	RCL 9
044	f LN	LN
045	.	.
046	8	8
047	0	0
048	1	1
049	x	x
050	CHS	CHS
051	STO + 2	STO + 2
052	.	.
053	0	0
054	6	6
055	4	4
056	RCL 9	RCL 9

.../...

	HP 67	HP 97
057	÷	÷
058	CHS	CHS
059	STO + 3	STO + 3
060	RCL 3	RCL 3
061	h 1/x	1/x
062	STO 3	STO 3
063	.	.
064	4	4
065	8	8
066	5	5
067	STO 4	STO 4
068	.	.
069	1	1
070	8	8
071	8	8
072	7	7
073	RCL 9	RCL 9
074	x	x
075	STO + 4	STO + 4
076	RCL 9	RCL 9
077	g x^2	x^2
078	.	.
079	0	0
080	2	2
081	6	6
082	9	9
083	x	x
084	CHS	CHS
085	STO + 4	STO + 4
086	RCL 9	RCL 9
087	g x^2	x^2
088	.	.
089	0	0
090	1	1

.../...

	HP 67	HP 97
091	0	0
092	2	2
093	h $x \lessgtr y$	$x \lessgtr y$
094	÷	÷
095	STO + 4	STO + 4
096	RCL 8	RCL 8
097	1	1
098	.	.
099	0	0
100	2	2
101	5	5
102	h y^x	y^x
103	STO 8	STO 8
104	RCL 1	RCL 1
105	1	1
106	.	.
107	9	9
108	7	7
109	5	5
110	-	-
111	3	3
112	.	.
113	2	2
114	8	8
115	1	1
116	h $x \lessgtr y$	$x \lessgtr y$
117	h y^x	y^x
118	RCL 8	RCL 8
119	x	x
120	RCL 0	RCL 0
121	x	x
122	STO 0	STO 0
123	RCL 8	RCL 8

/...

	PH 67	PH 97
124	RCL 2	RCL 2
125	x	x
126	STO 2	STO 2
127	RCL 4	RCL 4
128	STO 9	STO 9
129	RNT	RNT
130	f LBL B	LBL B
131	h SPACE	f SPACE
132	STO 5	STO 5
133	h R↓	R↓
134	STO 4	STO 4
135	f -x-	PRINT x
136	↓	↓
137	f P≶S	f P≶S
138	STO 1	STO 1
139	↓	↓
140	STO 2	STO 2
141	f P≶S	f P≶S
142	RCL 5	RCL 5
143	f -x-	PRINT x
144	RCL 4	RCL 4
145	÷	÷
146	RCL 9	RCL 9
147	g x>y	f x>y
148	GTO C	GTO C
149	RCL 4	RCL 4
150	RCL 1	RCL 1
151	h y^x	y^x
152	RCL 0	RCL 0
153	x	x
154	STO 4	STO 4
155	f LBL D	LBL D

.../...

	HP 67	HP 97
156	f -x-	PRINT x
157	f P≶S	f P≶S
158	. RCL 2	. RCL 2
159	f P≶S	f P≶S
160	1	1
161	g x≠y	f x≠y
162	GTO E	GTO E
163	0	0
164	STO 7	STO 7
165	RCL 4	RCL 4
166	STO 6	STO 6
167	RTN	RTN
168	f LBL E	LBL E
169	RCL 4	RCL 4
170	RCL 6	RCL 6
171	+	+
172	2	2
173	÷	÷
174	f P≶S	f P≶S
175	RCL 1	RCL 1
176	f P≶S	f P≶S
177	x	x
178	6	6
179	0	0
180	x	x
181	STO + 7	STO + 7
182	RCL 4	RCL 4
183	STO 6	STO 6
184	RCL 7	RCL 7
185	f -x-	PRINT x
186	RTN	RTN

.../...

	HP 67	HP 97
187	f LBL C	LBL C
188	h $x \lessgtr y$	$x \lessgtr y$
189	f LOG	f LOG
190	CHS	CHS
191	RCL 3	RCL 3
192	h y^x	y^x
193	h 1/x	1/x
194	RCL 4	RCL 4
195	RCL 5	RCL 5
196	-	-
197	RCL 1	RCL 1
198	h y^x	y^x
199	x	x
200	RCL 2	RCL 2
201	x	x
202	STO 4	STO 4
203	GTO D	GTO D

STRUCTURE

* Load a program
1- Lenth in meter ENTER
Cutthroat in meter
2- Press A
3- # of point ENTER
time in minutes ENTER
U.S.L. H_a in meters ENTER
D.S.L. H_b in meters
4- Press B
5- REPEAT 3 and 4
if finished

.../...

6- [1] [0] [0] [x]

7- Area in square meter

8- press ÷

to get an DIPTH in Cantimeter

Example

Flume	90 cm x 20 cm		area 525.3 mt^2
# of point	U.S.L. H_a cm	D.S.L. H_b cm	Time
1	11	6	
2	8.5	7	10
3	10	8.5	10
4	11.5	10	10
5	11	10	10
6	11	10	10
7	10	9	10
8	11	5	10
9	11	5.5	10
10	10	6	10

.9

ENTER

.2

A

1	2	3	10	100
ENTER	ENTER	ENTER	ENTER	x
0	10	10	10	525.3
ENTER	ENTER	ENTER	ENTER	÷
.11	.085	.1	.1	f Displace
ENTER	ENTER	ENTER	ENTER	PRINT x
.06	.07	.085	.06	
B	B	B	B	

Staff Paper #7

PROGRESS REPORT OF RICE PLANTING TRIALS AT ABOU RAIA, KAFR EL SHEIKH GOVERNORATE 1979

M. Samire Abdel Aziz, Ragy Darwish and Gene Quenemoen

June, 1980

INTRODUCTION

Rice production in Egypt started about 100 years ago with the reclamation of saline soils in the North Delta. Continuous flooding of fields produced rice crops and at the same time leached salts from the soil profile. The rice was broadcast directly into the soil.

The salts were gradually leached to lower levels in the soil profile. Then higher yielding rice arities, although less salt tolerant, were introduced and the farmers rapidly increased rice production. It was then observed that the limiting factor to rice production was shortage of water. The delivery canals did not have sufficient cross section to carry an amount of water to accommodate continuous flooding of all the rice fields.

In 1945 El Belkeanee introduced the technique of transplanting rice seedlings in puddled soil. The rice fields were puddled with animal drawn floats prior to planting rice. This broke down the soil structure and reduced the infiltration rate saving about 18% of the water that had been used in the older methods of rice culture.[2/] Total water use efficiency increased from

.../...

1/ The authors are Team Leader and Agronomist, Team Economist and Main Office Economist respectively, Egypt Water Use and Management Project (EWUP), Cairo, A.R.E.

2/ Giballi and Mahrous, "Water Requirements of Rice at the North Delta," First Conference of Rice, Cairo, Egypt, 1970.

0.374 kg. of rice produced per cubic meter of water used under the old method to 0.601.

Egypt currently produces about 1 million feddans of rice annually using the method of transplanting on puddled soil. However because of increasing labor costs some farmers are going back to the older dry seeding method which is expected to increase the annual water duty per feddan from 8,000 cubic meters to 10,000. The dry method is also expected to reduce yields.

In order to get quantitative data regarding this problem EWUP personnel conducted a field trial during the summer of 1979 at its field site at Abou Raia Village in Kafr El Sheikh Governorate.

RICE PRODUCTION AT ABOU RAIA

Rice is an important crop in the area served by the Abou Raia Cooperative. As shown in Table 1 it occupied the largest area of land during the 1979 summer season and yielded the largest return (financial value) to farmers. Only cotton exceeded it in "economic value".[1/]

Unfortunately rice production at Abou Raia is becoming increasingly uneconomical due to high costs and low returns. Crop enterprise reports prepared by EWUP scientists in 1978 indicated that rice ranked near the bottom in terms of returns to farmers per feddan for each month it occupied the land.[2/]

.../...

1/ Financial value reflects price actually paid and received by farmers as influenced by subsidies and government administered prices. Economic value reflects world market price minus the marketing and transportation costs between the Egyptian "farm gate" and the international market receiving center.

2/ From unpublished EWUP data collected for problem identification studies at Abou Raia.

Only wheat had lower returns. Considering that it is produced during the best months of the summer growing season farmers complain that the returns are too low to justify producing this crop. The net returns for major crops produced at the EWUP Abou Raia field site in 1979 are shown in Table 2.

Subsequent studies completed in late 1979 by Farouk Abdel Al and students from Kafr El Sheikh University show even lower net returns from rice production. Table 3 indicates that net returns (returns above all costs) are negative L.E. 37.16. Since the date of completing that study rice prices to farmers have been increased to L.E. 70.0 per tonne. This may somewhat alleviate the cost-price squeeze but it should also be recognized that the costs to the farmer are continually increasing.

Data from Table 3 indicate that pulling seedlings from the nursery and transplanting them requires 48 hours of labor per feddan. This represents 17 percent of the total labor required for producing and harvesting a crop of rice.

Farmers report it is currently very difficult to find laborers to pull rice from nurseries and transplant it. Apparently many laborers have left the villages in the vicinity of Abou Raia for jobs in other Arab countries and industrial areas of Egypt. Farmers also report that the laborers who remain are no longer willing to work long days as in former times. Labor demands are at a peak in June and July, the months normally devoted to transplanting rice. This drives up the wage rate on a seasonal basis as shown in Figure 1.

The labor costs shown in Table 3 seem to reflect relatively low-paid family labor. Recent experience with commercial labor crews indicates the wage rate per hour should be at least L.E. 0.31 per hour. At this rate the cost of pulling seedlings from the nursery and transplanting is nearly L.E. 15.0 per feddan (L.E. 0.31 x 48 hours = L.E. 14.88). The average length of day worked is five hours.

.../...

Table 1: Production and Value of Major Crops Grown at Abou Raia Cooperative, Kafr El Sheikh Governorate, 1979.

Crop	Number of Feddans	Estimated Value	
		Economic	Financial
	feddans	L.E.	L.E.
Summer Season:			
Cotton	850	589,333	265,200
Maize	285	65,142	29,640
Rice	1642	553,354	276,677
Winter Season:			
Berseem, long season	758	121,280	121,280
Berseem. short season	850	51,000	51,000
Flax	200	37,800	37,800
Wheat	800	186,046	80,000
Broad beans	30	4,485	4,485

Source: EWUP problem identification studies.

Table 2: Average Net Return per Feddan Crop-Month at Abou Raia in 1978.

Crop	Average Net Return Per Month
	L.E.
Cotton	7.2
Maize	7.8
Rice	6.3
Berseem, long season	12.5
Flax	10.8
Wheat	6.0
Broad beans	6.7

Source: EWUP problem identification studies.

.../...

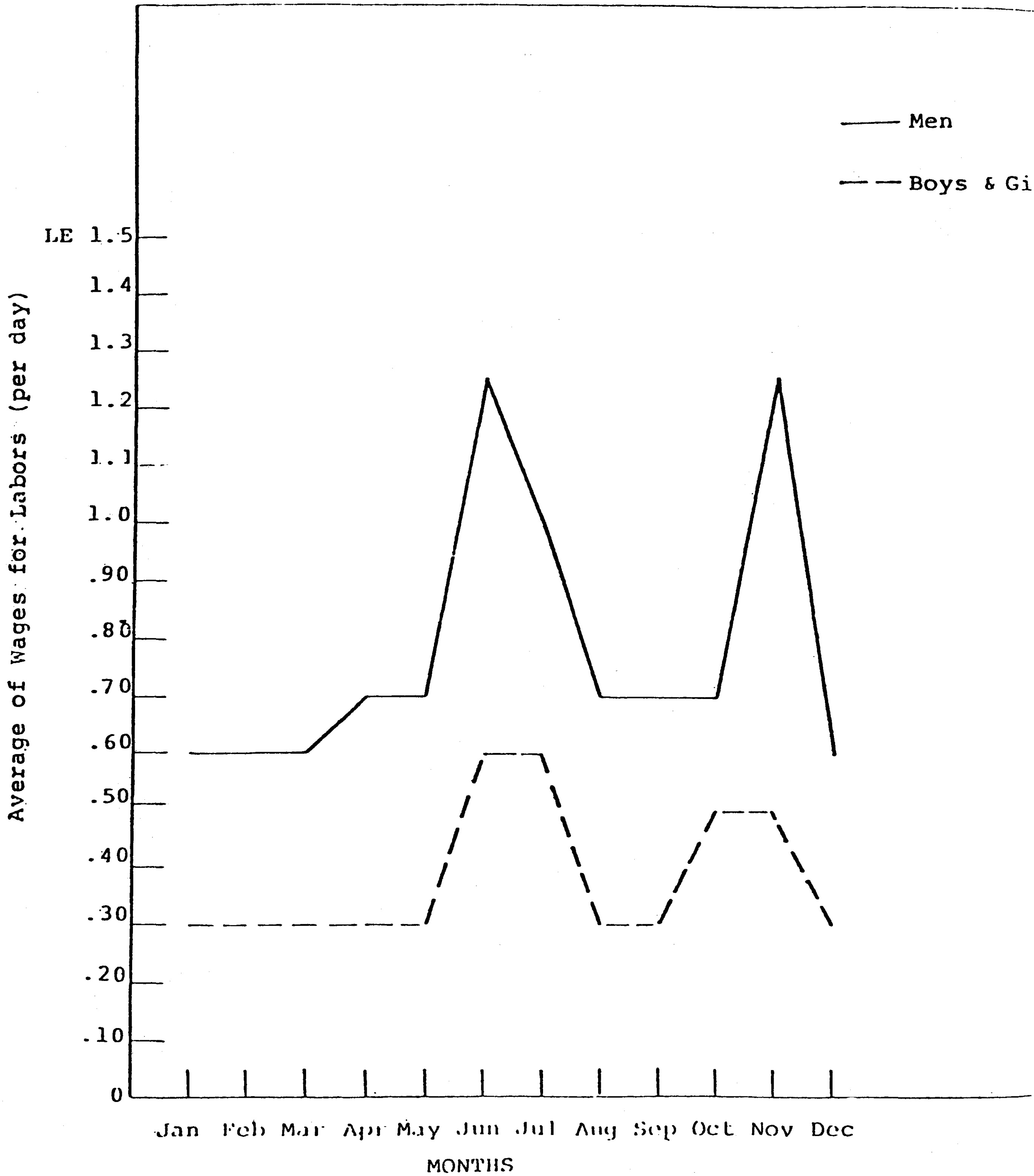


Figure 1. Average Wage Rates for Farm Labor at Kafr El Sheikh, 1
Source: EWUP problem identification studies.

TABLE 3. CROP ENTERPRISE COST STUDY *
RICE AT ABU-RAIA AREA (1)

Prepared by: 4Students& FAROUK ABDELAL
Identifier Code: tp-1,trk-1,f11
Date Prepared: AUGUST 20,1979

EGYPT WATER USE & MANAGEMENT PROJECT

Item	Unit	Number of Units	Price or Value per unit L.E.	Total income or Costs L.E.
Income				
Rice grains	Ton	2.5	65.000	162.50
Rice straw	Camel load	4.0	1.500	6.00
Total Income				168.50
Variable Costs				
Org. fert. transportation	Donkey load	250.0	0.050	12.50
Labor to spread org. fert.	Man hour	6.0	0.200	1.20
Plowing	Tractor hour	2.0	1.250	2.50
Buddling	Buddling/F	1.0	4.000	4.00
Nursary planting seeds	Kila	6.0	0.800	4.80
Labor to spread seeds	Man hour	1.0	0.200	0.20
Nursary plants pulling	Man hour	18.0	0.200	3.60
Transplanting	Boy hour	30.0	0.100	3.00
Weeding	B.orG. hour	24.0	0.100	2.40
CHEMICAL FERTILIZER		0.0	0.000	0.00
Ammonium Sulphate	Kg.	150.0	0.050	7.50
Super Trible	Kg.	50.0	0.070	3.50
Labor to spread chem. fert.	Man hour	6.0	0.200	1.20
IRRIGATION (2)		0.0	0.000	0.00
Sakia rent	Sakia hour	157.0	0.080	12.56
Cow or Bufflo rent	C.or B. rent	157.0	0.300	47.10
Labor to spread water	Man hour	157.0	0.200	31.40
HARVESTING (3)		0.0	0.000	0.00
Labor for harvesting	Man hour	30.0	0.200	6.00
Labor for bundlling	Man hour	8.0	0.200	1.60
Labor for loading	Man hour	3.0	0.200	0.60
Transporting by camel	Camel load	6.0	1.000	6.00
Thrashing	Machine hour	2.0	1.500	3.00
Winnowing	Machine hour	2.0	1.500	3.00
Total Variable Costs				157.66
Return Above Variable Costs				10.84
Fixed Costs				
Land rent	Month	6.0	7.000	42.00
Management charge	Month	6.0	1.000	6.00
Total Fixed Costs				48.00
Grand Total Costs				205.66
Return Above All Costs				-37.16

FOOTNOTES:

* This study for an area of one feddan.
(1) These data was collected from 4 study cases at ABU-RAIA site by IBRAHIM ELSHENNAWY , MOHAMED ELGAZZAR, ABDELHALIM ELSHERBINI, and Med.SALAMA Students from faculty of AGRICULTURE at KAFR ELSHEIKH, ECONOMIC DEPARTMENT.
(2) Rice needs adding water day after day and some times evrey day.1F.needs abou 8800 Cu. meters .
(3) Rice is the second most important export crop of EGYPT after Cotton . Rice nursaries are planted in late APRIL and in early MAY. Young plants transplanted to the fields one month later , usually during JUNE . Harvesting of rice starts in OCTOBER and continues in NOVEMBER .

	LABOR DISTRIBUTION			WATER DISTRIBUTION, CU METERS			
	Man Hours	Woman Hours	Boy/Girl Hours	First Irrig.	Second Irrig.	Third Irrig.	Fourth Irrig.
October	41	0	0	0	0	0	0
November	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	0	0	0	0	0	0	0
May	24	0	0	960	0	0	0
June	48	0	30	1568	0	0	0
July	47	0	12	2520	0	0	0
August	47	0	12	2520	0	0	0
September	22	0	0	1232	0	0	0
Total	229	0	54	Total Water Applied=	8800 cu meters		

FOOTNOTES:

- Water reqoirement based on our project researcch stations data .
- The quantity of water which is written under firest irrigation represents the quantity used in this month .
- Working day = 6 hours .

Within this context a field experiment was designed to evaluate rice production under alternative methods of planting seeds or transplanting seedlings. The objectives of the experiment were to compare (1) production costs, (2) yields and (3) requirements for alternative methods of planting seeds and seedlings.

EXPERIMENTAL DESIGN

A plot of land near Drain #7 at Abou Raia Village was obtained through the cooperation of a local farmer. This plot, containing 4.27 feddans, was plowed and leveled before being divided into 10 strips as shown in Figure 2. Strips 2, 6 and 10 were provided extra plowing before leveling in order to prepare a better seedbed for dry seeding (treatment B).

Treatment A, applied to strips 1, 5 and 9 consisted of traditional transplanting. The strips were puddled before pulling the nursery seedlings which were transplanted manually.

Treatment B consisted of drilling, with EWUP tractor and drill, dry seed into dry granulated soil in strips 2, 6 and 10. Before seeding the strips were smoothed with animals and a wooden float. These strips were then irrigated frequently while the seeds germinated and began their growth.

Treatment C was applied to strips 3 and 7. Pre-germinated seeds were planted in puddled soil with a row seeder, pulled and operated manually. The row seeder was developed bv the International Rice Research Institute(IRRI).

Treatment D, applied to strips 4 and 8, utilized a Japanese made mechanical transplanter to place the seeds in puddled soil.

After the seedlings were established each strip was treated the same throughout the remainder of the growing season. Each strip was irrigated as

Strip	1	2	3	4	5	6	7	8	9	10
	A	B	C	D	A	B	C	D	A	B
Size in Feddans	.43	.47	.42	.44	.37	.41	.48	.42	.41	.42

Treatment	Description
A	Traditional manual transplanting of seedlings in puddled soil.
B	Drilling dry seed on dry granulated soil.
C	Drilling pre-germinated seeds on puddled soil.
D	Power transplanting of seedlings in puddled soil.

Figure 2: Layout of the Rice Seeding Trial at Abou Raia Coop., Kafr El Sheikh Governorate.

.../...

necessary to keep the base of the plants submerged in water. Irrigation water was measured at each application.

RESULTS OF TREATMENTS

The production costs and yields are sumarized in Table 4. Note the additional costs for plowing and smoothing for treatment B. Only treatments A, C and D included puddling. The amount and cost of seed for each treatment varied somewhat.

For treatment A the cost of removing seedlings from the nursery and transplanting them was L.E. 6.0 and L.E. 9.0 respectively. This was based on actual cost for hired labor.

The seeding cost for treatment B was estimated at L.E. 2.57 per feddan using data from EWUP machinery cost studies. This work required 1 hour per feddan of man and machine time. EWUP project equipment was used to do the work because machinery for rice seeding is not currently available through government or commercial sources.

Treatment C, utilizing the IRRI row seeder, was the lowest cost method of seeding. It required 1.5 hours to seed one feddan. Using prevailing wage rates we estimated the total cost of this operation to be L.E. 0.92 per feddan.

Treatment D required four hours of planting time using the two-row mechanical transplanter. Assuming this transplanter would be used 300 hours per year we estimated the cost per feddan at L.E. 5.11 (see page 15).

After the transplanting or seeding operation, all costs for each treatment were constant. The small difference for harvesting and handling due to variations in yield per feddan were not measurable.

.../...

Table 4: Summary of Costs and Returns from One Feddan of Four Systems of Seeding or Transplanting Rice.

Items	Treatments			
	A	B	C	D
	LE	LE	LE	LE
Variable Costs (per feddan)				
Plowing	2.40	3.69	2.40	2.40
Leveling	1.00	1.00	1.00	1.00
Puddling	1.62	–	1.62	1.62
Smoothing	–	1.54	–	–
Seeds	5.21	4.03	3.92	4.88
Removing Seedlings from nursery	6.00	–	–	–
Seeding and transplanting	9.00	2.57	.92	5.11 1/
Weeding, manually	12.07	12.07	12.07	12.07
Weeding with chemicals	4.50	4.50	4.50	4.50
Fertilizer	8.60	8.60	8.60	8.60
Irrigation	8.00	8.00	8.00	8.00
Harvesting	6.00	6.00	6.00	6.00
Transporting to village	3.30	3.30	3.30	3.30
Threshing	1.50	1.50	1.50	1.50
Winnowing	2.75	2.75	2.75	2.75
Total Variable Costs	71.95	59.55	56.58	61.73
Fixed Cost of Land and Mgmt.	42.00	42.00	42.00	42.00
Total Costs	113.95	101.55	98.58	103.73
Value of Grain and Straw at Financial Prices	129.00	105.00	117.00	149.00
Return Above Costs (per feddan)	15.05	3.45	18.42	45.27

1/ Based on using a two-row transplanter 300 hours per year.

.../...

The average yields per feddan for grain and straw from the four treatments are shown below.

	Grain		Straw	
Treatment A	1.68	tonnes	4.86	tonnes
Treatment B	1.41	tonnes	3.65	tonnes
Treatment C	1.53	tonnes	4.34	tonnes
Treatment D	2.08	tonnes	3.37	tonnes

Using financial prices L.E. 65.0 per tonne for rice grain and L.E. 4.0 per tonne for rice straw, the values of the crops produced per feddan for each treatment are shown in Table 4. The return above cost is greatest for treatment D with C, A and B following in that order.

The water applied during the season was measured and is reported in Table 5. As expected treatment B, drilling seeds in dry soil, required the most water. Treatment D required the least due to savings in production of nursery seedlings.

Table 5: Average Water Applied per Feddan of Rice According to Specified Treatments.

	Treatments			
	A	B	C	D
Nursery	1,500	—	—	500
Field	6,500	10,000	9,000	6,500
Total	8,000	10,000	8,000	7,000
Percentage	100%	125%	113%	88%

.../...

THE MECHANICAL RICE TRANSPLANTER

Since the cost-return analysis of the field trial shows substantial gains in favor of the rice transplanter (treatment D) it is appropriate to give additional information about this machine. This will provide the reader with a basis for making judgements about its potential for Egypt.

The field trial was conducted with the use of a transplanting machine loaned to EWUP by Tanta Motors, a machine supply firm located at the city of Tanta. The Japanese Mitsubishi model MP206, 2-row transplanter costs L.E. 1380 and has a capacity of one-quarter feddan per hour. Cost and performance specifications of the transplanter are shown in Table 6.

The cost and performance specifications were subjected to analysis as shown in Table 7 and Figure 3. If we assume the transplanter is used 6 hours per day for 50 days, 300 hours each season, we can see from Table 7 that the cost per feddan would be L.E. 5.107. At this rate the transplanter could be used on a total of 75 feddans per planting season.

$$\frac{\text{6 hours per day x 50 days}}{\text{4 hours/feddan}} = \text{75 feddans/year}$$

If one assumes a shorter season or shorter working hours per day the appropriate cost figures can be found in Table 7.

Figure 3 shows that the cost per feddan declines as the number of feddans served per year increases. For any number of feddans greater than 9.18 the 2-row planter is less costly than doing the work manually. This so called "break-even point" can be determined by the following formula:

$$\text{(1)} \quad \text{Break-even Feddans} = \frac{\text{Annual Fixed Cost}}{\text{Manual Rate per Feddan - Variable Cost of Machine/Feddan}}$$

Table 6: Basic Data For 2-Row Rice Transplanter.

1. Name of machine	1. RICE TRANSPLANTER
2. Make	2. MITSUBISHI
3. Model	3. MP206
4. Size	4. 2-ROW
5. Power Source	5. GASOLINE
A*	
1. Date preparing data (day/month/year)	1. 310380
2. Present replacement price in Egypt L.E.	2. L.E. 1380
3. Wearout life in hours	3. 14,400
4. Av. expected repair cost/hr. L.E.	4. L.E. 0.20
5. Fuel consumption/hr.	5. 0.25
6. Fuel cost/liter L.E.	6. L.E. 0.12
7. Oil cost/100/hr. L.E.	7. L.E. 0.56
8. Grease cost/100 hr. L.E.	8. L.E. 0.10
9. Electric power required/hr. kw	9. ———
10. Electric cost/kw L.E.	10. ———
11. Salvage value, at end of wearout life L.E.	11. 0.00
12. Annual taxes, license and permit L.E.	12. 0.00
13. Interest rate in percent	13. 15 percent
14. Operator cost per hr. L.E. 2 laborers @ .30	14. L.E. 0.60
15. Hrs. per feddan	15. 4.0
16. Cubic meter per hr.	16. ———
17. Animal Power Cost/hr. L.E.	17. ———

.../...

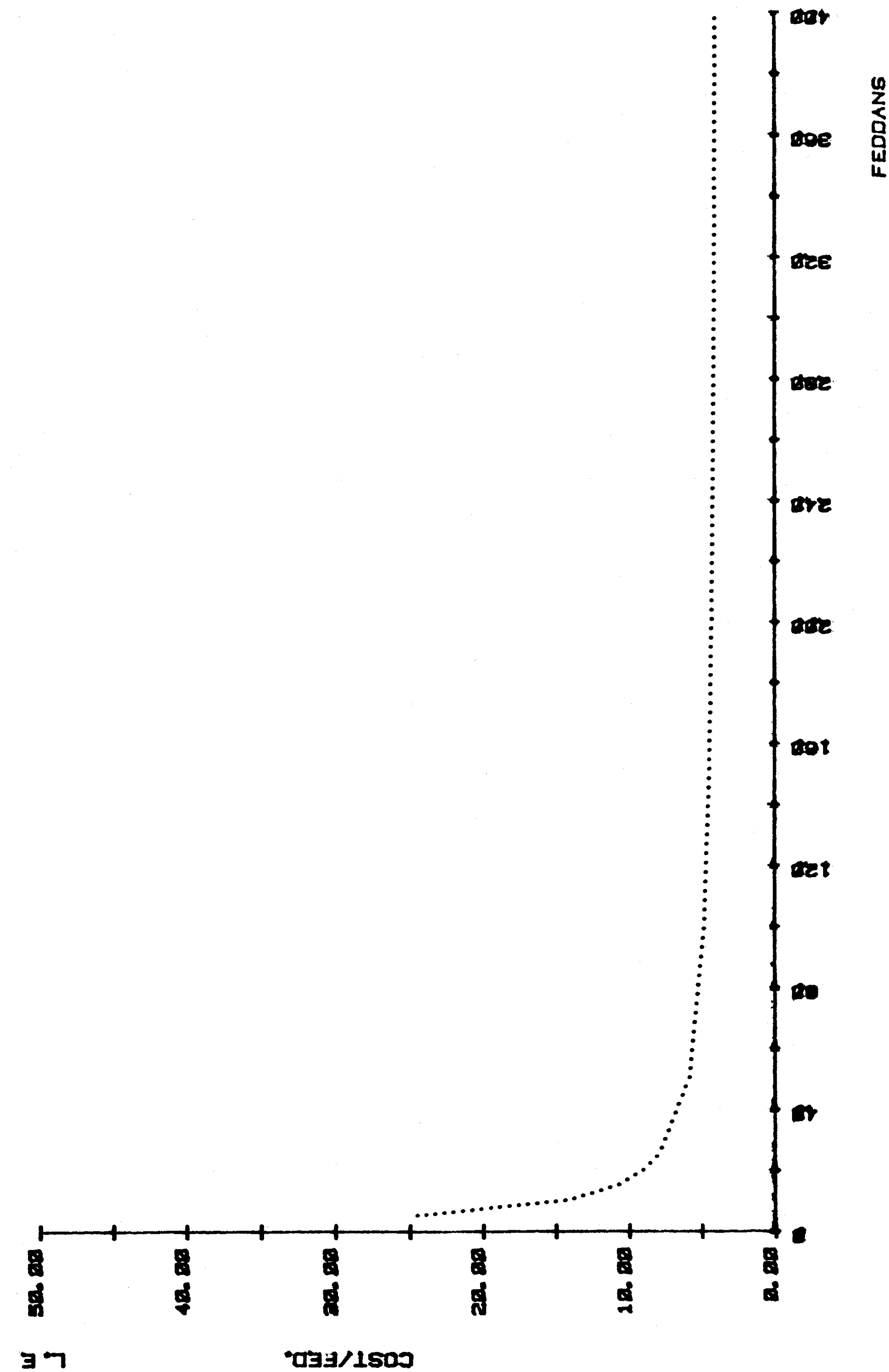

FEDDANS
COST/FED.
L.E
0.00
10.00
20.00
30.00
40.00
50.00
0
40
80
120
160
200
240
280
320
360
400

Table 7: Cost Analysis for Rice Planter.

MAKEMITSUBISHI MODEL MP 206 SIZE 2 ROW
POWER SOURCE GASOLINE

DATA PREPARING DATE:	31/ 3/80	SALVAGE VALUE AT END OF WEAR OUT LIFE:LE	0.000
PRESENT REPLACEMENT PRICE IN EGYPT	1300.000	ANNUAL TAXES , LICENSE AND PERMIT:LE	0.000
WEAR OUT LIFE IN HOURS	14400.000	INTEREST RATE	15.000 %
AVAREGE EXPECTED REPAIR COST PER HOUR:LE	0.200	OPERATOR COST PER hr.:LE	0.600
FUEL CONSUMPTION LITERS PER HOUR	0.250	Hrs PER FEDDAN	4.000
FUEL COST PER LITER:LE	0.120	CUBIC METERS PER hr	0.000
OIL COST PER 100 HOURS:LE	0.500	ANIMAL POWER COST/hr:LE	0.000
GREASE COST PER 100 HOURS:LE	0.108		

AN.HOURS OF USE	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	POWER COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	COST/hr	ANNUAL COST/Fd	COST/c.mt
10	103.500	0.958	2.000	0.300	0.060	6.000	112.818	11.282	45.127	0.0000
20	103.500	1.917	4.000	0.600	0.120	12.000	122.137	6.107	24.427	0.0000
30	103.500	2.875	6.000	0.900	0.180	18.000	131.455	4.382	17.527	0.0000
40	103.500	3.833	8.000	1.200	0.240	24.000	140.773	3.519	14.077	0.0000
50	103.500	4.792	10.000	1.500	0.300	30.000	150.092	3.002	12.007	0.0000
60	103.500	5.750	12.000	1.800	0.360	36.000	159.410	2.657	10.627	0.0000
70	103.500	6.708	14.000	2.100	0.420	42.000	168.728	2.410	9.642	0.0000
80	103.500	7.667	16.000	2.400	0.480	48.000	178.047	2.226	8.902	0.0000
90	103.500	8.625	18.000	2.700	0.540	54.000	187.365	2.082	8.327	0.0000
100	103.500	9.583	20.000	3.000	0.600	60.000	196.683	1.967	7.867	0.0000
200	103.500	19.167	40.000	6.000	1.200	120.000	289.867	1.449	5.797	0.0000
300	103.500	28.750	60.000	9.000	1.800	180.000	383.050	1.277	5.107	0.0000
400	103.500	38.333	80.000	12.000	2.400	240.000	476.233	1.191	4.762	0.0000
500	103.500	47.917	100.000	15.000	3.000	300.000	569.417	1.139	4.555	0.0000
600	103.500	57.500	120.000	18.000	3.600	360.000	662.600	1.104	4.417	0.0000
700	103.500	67.083	140.000	21.000	4.200	420.000	755.783	1.080	4.317	0.0000
800	103.500	76.667	160.000	24.000	4.800	480.000	848.967	1.061	4.245	0.0000
900	103.500	86.250	180.000	27.000	5.400	540.000	942.150	1.047	4.187	0.0000
1000	103.500	95.833	200.000	30.000	6.000	600.000	1035.333	1.035	4.141	0.0000

FEDD.	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	POWER COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	ANNUAL COST/Fd	COST/hr	COST/c.mt
5.00	103.500	1.917	4.000	0.600	0.120	12.000	122.137	24.427	0.000	0.0000
10.00	103.500	3.833	8.000	1.200	0.240	24.000	140.773	14.077	0.000	0.0000
15.00	103.500	5.750	12.000	1.800	0.360	36.000	159.410	10.627	0.000	0.0000
20.00	103.500	7.667	16.000	2.400	0.480	48.000	178.047	8.902	0.000	0.0000
25.00	103.500	9.583	20.000	3.000	0.600	60.000	196.683	7.867	0.000	0.0000
50.00	103.500	19.167	40.000	6.000	1.200	120.000	289.867	5.797	0.000	0.0000
100.00	103.500	38.333	80.000	12.000	2.400	240.000	476.233	4.762	0.000	0.0000
150.00	103.500	57.500	120.000	18.000	3.600	360.000	662.600	4.417	0.000	0.0000
200.00	103.500	76.667	160.000	24.000	4.800	480.000	848.967	4.245	0.000	0.0000
250.00	103.500	95.833	200.000	30.000	6.000	600.000	1035.333	4.141	0.000	0.0000
300.00	103.500	115.000	240.000	36.000	7.200	720.000	1221.700	4.072	0.000	0.0000
350.00	103.500	134.167	280.000	42.000	8.400	840.000	1408.067	4.023	0.000	0.0000
400.00	103.500	153.333	320.000	48.000	9.600	960.000	1594.433	3.986	0.000	0.0000

Using figures from Table 7 and assuming the manual rate of transplanting one feddan is L.E. 15.0, we can compute BEF as follows:

$$BEF = \frac{103.5}{15.0 - 3.73^{1/}} = 9.18 \text{ feddans/year}$$

The break-even point, 9.18 feddans, indicates that if the machine is to be used on more than 9.18 feddans per year it will be less costly than transplanting manually. Note however, that this considers only the cost of transplanting. Other factors such as change in seed requirement and yield will also influence the break-even point. The cost of seed for machine planting was slightly lower in the field trial (5.21 - 4.88 = 0.33). Also the value of grain and straw increased (L.E. 149 - 129 = L.E. 20). The combination of these two factors adds L.E. 20.33 to the benefits in favor of machine transplanting. This value can be added to the denominator, as shown below and BEF changes accordingly.

$$BEF = \frac{103.5}{20.33 + 15.00 - 3.73} = 3.29 \text{ feddans/year}$$

This implies that if the yield increases and cost advantages are accounted for it will be economically advantageous to use the machine transplanter if it can be used on more than 3.29 feddans per year.

SUMMARY, CONCLUSION AND CAUTION

This field trial compares four methods of seeding rice, viz. (A) traditional manual transplanting, (B) seeding in dry soil, (C) seeding in wet puddled soil

.../...

1/ The variable cost per feddan is computed from numbers circled in Table 7

$$L.E.\ 3.73 = \frac{1.917 + 4.000 + 0.600 + 0.120 + 12.000}{5 \text{ feddans}}$$

and (D) machine transplanting. The returns above costs are highest for treatment D with C, A and B following in that order.

Water requirements were highest for treatment B, with treatment C, A and D following in that order. The savings in water between treatments B and D is 3,000 cubic meters per feddan per season.

The reader is cautioned that this trial represents only one year of research. Problems were noticed which will require additional study before any general recommendations can be made.

Matted seedlings for mechanical transplanting are easy to grow but they must be transplanted at a younger growth stage than nursery seedlings transplanted by hand. Also the time allowance for using them, between the 10th and 14th day of growth, is narrower than for nursery seedlings, 21st to 35th day. This intensifies the coordination needed between seedling production and transplanting.

Additional study is needed to determine how this technology can be adapted into the farmer's total production system, the net effect on production of rice and other crops in the rotation, total water requirements, and coordination between seedling production and transplanting.

Staff Paper #8

CALCULATION OF MACHINERY COSTS FOR EGYPTIAN CONDITIONS

Mohamed Halel, Bayomi Ahmed, Gamal Ayad,
James Loftis, M.E. Quenemoen and
R. J. McConnen

December, 1979

The purpose of this report is to familiarize the reader with the methods developed by and used to calculate machinery costs for the Egyptian Water Use Project. The costs are calculated by using a program developed in Cairo to be used on the Project's HP9825A desktop computer system. This report is not meant to be a users manual for the program. Instead, the two main purposes are (1) to illustrate the methods of preparing the data used by the program and (2) to outline the principle uses of the program.

DATA PREPARATION

The data input form is presented on the next page. The items are identified by the symbols A$[1], A$[2], ... A$[5], A[2], ... A[17] These symbols also identify the name of the variables used in the computer program and are used in the process of both correcting any errors that might occur in recording data and in conducting sensitivity analysis. Sensitivity analysis involves the systematic changing of the value of some set of variables such as cost of fuel and then using the program to calculate the impact of machinery costs. This last characteristic makes the program especially useful in exploring a wide range of interesting and relevant problems associated with machinery cost.

If no data are entered for one of the items on the data form, the blank will either be ignored (most A$[*].items) or treated as zero (some A[*] items). This feature helps make the program a general program which can be used to analyze costs for items that range from a manpowered

DATA INPUT FORM

MACHINE COST

DATA PREPARED BY ____________________ DATE ____________________

Tape # Track # File #

A $ [*] 1/

1.	Name of machine	(19)	1.	________
2.	Make	(19)	2.	________
3.	Model	(9)	3.	________
4.	Size	(19)	4.	________
5.	Power Source	(9)	5.	________

A *

1.	Date preparing data DDMMYY		1.	________
2.	Present replacement price in Egypt L.E.	(12)	2.	________
3.	Wearout life in hours	(12)	3.	________
4.	Av. expected repair cost/hr. L.E.	(12)	4.	________
5.	Fuel consumption/hr	(12)	5.	________
6.	Fuel cost/liter L.E.	(12)	6.	________
7.	Oil cost/100/hr. L.E.	(12)	7.	________
8.	Grease cost/100 hr. L.E.	(12)	8.	________
9.	Electric power required/hr. kw	(12)	9.	________
10.	Electric cost/kw L.E.	(12)	10.	________
11.	Salvage value, at end of wearout life L.E.	(12)	11.	________
12.	Annual taxes, license and permit L.E.	(12)	12.	________
13.	Interest rate in percent	(12)	13.	________
14.	Operator cost per hr. L.E.	(12)	14.	________
15.	Hrs. per feddan per year	(12)	15.	________
16.	Cubic meter per hr.	(12)	16.	________
17.	Animal Power Cost/hr L.E.	(12)	17.	________

1/ Maximum characters allowed.

Shaduf to large modern earthmoving equipment. The numbers in brackets (e.g. (19) for item A$[1]) indicates the maximum number of characters which can be used to assign either a name or a value to a variable.

ASSUMPTION USED IN THE ANALYSIS

The program was developed to make use of the type of data generally available for Egyptian farm related equipment. While more elaborate models could be used, in most cases they would add little useful information to an analysis.

The present replacement price in Egypt is used rather than purchase price - although both prices could be the same. Largely because of inflation, it was assumed that replacement price was the most relevant price for the purposes of calculating the costs of using machinery. If you disagree, you are of course free to treat item A[2] as you see fit. Depreciation is calculated on a straight line basis over the wearout life of the machine rather than a yearly basis. Egyptian machinery is more apt to be used until it wears out rather than become obsolete. Because level of use per year will vary greatly from farm to farm, the useful life of machinery in years is also likely to vary. Wearout life can be influenced by the type of maintenance program and some may wish to consider alternative sets of wearout life (A[3]) as related to repair cost (A[4]), oil costs (A[7]) and grease costs (A[8]). This is an example of the kind of sensitivity analysis the program can handle very easily. The variable costs per hour are assumed to be constant on a per hour basis as use increases.

Only a few of the many possible uses of the program will be shown here. The purpose is to acquaint the reader with the general kind of uses which can be made of the program. Hopefully, the reader will find many other suitable ways of using the program. One caution should be heeded. The analysis of machinery cost is often specific and care should be taken in generalizing from any particular analysis. For example, the plowing cost per feddan for a particular set of equipment will generally be affected by soil type. Initial assumptions about wearout life or repaid costs may need to be changed. Pumping costs per feddan will be influenced by such things as head or amount of lift, soil type, crop water requirements and type of irrigation system. Therefore, machinery costs should not be calculated once and for all. The basic assumption used as well as the results need to be reviewed and evaluated periodically. The recommended review and evaluation can easily be done using the program discussed here.

ESTIMATING COSTS FOR A SINGLE MACHINE

ine example used here is a 6.5 H.P. diesel pump. The data presented and analyzed in Table 1 were gathered from farmers in the Mansouria area near Cairo. The first part of the table contains information which identifies the study including the location on the computer cassette where the data is stored in case further computer work is done with the same data. The data are specific for this particular analysis. For example it is assumed that the pumping capacity is 150 cubic meters per hour and that 6400 cubic meters (150 cubic meters x 42.672 hours per fed.) will be pumped for each feddan during a year.

The first numerical part of Table 1 presents the calculation in terms of the hours of pumping listed in the left hand column. If the pump is used to capacity for 1000 hours, the Power Cost (the cost of diesel fuel in this case) will be L.E. 35.725, and the total Annual Cost

TABLE 1. MACHINERY COSTS FOR A 6.5 H.P. DIESEL PUMP

MACHINERY COST STUDY
DATA PREPARED BY GENE QUENEMOEN
track 0 ; file 1

NAME OF MACHINE	DIESEL PUMP
MAKE / MODEL / SIZE	6.5 HP
POWER SOURCE	
DATA PREPARING DATE:	5/12/79
PRESENT REPLACEMENT PRICE IN EGYPT	900.000
WEAR OUT LIFE IN HOURS	15000.000
AVAREGE EXPECTED REPAIR COST PER HOUR:LE	0.060
FUEL CONSUMPTION LITERS PER HOUR	1.429
FUEL COST PER LITER:LE	0.025
OIL COST PER 100 HOURS:LE	1.500
GREASE COST PER 100 HOURS:LE	1.000
SALVAGE VALUE AT END OF WEAR OUT LIFE:LE	0.000
ANNUAL TAXES , LICENSE AND PERMIT:LE	0.000
INTEREST RATE	15.000 %
OPERATOR COST PER hr.:LE	0.100
Hrs PER FEDDAN	42.672
CUBIC METERS PER hr	150.000
ANIMAL POWER COST/hr:LE	0.000

HOURS OF USE	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	POWER COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	COST/hr	COST/fd	COST/c.mt
100	67.500	6.000	6.000	3.573	2.500	10.000	95.573	0.956	40.783	0.0064
110	67.500	6.600	6.600	3.930	2.750	11.000	98.380	0.894	38.164	0.0060
120	67.500	7.200	7.200	4.287	3.000	12.000	.01.187	0.843	35.982	0.0056
130	67.500	7.800	7.800	4.644	3.250	13.000	103.994	0.800	34.136	0.0053
140	67.500	8.400	8.400	5.002	3.500	14.000	106.802	0.763	32.553	0.0051
150	67.500	9.000	9.000	5.359	3.750	15.000	109.609	0.731	31.181	0.0049
175	67.500	10.500	10.500	6.252	4.375	17.500	116.627	0.666	28.438	0.0044
200	67.500	12.000	12.000	7.145	5.000	20.000	123.645	0.618	26.381	0.0041
300	67.500	18.000	18.000	10.718	7.500	30.000	151.718	0.506	21.580	0.0034
400	67.500	24.000	24.000	14.290	10.000	40.000	179.790	0.449	19.180	0.0030
500	67.500	30.000	30.000	17.863	12.500	50.000	207.863	0.416	17.740	0.0028
600	67.500	36.000	36.000	21.435	15.000	60.000	235.935	0.393	16.780	0.0026
700	67.500	42.000	42.000	25.008	17.500	70.000	264.008	0.377	16.094	0.0025
800	67.500	48.000	48.000	28.580	20.000	80.000	292.080	0.365	15.580	0.0024
900	67.500	54.000	54.000	32.153	22.500	90.000	320.153	0.356	15.179	0.0024
1000	67.500	60.000	60.000	35.725	25.000	100.000	348.225	0.348	14.859	0.0023
1250	67.500	75.000	75.000	44.656	31.250	125.000	418.406	0.335	14.283	0.0022
1500	67.500	90.000	90.000	53.588	37.500	150.000	488.588	0.326	13.899	0.0022
1750	67.500	105.000	105.000	62.519	43.750	175.000	558.769	0.319	13.625	0.0021
2000	67.500	120.000	120.000	71.450	50.000	200.000	628.950	0.314	13.419	0.0021
2500	67.500	150.000	150.000	89.313	62.500	250.000	769.313	0.308	13.131	0.0021
3000	67.500	180.000	180.000	107.175	75.000	300.000	909.675	0.303	12.939	0.0020

FEDD	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	POWER COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	COST/fd	:OST/hr	COST/c.mt
1.00	67.500	2.560	2.560	1.524	1.067	4.267	79.479	79.479	1.863	0.0124
2.00	67.500	5.121	5.121	3.049	2.134	8.534	91.458	45.729	1.072	0.0071
3.00	67.500	7.681	7.681	4.573	3.200	12.802	103.437	34.479	0.808	0.0054
4.00	67.500	10.241	10.241	6.098	4.267	17.069	115.416	28.854	0.676	0.0045
5.00	67.500	12.802	12.802	7.622	5.334	21.336	127.395	25.479	0.597	0.0040
10.00	67.500	25.603	25.603	15.245	10.668	42.672	187.291	18.729	0.439	0.0029
15.00	67.500	38.405	38.405	22.867	16.002	64.008	247.186	16.479	0.386	0.0026
20.00	67.500	51.206	51.206	30.489	21.336	85.344	307.082	15.354	0.360	0.0024
25.00	67.500	64.008	64.008	38.111	26.670	106.680	366.977	14.679	0.344	0.0023
30.00	67.500	76.810	76.810	45.734	32.004	128.016	426.873	14.229	0.333	0.0022
40.00	67.500	102.413	102.413	60.978	42.672	170.688	546.664	13.667	0.320	0.0021
50.00	67.500	128.016	128.016	76.223	53.340	213.360	466.455	13.329	0.312	0.0021

will be L.E. 348.225. The cost of pumping water will be L.E. .348 per hour, L.E. 14.859 per feddan and L.E. 0.0023 per cubic meter. Other studies indicate the average value of water to farmers will vary from .5 Piasters to 4.0 Piasters per cubic meter.

The second numerical part of Table 1 presents the calculations in terms of the number of feddans listed in the left hand column. For example, if the pump is used to supply water to ten feddans, the Power Cost will be L.E. 15.245 and the total Annual Cost will be L.E. 187.291. The costs of pumping water for one feddan when the pump is used to supply water for ten feddans will be L.E. 18.729.

Both numberical parts of Table 1 involve use of the same data and calculations. The program contains an option which allows the analyst to have either or both of the two numerical portions of the table printed.

Figures 1 and 2 are graphic displays of the data presented in Table 1. The analyst can elect to have none of the graphs produced, both, or either one of the graphs. The scale used on the X axis and the Y axis must be spcified by the analysts.

The information presented in Table 1 and Figures 1 and 2 have many potential uses. For example, the information could be used to help establish minimal rental rates on either a feddan or an hour basis. Extra analysis may need to be done. For example, separate transport costs may need to be calculated. Perhaps one of the most important factors demonstrated is the need to use a significant portion of the work capacity of machinery if average per unit costs are to reach reasonable levels.

Figure 1   Average Pumping Cost Per Hour for a 6.5 H.P. Diesel Pump

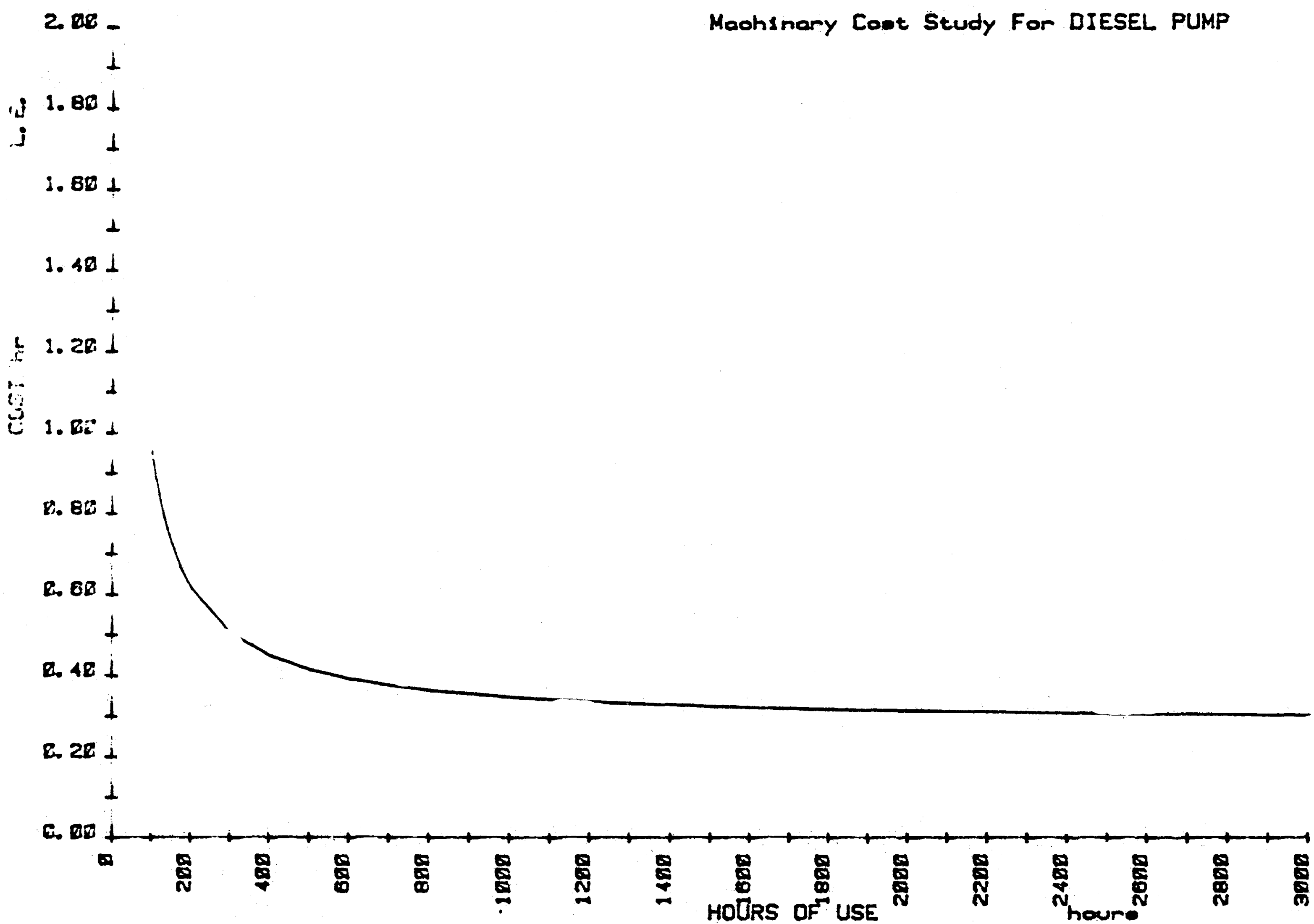
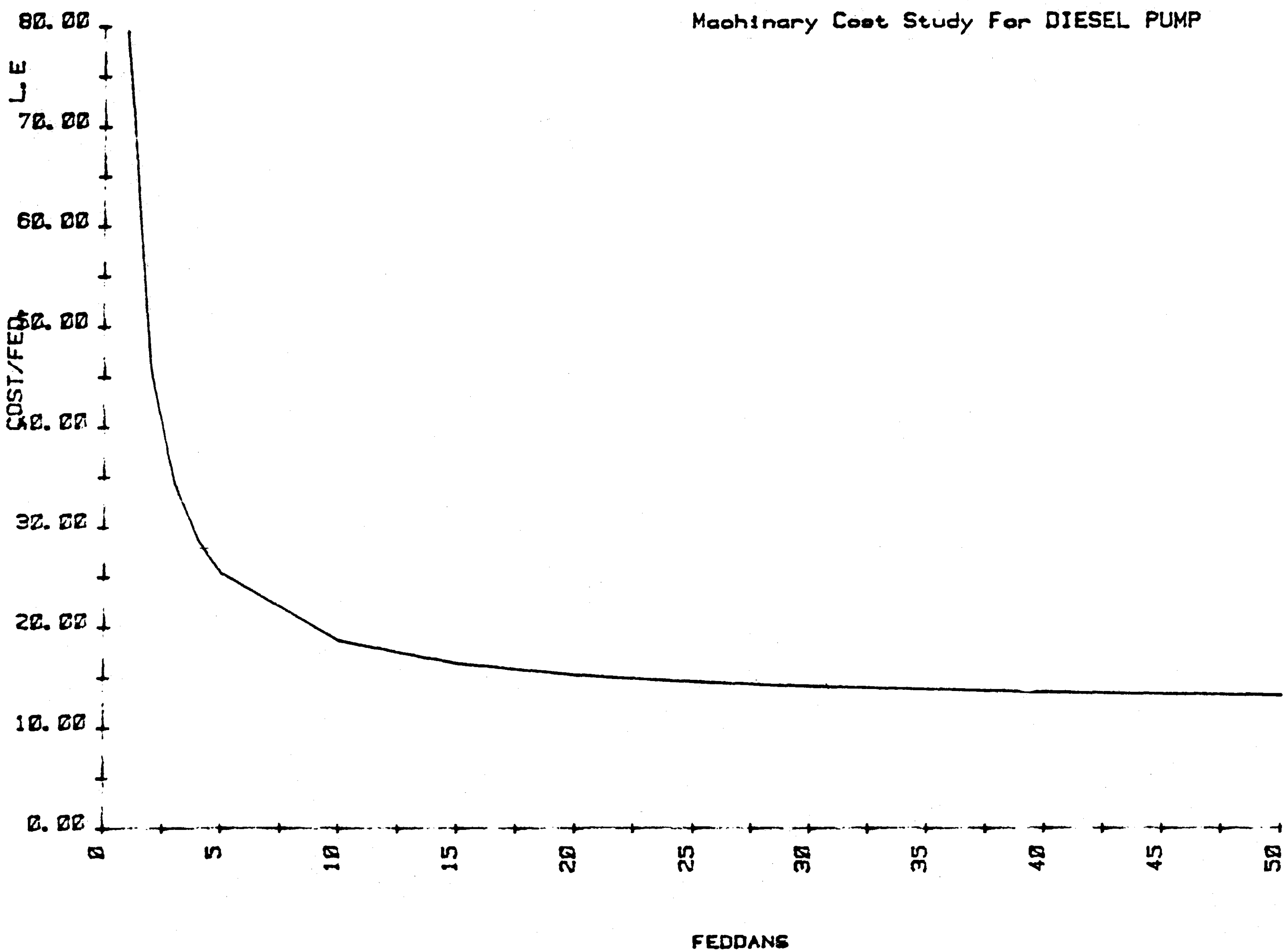


Figure 2   Average Pumping Cost Per Feddan for a 6.5 H.P. Diesel Pump



EVALUATION OF MACHINERY SYSTEMS

Many times, different pieces of machinery must be used together to complete a job. The example which follows involves a 60 hp tractor and a two-row planter. In a more elaborate analysis, this same approach could be used to deal with a complete farm operation.

The data for a 60 hp Yugoslavian tractor is presented in Table 2. The data for this analysis were provided by a farmer in the Kafr El-Sheikh area. In this case, only a portion of the table based on the number of hours per feddan was used since the tractor will be used for many different tasks. No graphical displays were requested of the computer. The figure of 1839 hours was entered since this was the number of hours the farmer reported using the tractor during the past year. In that case, the costs per hour were L.E. .916. If the tractor would have been used only 200 hours, the hourly cost would have been L.E. 2.030. The interest rate of 10% was used because it would have been possible for this farmer to borrow money at that rate.

The data for the two-row planter presented in Table 3 was provided by an EWUP Agricultural Engineer, Bayoumi Ahmed. No power cost is calculated for this machine since it will be included in the calculated cost of the tractor. The operator cost reflects the requirement that a laborer hired by the hour would work with the tractor operator, who is paid an annual salary.

What would it cost per feddan to use these two pieces of equipment to seed maize? While the method of answering this question is straight forward, certain facts must be agreed upon. For example, assume the two row planter will be used to seed 40 feddans per year. The cost per hour can be found by calculating the hours of use, (40 feddans) x (3 hours

TABLE 2. MACHINERY COSTS FOR A 60 H.P. TRACTOR

MACHINERY COST STUDY

DATA PREPARED BY RAGY DARWESH
track 0 ; file 10

NAME OF MACHINE TRACTOR

MAKE Y.S. MODEL 1975 SIZE 60 HP
POWER SOURCE

DATA PREPARING DATE:	5/12/79
PRESENT REPLACEMENT PRICE IN EGYPT	5000.000
WEAR OUT LIFE IN HOURS	15000.000
AVAREGE EXPECTED REPAIR COST PER HOUR:LE	0.010
FUEL CONSUMPTION LITERS PER HOUR	5.000
FUEL COST PER LITER:LE	0.028
OIL COST PER 100 HOURS:LE	8.330
GREASE COST PER 100 HOURS:LE	1.300
SALVAGE VALUE AT END OF WEAR OUT LIFE:LE	0.000
ANNUAL TAXES , LICENSE AND PERMIT:LE	0.000
INTEREST RATE	10.000 %
OPERATOR COST PER hr.:LE	0.200
Hrs PER FEDDAN	0.000
CUBIC METERS PER hr	0.000
ANIMAL POWER COST/hr:LE	0.000

HOURS OF USE	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	POWER COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	COST/hr	COST/fd	COST/c.mt
100	250.000	33.333	1.000	14.000	9.630	20.000	327.963	3.280	0.000	0.0000
110	250.000	36.667	1.100	15.400	10.593	22.000	335.760	3.052	0.000	0.0000
120	250.000	40.000	1.200	16.800	11.556	24.000	343.556	2.863	0.000	0.0000
130	250.000	43.333	1.300	18.200	12.519	26.000	351.352	2.703	0.000	0.0000
140	250.000	46.667	1.400	19.600	13.482	28.000	359.149	2.565	0.000	0.0000
150	250.000	50.000	1.500	21.000	14.445	30.000	366.945	2.446	0.000	0.0000
175	250.000	58.333	1.750	24.500	16.853	35.000	386.436	2.208	0.000	0.0000
200	250.000	66.667	2.000	28.000	19.260	40.000	405.927	2.030	0.000	0.0000
300	250.000	100.000	3.000	42.000	28.890	60.000	483.890	1.613	0.000	0.0000
400	250.000	133.333	4.000	56.000	38.520	80.000	561.853	1.405	0.000	0.0000
500	250.000	166.667	5.000	70.000	48.150	100.000	639.817	1.280	0.000	0.0000
750	250.000	250.000	7.500	105.000	72.225	150.000	834.725	1.113	0.000	0.0000
1000	250.000	333.333	10.000	140.000	96.300	200.000	1029.633	1.030	0.000	0.0000
1250	250.000	416.667	12.500	175.000	120.375	250.000	1224.542	0.980	0.000	0.0000
1500	250.000	500.000	15.000	210.000	144.450	300.000	1419.450	0.946	0.000	0.0000
1839	250.000	613.000	18.390	257.460	177.096	367.800	1683.746	0.916	0.000	0.0000
2000	250.000	666.667	20.000	280.000	192.600	400.000	1809.267	0.905	0.000	0.0000
3000	250.000	1000.000	30.000	420.000	288.900	600.000	2588.900	0.863	0.000	0.0000

TABLE 3. Machinery Costs for a Two Row Planter

MACHINERY COST STUDY
DATA PREPARED BY BAYOMI ,AHMED
track 0 ; file 6

NAME OF MACHINE	ROW CROP PLANTER
MAKE MODEL	SIZE 2 ROWS
POWER SOURCE	
DATA PREPARING DATE:	5/12/79
PRESENT REPLACEMENT PRICE IN EGYPT	494.000
WEAR OUT LIFE IN HOURS	10000.000
AVAREGE EXPECTED REPAIR COST PER HOUR:LE	0.100
OIL COST PER 100 HOURS:LE	0.000
GREASE COST PER 100 HOURS:LE	0.240
SALVAGE VALUE AT END OF WEAR OUT LIFE:LE	0.000
ANNUAL TAXES , LICENSE AND PERMIT:LE	0.000
INTEREST RATE	15.000 %
OPERATOR COST PER hr.:LE	0.250
Hrs PER FEDDAN	3.000
CUBIC METERS PER hr	0.000
ANIMAL POWER COST/hr:LE	0.000

HOURS OF USE	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	POWER COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	COST/hr	COST/fd	COST/c.mt
100	37.050	4.940	10.000	0.000	0.240	25.000	77.230	0.772	2.317	0.0000
110	37.050	5.434	11.000	0.000	0.264	27.500	81.248	0.739	2.216	0.0000
120	37.050	5.928	12.000	0.000	0.288	30.000	85.266	0.711	2.132	0.0000
130	37.050	6.422	13.000	0.000	0.312	32.500	89.284	0.687	2.060	0.0000
140	37.050	6.916	14.000	0.000	0.336	35.000	93.302	0.666	1.999	0.0000
150	37.050	7.410	15.000	0.000	0.360	37.500	97.320	0.649	1.946	0.0000
175	37.050	8.645	17.500	0.000	0.420	43.750	107.365	0.614	1.841	0.0000
200	37.050	9.880	20.000	0.000	0.480	50.000	117.410	0.587	1.761	0.0000
250	37.050	12.350	25.000	0.000	0.600	62.500	137.500	0.550	1.650	0.0000
300	37.050	14.820	30.000	0.000	0.720	75.000	157.590	0.525	1.576	0.0000
350	37.050	17.290	35.000	0.000	0.840	87.500	177.680	0.508	1.523	0.0000
400	37.050	19.760	40.000	0.000	0.960	100.000	197.770	0.494	1.483	0.0000
500	37.050	24.700	50.000	0.000	1.200	125.000	237.950	0.476	1.428	0.0000

per feddan) = 120 hours, and finding the appropriate cost per hour from Table 3, L.E. .711. Assume the tractor will be used a total of 1000 hours per year for all purposes. In this case, the average tractor cost per hour will be L.E. 1.03 (From Table 2). The total cost per hour for both machines will be L.E. 1.741. The cost per feddan will then be (L.E. 1.741) x (3 hours per feddan) = L.E. 5.223 per feddan. If a minimum rental rate per feddan is being established, transport cost should be added to such a figure.

MACHINERY REPLACEMENT DECISIONS

When should an old tractor be replaced by a newer tractor? In reaching an answer to this question, many factors such as reliability, availability of money for purchase, etc. must be considered. Certaintly, the comparative costs of using the machine should also be considered.

Table 4 presents the figures for a 1964 tractor. This farmer, again from the Kafr El Sheikh area, purchased the tractor "used" for L.E. 1500, but he feels he could sell the tractor today for L.E. 3000. It is estimated that the tractor only has 2760 hours of useful life left. The cost for both repairs and grease and oil are fairly high.

Assume the farmer is considering replacing the tractor of Table 4 with the tractor of Table 2. How do the costs of these two tractors compare? Table 5 presents the costs for selected hours of use for both tractors which are taken from Tables 2 and 4.

When the replacement value of the 1964 Ford tractor is L.E. 3000, the Ford tractor will be more expensive than the Yugoslavian tractor at all levels of use have higher costs than if he used the 1975 Yugoslavian tractor. At this point, it may well be to check the validity

TABLE 4. MACHINERY COSTS FOR A 1964 TRACTOR

MACHINERY COST STUDY

DATA PREPARED BY JOUSEPH [redacted] !
track 0 ; file 7

NAME OF MACHINE TRACTOR

MAKE FORD MODEL$$$$$$$$$$$$$$$$$$ SIZE 53 HP
POWER SOURCE

DATA PREPARING DATE:	5/12/79
PRESENT REPLACEMENT PRICE IN EGYPT	3000.000
WEAR OUT LIFE IN HOURS	2760.000
AVAREGE EXPECTED REPAIR COST PER HOUR:LE	0.326
FUEL CONSUMPTION LITERS PER HOUR	4.000
FUEL COST PER LITER:LE	0.028
OIL COST PER 100 HOURS:LE	5.885
GREASE COST PER 100 HOURS:LE	4.000
SALVAGE VALUE AT END OF WEAR OUT LIFE:LE	200.000
ANNUAL TAXES , LICENSE AND PERMIT:LE	0.000
INTEREST RATE	10.000 %
OPERATOR COST PER hr.:LE	0.260
Hrs PER FEDDAN	0.000
CUBIC METERS PER hr	0.000
ANIMAL POWER COST/hr:LE	0.000

HOURS OF USE	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	POWER COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	COST/hr	COST/fd	COST/c.mt
100	160.000	101.449	32.600	11.000	9.885	26.000	340.934	3.409	0.000	0.0000
110	160.000	111.594	35.860	12.100	10.874	28.600	359.028	3.264	0.000	0.0000
120	160.000	121.739	39.120	13.200	11.862	31.200	377.121	3.143	0.000	0.0000
130	160.000	131.884	42.380	14.300	12.851	33.800	395.215	3.040	0.000	0.0000
140	160.000	142.029	45.640	15.400	13.839	36.400	413.308	2.952	0.000	0.0000
150	160.000	152.174	48.900	16.500	14.828	39.000	431.401	2.876	0.000	0.0000
200	160.000	202.899	65.200	22.000	19.770	52.000	521.869	2.609	0.000	0.0000
250	160.000	253.623	81.500	27.500	24.713	65.000	612.336	2.449	0.000	0.0000
300	160.000	304.348	97.800	33.000	29.655	78.000	702.803	2.343	0.000	0.0000
350	160.000	355.072	114.100	38.500	34.598	91.000	793.270	2.266	0.000	0.0000
400	160.000	405.797	130.400	44.000	39.540	104.000	883.737	2.209	0.000	0.0000
500	160.000	507.246	163.000	55.000	49.425	130.000	1064.671	2.129	0.000	0.0000
750	160.000	760.870	244.500	82.500	74.138	195.000	1517.007	2.023	0.000	0.0000
1000	160.000	1014.493	326.000	110.000	98.850	260.000	1969.343	1.969	0.000	0.0000
1250	160.000	1268.116	407.500	137.500	123.563	325.000	2421.678	1.937	0.000	0.0000
920	160.000	933.333	299.920	101.200	90.942	239.200	1824.595	1.983	0.000	0.0000

FEDD.	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	POWER COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	COST/fd	COST/hr	COST/c.mt

Table 5. Comparative Hourly Costs for Two Tractors

Hours of Use	1964 Ford - Value L.E. 3000[a/]		1975 Yugoslavian Tractor[b/]		1964 Ford - Value L.E. 1500[c/]	
	Cost/hr.	Total Annual Cost	Cost/hr.	Total Annual Cost	Cost/hr.	Total Annual Cost
	L.E.	L.E.	L.E.	L.E.	L.E.	L.E.
100	3.41	340.93	3.28	327.96	2.12	211.86
110	3.26	359.03	3.05	335.76	2.04	224.24
120	3.14	377.12	2.86	343.56	1.97	236.90
130	3.04	395.22	2.70	351.35	1.92	249.55
140	2.95	413.31	2.57	359.15	1.87	262.22
150	2.87	431.40	2.45	366.95	1.83	274.88
200	2.61	521.87	2.30	405.93	1.69	338.17
300	2.34	702.80	1.61	483.84	1.68	504.50
400	2.21	883.74	1.41	561.85	1.48	591.34
500	2.13	1064.67	1.28	639.82	1.44	717.93
750	2.02	1517.01	1.11	834.73	1.38	1034.39
1000	1.97	1969.34	1.03	1029.63	1.35	1351.85
1250	1.94	2421.68	.98	1224.54	1.33	1667.31

a/ From Table

b/ From Table 2

c/ Data same as for Table 2 except for replacement cost which is changed to L.E. 1500.

of the data used. Assume the data is found to be correct. The added cost per year of keeping the 1964 Ford tractor would not be great for low hours of use. However, if the farmer planned to use the tractor 1250 hours per year, the total annual cost would be L.E. 2,421.25 for the 1964 Ford and L.E. 1,224.54 for the 1975 Yugoslavian tractor. Unless other factors were important, and if the tractor will be used heavily, the 1964 Ford tractor should probably be sold for L.E. 3000. If that price could not be obtained, the present value of the 1964 Ford should be re-evaluated and the analysis run again.

The last two columns of Table 5 list those costs which would exist if the replacement value (the sale price) were reduced to L.E. 1500. In this case, the costs of using the 1964 Ford would be less than the costs of using the 1975 Yugoslavian tractor for levels of use of less than 300 hours per year.

Sensitivity Analysis

Data and information about any economic phenomena are seldom as precise as the analyst would like. Therefore, the analyst is often tempted to ask a series of "what if" questions. The machinery cost program can be used to help conduct this kind of analysis. The example used here involved water pumping costs and the impact of using two alternative costs for electricity. In this example, the comparisons are only presented graphically. The example is discussed in greater detail in a forthcoming publication on pumping costs.(__)

The pumping cost per feddan for a 150 cubic meter per hour, 3 H.P. electric pump when the cost electricity is Pt.1.5 per KWH is shown by AC_1 in Figure 3. This represents the average pumping cost per feddan which would face an Egyptian farmer using this equipment. The average

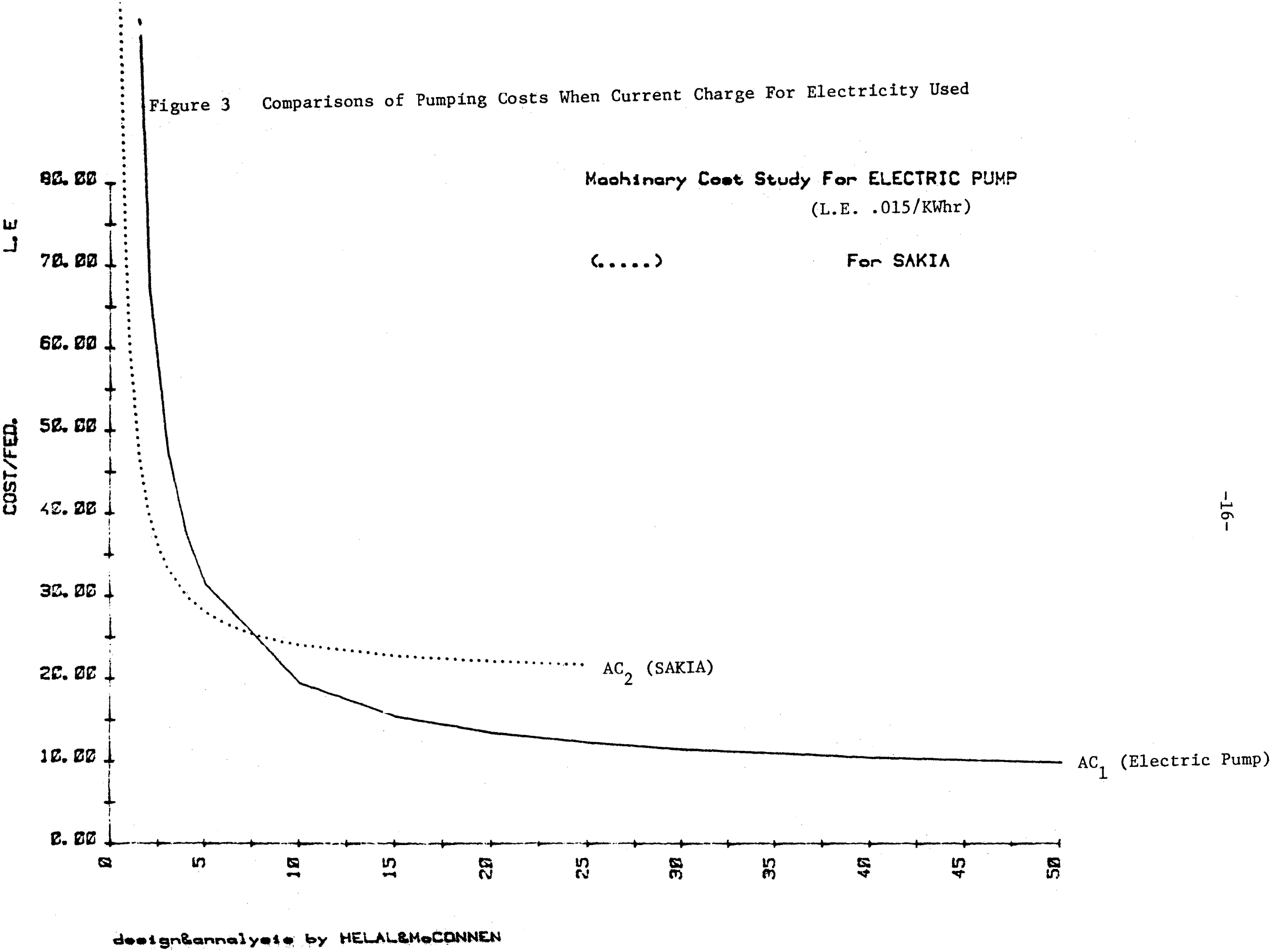


Figure 3 Comparisons of Pumping Costs When Current Charge For Electricity Used

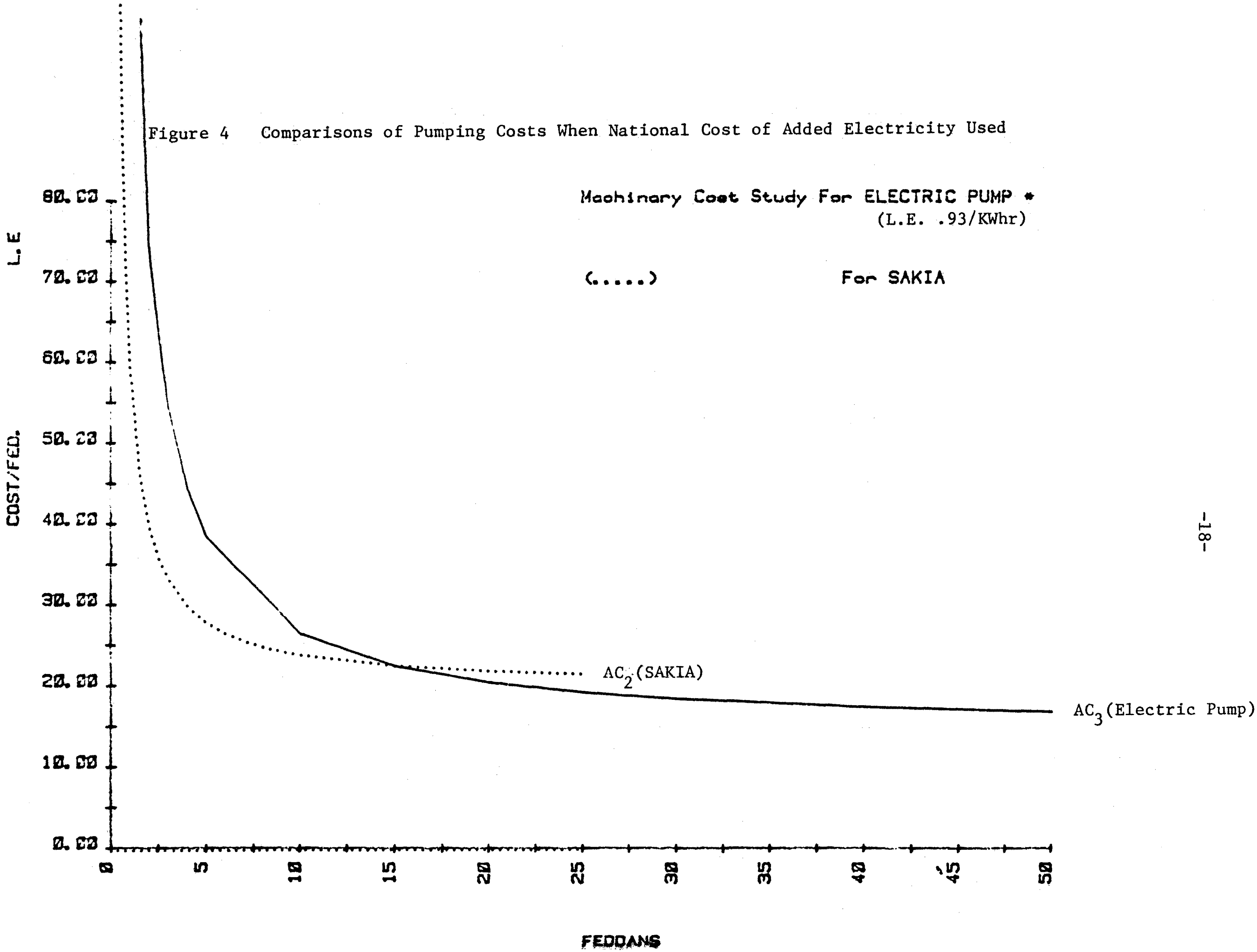
cost per feddan for a 3 meter Sakai in the Mansouria area near Cairo is shown by AC_2 in Figure 3. If the farmer is to use a pump to provide water for more than about 7.5 feddans, it would be cheaper to use the electric pump than the sakia. Such analysis does not address the problem of reliability of delivery of power for pumping. Setting this important issue aside, there is still the question of what would happen if electricity became more expensive?

The present hydro and thermal generating plans in Egypt are currently used to capacity. If increased demands for electricity are to be met, additional generating capacity would have to be constructed. A recent study indicates that the average cost to the national per added KWhr would be Pt. 9.32.(__) If this figure is correct, what would be the national consequences of shifting from Sakia to electric pumps? The average cost of pumping per feddan for a 150 cubic meter pump when electricity cost Pt 9.32 is shown in Figure 4 by AC_3. Again AC_2 shows the average cost of pumping when a Sakia is used. Sakias are still more expensive, if more than about 16 feddans are to be irrigated. However, the added costs are slight. The desirability of a shift from sakia to electric pumps from a national standpoint is no longer all that clear. Other alternatives should probably be investigated if the data used here are representative.

Conclusion

The EWUF machinery cost program can be a very useful tool. But like all tools, it can also be misused. If the analyst uses it mechanically, he will probably overlook important issues which were not included in the analysis. If however, the program is used both to free

Figure 4 Comparisons of Pumping Costs When National Cost of Added Electricity Used



the analyst from the burden of calculations and to permit the numerical exploration of relevant alternatives, the analyst can have more time to apply the judgement which should be an important part of any economic analysis.

Staff Paper #9

HONEY PRODUCTION AT KAFR EL SHEIKH GOVERNORATE

Yusef Yusef

Archeological evidence indicates that ancient Egyptians kept bees for the production of honey. It is still important today as indicated by the fact that in 1977 Egypt produced 7,336 tons of honey and 176 tons of wax. The gross value of this production was more than L.E. 3.5 million. In addition to the value of honey and wax, bees contribute to better farm yields by pollinating the flowers of important commercial crops.

Honey production requires only a small capital investment. The season of major activity is from February through June. Bees gather wealth from the agricultural areas which would otherwise be lost. As the Koran says, "bees gather the nectar of flowers and turn it into honey which can be recovered for the use of people".

There are nine bee keepers at Abu Raya Village. Six of them have 910 local or "baladi" hives and three of them have 100 modern commercial hives. There is an agricultural advisor at the Abu Rayah cooperative who helps the farmers with problems of honey production. There is a beekeeper's cooperative at Kafr el Sheikh. The governorate is served by several carpentry shops which produce wooden hives that sell for L.E. 13.5 each.

Honey production in the vicinity of Abu Rayah Village ranges from 10-30 kg. per hive per year depending on flower conditions and the care of the hives.

.../...

(1 The information for this report was obtained from two farmers at Abu Rayah Village, the Agricultural Department at Kafr el Sheikh and the book Bee Breading by Dr. Abdel Latief El Deeb.

The following cost analysis shows that a farmer can earn up to L.E. 58 per year with 10 colonies of bees. It assumes the wooden hives have a life of ten years with no salvage value. At the end of ten years the farmer can recover his investment in the colonies of bees and wax. An interest rate of ten percent is used to calculate the Net Annual Return. A cash flow analysis indicates the farmer would earn 31 percent return on his investment. This assumes, of course that his own labor and management is donated.

I Initial investment for 10 hives and other equipment.

<u>Depreciable items 10 years of life</u>		
a. 10 hives x L.E. 14.0	L.E.	140
b. Embedder and hive tools		1
c. 2 kg. wire x L.E. 1.5		3
<u>Non-depreciable items renewed annually</u>		
d. 10 colonies of first hybrid bees x L.E. 6.0		60
e. 12 kg. of wax x L.E. 3.0		36
<u>Non-depreciable items replaced biannually</u>		
f. Smoker, mask, gloves, brush, overalls		13
Total		253

II Annual fixed costs

a. Depreciation of I-a, I-b and I-c $\frac{\text{L.E. } 144}{10 \text{ years}}$	L.E.	14
b. Interest on investment of depreciable items $(\frac{144}{2})$ .10		7
c. Interest on investment of non-deprec. items 109 x .10		11

.../...

d.	Rent of land		5
	Total Annual Fixed Costs	L.E.	37

III Annual variable costs

a.	Replacement of smokers, gloves, masks, brushes, etc.	L.E.	7
b.	Sugar for winter feeding of colonies		10
c.	Replacement of 2 queens		3
d.	Insecticide to control wax worms		3
e.	Sacks to cover hives in winter		1
f.	Straw mat for windbreak in winter		2
g.	Rent of honey extracter		2
h.	Laborers to extract honey		2
i.	Miscellaneous costs		5
		L.E.	35

IV Annual income the first year

a.	Honey of first collection (berseem) 100 kg x L.E. 0.6	L.E.	60
b.	Honey of second collection (cotton) 50 kg x L.E. 0.45		23
c.	Bees, 3 colonies x L.E. 5.5		17
d.	Wax 1 kg. x L.E. 2.0		2
	Total Annual Income the First Year	L.E.	102

V Annual income after the first year

a.	Honey of first collection (berseem) 140 kg. x L.E. 0.6	L.E.	84
b.	Honey of second collection (cotton) 60 kg. x L.E. 0.45		27
c.	Bees, 3 colonies x L.E. 5.5		17
d.	Wax, 1 kg. x L.E. 2.0		2

VI Summary of estimated annual income for ten hives

Year	Gross Income	Variable Cost	Gross Margin	Fixed Costs	Net Annual Return
	L.E.	L.E.	L.E.	L.E.	L.E.
1	102	35	67	37	30
2	130	35	95	37	58
3	130	35	95	37	58
4 through 10	130	35	95	37	58

VII Estimated cash flow analysis for ten years

Year	Cash Out-flow 1)	Cash In-flow 2)	Net Cash Flow *
	L.E.	L.E.	L.E.
0	253	0	-253
1	40	102	62
2	40	130	90
3	40	130	90
4	40	130	90
5	40	130	90
6	40	130	90
7	40	130	90
8	40	130	90
9	40	130	90
10	40	226	186

* The internal rate of return on this cash flow is 31%

1) The cash outflow is made up of the original cash investment, L.E. 253 and then L.E. 40 each year. The latter consists of L.E. 35 as shown in part III plus land rent from part II. These are the only cash out-flow items.

2) Cash in-flow is from part IV and part V. At the end of the tenth year the cash in-flow increases to L.E. 226 as a result of the liquidation of bees, L.E. 60 and wax, L.E. 36.

Staff Paper #10

AN ECONOMIC EVALUATION OF CORN TRIALS AT ABUEHA

Elia Sorial

April, 1980

During the spring of 1979 an area of 3 feddans on Mr. Ali Yousif's farm was selected for field trials with hybrid corn. The trial included 4 specific practices:

1. Hybrid corn variety (Pioneer 514).
2. Achieve plant population of 24,000 plants/feddan.
3. Apply zinc and bayfolan fertilizers.
4. Insect control.

In order to evaluate fertilizer alternatives each feddan was divided into four quarter-feddan parcels and treated as follows:

#1 control
#2 treated by zinc sulphate one time after 30 days from the planting date.
#3 treated by zinc sulphate two times, the first one after 30 days from planting date and the second after 24 days from the first one.
#4 treated by bayfolan, one time after 54 days from planting date.

Mr. Yousif carried out all field operations while receiving help from EWUP scientists on plant spacing, fertilizer application and insect control. Cost and yield data were gathered during the course of the field trial.

Table 1 shows the average costs and returns per feddan for each of four different treatments. Notice that the return above cost is greatest for the #2 treatment which included a single application of zinc.

Most farmers in the Abueha area produce common (balady) corn. Cost and return data gathered during the summer of 1979 are summarized in Table 2. Notice that farmers normally take part of their returns from

Table 1. Average Costs and Returns for Each of Four Treatments of Corn at Aueha Site, summer, 1979.

Item	Costs and Returns per Feddan			
	#1 Control	#2 Zinc 1 time	#3 Zinc 2 times	#4 Bayfolan
Costs:	L.E.	L.E.	L.E	L.E
Plowing 2 times by tractor	5.050	5.050	5.050	5.050
Leveling	0.900	0.900	0.900	0.900
Furrowing by animals	1.500	1.500	1.500	1.500
Ridging and making field ditches	5.000	5.000	5.000	5.000
Planting	1.500	1.500	1.500	1.500
Seeds, 2 kela x L.E. 5.0	10.000	10.000	10.000	10.000
Irrigation 8 times by gravity	2.800	2.800	2.800	2.800
Hoeing 2 times and thinning	12.300	12.300	12.300	12.300
Chemical fertilizer 200 kg. urea 46-0-0	14.920	14.920	14.920	14.920
Distribution of fertilizer	1.000	1.000	1.000	1.000
Zinc sulphate 2.4 kg x LE 0.90	---	2.160	4.320	---
Bayfolan 1.2 liter x LE. 1.0	---	---	---	1.200
Spraying fertilizer (labor L.E. 2.8 + motor L.E. 2)	---	4.800	9.600	4.800
Insecticides 1.4 liter Malathyon x L.E. 1.695 x 2 times	5.084	5.084	5.084	5.084
Spraying insecticide (labor L.E. 1.4 + motor L.E. 1.0) x 2 times.	4.800	4.800	4.800	4.800
Harvesting	5.400	5.400	5.400	5.400
Transportation	5.700	5.700	5.700	5.700
Peeling the ears	10.500	10.500	10.500	10.500
Total Costs	86.454	93.414	100.374	92.454
Returns: Corn grain 1/	193.200	219.360	192.000	198.840
C Stalk 2/	12.000	14.000	12.000	14.000
Total Income	205.200	233.360	204.000	212.840
Returns above costs	118.746	139.940	103.626	120.386
1/ Number of Ardab	16.1	18.28	16.0	16.57
2/ Number of Loads	12	14	12	14

Table 2. Average Costs and Returns per Feddan for Balady Corn at Abueha, Summer, 1979

Item	Costs and Return per Feddan
Costs:	L.E.
Planting	1.200
Seeds 1.5 kela	2.25
Irrigation 8 times by gravity	4.000
Hoeing 3 times and thinning	13.000
Chemical fertilizer 275 kg. netro kema 31-0-0	13.942
Distribution of fertilizer	1.000
Harvesting	1.800
Transportation	2.500
Peeling the ears	3.750
Total Costs	43.442
Returns:	
Leaves and tops for animal feed	20.000
Corn grain 8 ardab x L.E. 12.0	96.000
Corn Stalk 5 loads	5.000
Total Income	121.000
Returns above costs	77.558

leaves and tops. The net difference between the "return above costs" for treatment #2 of the field trial and balady corn was L.E. 62.382 (L.E. 139.940 - 77.558 = L.E. 62.382). Even the difference between balady and treatment # 3 was L.E. 26.068 (L.E. 103.626 - 77.558 = L.E. 26.068). Although the trials should be repeated for further verification it appears there is a good opportunity for farmers in the Abueha area to increase their income from applying the practices used in the field trials

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Staff Paper #11

ECONOMIC COSTS OF WATER SHORTAGES ALONG BRANCH CANALS

Shinnawi Abdel Atty El Shinnawi, Melvin D. Skold and Mohamed Loutfy Nasr

June, 1980

INTRODUCTION

One of the problems identified by the Egyptian Water Use Project (EWUP) personnel is that of water shortages at the tail ends of certain branch canals. A report by EWUP engineers indicates a decrease in water delivery to branch canals at reaches successively more distant from the Mansouria intake. Decreases in water availability along branch canals were also observed; farmers at the tail of branch canals were not being delivered as much water as those at the beginning of branch canals. The authors make a concluding comment: "The most remote areas may receive only one-fourth as much water as those at the beginning of the canal system." (p. 21)[1] Specific observations have been made of severe water shortages during the summer season at the lower end of the El Shimi cannal located in the El Hammami Project site (Figure 1). Important economic costs are likely to be associated with these water shortages, both to farmers and to Egyptian agricultural economy. The purpose of this report is to present some observed differences in farms and farming practices resulting from varied amounts of water available and to make some economic evaluations of these differences.

The El Shimi branch serves an area of about 600 feddans. Estimates are that up to 200 feddans are affected by inadequate amounts of available water.[2] Thus, the amount of land affected represents a significant proportion of the

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[1] Wolfe, John, Farouk Shahin, and M. Saif Issa, "Preliminary Evaluation of Mansouria Canal System Gisa Governate, Egypt." Egypt Water Use Project Technical Report No. 3, Cairo, 1979.

[2] El Shinnawi Abdel Atty and M. E. Quenemoen, "The Problem of Water Delivery at the Tail of the El Shimi Branch Canal," EWUP Internal Report. December, 1978.

total area. The area studied includes the El Shimi branch and neighboring canals in the Mansouria area. Figure 1 locates the canals along which farmer enumerations were completed. Analysts of the Egyptian irrigation water delivery system do not see the problem represented by the El Shimi branch canal to be an isolated occurrence. Rather, water shortages at the ends of branch canals are widespread throughout the nation. A recently completed agricultural mechanization report holds that water shortages are a very important problem to farmers throughout Egypt. In a survey of farmers, 87 percent indicated that insufficient water was a problem.[3] This report does not evaluate the extent of the problem. It does consider the effects of water shortages along canals such as the El Shimi branch and proposes a more thorough investigation of the water shortage problem.

A detailed description of how water is delivered to farmers in the Mansouria District is reported by El Kady.[4] In the El Hammami region water is delivered on a four-days on, eight-days off rotation. According to El Kady, this system encourages more frequent irrigations than is necessary to meet the crops water requirements. The frequent irrigations lead to a tendency for over-irrigation, at least so far as water is available. Over-irrigation by farmers near the head of branch canals likely contribute to water shortages for farmers near the lower ends of branch canals. Farmers in the area affected by water shortages adjust to the water situation in a number of ways:

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[3]ERA 2000, Inc. "Further Mechanization of Egyptian Agriculture" Gaithersburg, MD, April, 1979.

[4]El Kady, Mona, Wayne Clyma, and Mahmoud Abu-Zeid, "On-Farm Irrigation Practices in Mansouria District, Egypt." Egypt Water Use and Management Project. EWUP Technical Report No. 4. 1980.

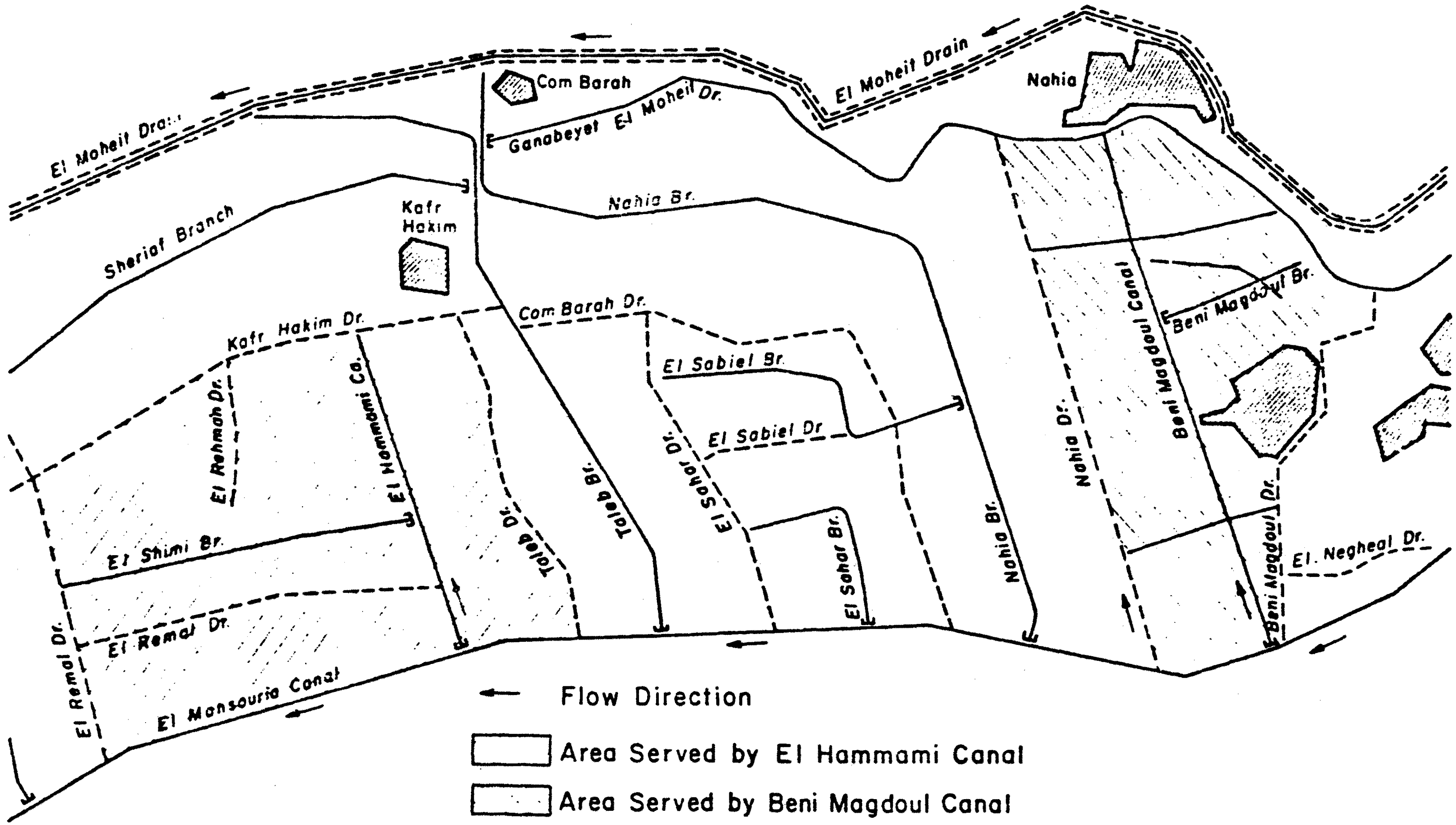

Figure 1. General layout and boundaries of the Beni Magdoul and El Hammami water courses.

(1) First, without action to reduce water shortages, land is left idle,

(2) or if planted to crops, poor yields result.

(3) Purchased inputs such as seed, fertilizer, and chemicals may be wasted (or not used) and the time and effort of farmers may be lost.

(4) Alternatively, crops may be planted which are less than optimal but are more tolerant of water shortages or require less water.

(5) Finally, farmers may have adjusted by finding other means to supply water to the land such as investments in wells and pumps or pumping from drains.

This report examines each of these adjustment hypotheses. It is expected that water shortages also affect land values. Inadequate water greatly lowers the potential productivity of the land and this is reflected in a lower land value.

RESEARCH PROCEDURE

To estimate which, if any, of the above adjustments are occurring along branch canals in the Mansouria canal system, data was obtained from farmer interviews during the 1979 summer season. Farmer interviews were conducted during the summer of 1979 by the Egyptian authors of this report. The interview questionnaire is included as Appendix A to this report. Farms were grouped along a given branch canal into upper one-third, middle one-third, and lower one-third depending on their location relative to the canal beginning and end. Only farmers in the upper and lower groups were interviewed. A total of 38 farmers were interviewed; 20 of these farmers have their land at the end of branch canals and data were obtained from 18 farmers at the upper reaches of branch canals.

The data are summarized by farmers located at the upper reaches of canals and those whose farms were located at the lower end of canals. Comparisons between the "upper-end" farmers and "lower-end" farmers will be the basis of our analysis. In this way we will be able to show the practices which are being followed by all farmers and those changes which are associated with water availability.

The data are summarized here to reflect the adjustments which these farmers have made or are making to perceived water-short situations. We first present the summaries of these data and in a final section some inferences about the economic costs associated with water shortages are presented.

RESULTS OF THE SURVEY

The questionnaire provided information about the way in which Egyptian farmers have adjusted or are adjusting to water shortages. The data collected provide information about most of the possible adjustments suggested in the introduction. These will be considered in turn. In addition, some other observations about farmer adjustments as revealed by the questionnaires will be offered.

Water Availability

First, we must answer the question as to whether there is a difference in canal water availability between upper-end farmers and lower-end farmers. Table 1 presents some information about the availability of canal water to farmers during the summer crop season. Farmers were asked about the proportion of time for which water availability is a problem. The question, as stated, may imply that the timing of water availability is the only problem. Because of the way which water is delivered, if water is not available according to schedule, the quantity of water delivered is also inadequate.[5] Responses from farmers, which indicate water is not available according to schedule, reveal that canal water is not available during the four-days on portion of the rotation. Appendix Tables A-1 and A-2 provide detailed information about how farmers at the lower end and upper end of branch canals, respectively, respond to this question.

In Table 1 it is seen that most farmers at the upper end of branch canals say water is available on schedule at least three-fourths of the time. Fifteen of eighteen respondents at the upper end indicate water is available three times out of four while only six of twenty respondents at the lower end of branch canals report water is available with such scheduled reliability. The largest number of farmers at the lower end of branch canals report water is available only one-fourth of the time. Thus, there is a marked difference between upper-end and lower-end farmers. Farmers at the lower reaches of branch canals experience inadequate water deliveries much more frequently than farmers in the upper reaches of these branch canals.

The report cited earlier indicated that night irrigation may be practiced by farmers for which daytime water deliveries are a problem.[6] Irrigation is sometimes possible at night because upper-end farmers may not be irrigating and water becomes available at the lower reaches of canals. Differences in night

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[5] El Kady, op. cit.

[6] op. cit., Wolfe, et al.

Table 1. Availability of Canal Water to Farmers Along Branch Canals During the Summer Season by Location.

Frequency of Canal Water Availability/ Night Irrigation	Location Along Branch Canal: Upper One-Third	Lower One-Third
	(number of farmers)	
Usually on time	3	4
About 3/4 of time	12	2
About 1/2 of time	3	5
About 1/4 of time	--	8
Never on time	--	2
Practice night irrigation	13	14

irrigation between upper-end and lower-end groups are not evident here. Thirteen of eighteen upper-end farmers and fourteen of twenty lower-end farmers do at least some irrigating at night.

Table 2 reports on the frequency with which water availability is a problem during the winter season. Appendix Tables A-3 and A-4 provide a more detailed treatment. All of the upper-end farmers stated that water is always available on schedule during the winter season. Among the 20 lower-end farmers only 11 indicate winter canal water availability was no problem. Six lower-end farmers said canal water was available about three-fourths of the time and the remaining three farmers are distributed among the three more serious water shortage groups.

Water availability appears to be a problem primarily during the summer season but it is not confined entirely to that time of the year. Given that water availability is a problem and one which affects lower-end farmers more severely than upper-end farmers, it is useful to examine the differences in farming operations between these two groups.

Access to Pumps

Because canal water is not available as scheduled, many farmers have gained access to diesel-powered pumps to apply water to their crops. These pumps either have been purchased or the use of a pump is rented. Table 3 divides the upper-end and lower-end farmers into three groups: those who rent pumps, those who own pumps, and those with no pumps. (See corresponding Tables A-5 and A-6.)

Farmers obtaining access to pumps corresponds closely to the intensity of water availability problem. At the upper end of branch canals, where water availability is not so severe a problem, only 2 of 18 farmers use pumps. These two farmers rent pumps (and then only for a few days each summer).

Table 2. Availability of Canal Water to Farmers Along Branch Canals During the Winter Season by Location

Frequency of Canal Water Availability	Location Along Branch Canal:	
	Upper One-Third	Lower One-Third
	(number of farmers)	
Usually on time	18	11
About 3/4 on time	--	6
About 1/2 of time	--	1
About 1/4 of time	--	1
Never on time	--	1

Table 3. Access to Pumps by Farmers Along Branch Canals, by Location

Access to Pump	Location Along Branch Canal: Upper End	Lower End
	(number of farmers)	
Rents a pump	2	8
Owns a pump	--	6*
No pump	16	7

*One farmer both owns and rents.

Among lower-end farmers, 13 of 20 either rent or own pumps. One farmer both owns and rents. Seven have no access to pumps. Of those with access to pumps, 8 is by renting and 6 by ownership of the pumps.

Differences in water availability to farmers along branch canals have resulted in some farmers being forced to provide other means to obtain water for their crops. The use of pumps is much more common among lower-end farmers than among farmers near the upper end of branch canals. Thus, farmers at the lower end of branch canals are incurring a cost to secure water that is not required of farmers near the start of branch canals. More will be said of these costs later, but the costs include the cost of renting a pump or the ownership and use costs of owned pumps. In addition, farmers have often invested in a well to provide the water needed for the pumps.

Since farmers at the lower end of branch canals fall into two groups according to access to pumps, it is now important to recognize differences between these two groups. The following discussions of farmer adjustments to lack of water availability will continue to call attention to differences between upper-end and lower-end farmers and will also compare those at the lower end with access to pumps to those at the lower end with no pumps.

Farm Size Differences

A difference between upper-end and lower-end farmers which was not expected at the initiation of the study was a difference in farm size. However, tabulation of the data revealed some important differences in this score too. Table 4 shows how the farms interviewed vary in size according to location along a branch canal. At the upper end farms averaged 1.38 feddans in size. At the lower end average farm size is more than twice as great, 3.69 feddans. Important differences can also be observed between lower-end farmers who have access to pumps

Table 4. Average Farm Size by Location and by Access to Pumps

Farms Group	Average Number of Feddans of Land
All Upper End	1.38
All Lower End	3.69
All with pump access	4.91
Pump renters	2.72
Pump owners	7.42
No pumps	1.43

and those who do not. Farmers with no access to pumps tend to be rather small, averaging only 1.43 feddans. Lower-end farmers with access to pumps average 4.91 feddans. Among all those with access to pumps, farmers who own pumps average 7.42 feddans and those who rent pumps are less than one-half that size, 2.72 feddans.

Two different interpretations can be made of these differences. First, in that lower-end farms tend to be larger may indicate that because of water shortages at the lower ends of branch canals, farmers have been forced to expand the amount of land farmed to provide a satisfactory level of living for themselves and their families. Lack of sufficient water requires more extensive type of farming using fewer nonland inputs per unit of land. Net returns per unit of land are lower and more land is needed to provide adequate levels of income. Thus, if this interpretation is valid, a part of the adjustment to lack of a reliable supply of water is an expanded land base.

A second interpretation is that larger land holdings are the result of efforts to spread the fixed costs of alternative water sources (wells and pumps) over more land. Notice that lower-end farmers without pumps are of about the same average size (1.43 feddans) as upper-end farms (1.38 feddans). Farmers who rent pumps are about twice that size. But, farmers who have invested in pumps average 7.42 feddans. The larger land holding has enabled them to justify the investment in a pump.

While farmers who obtained an alternative source of water by renting or purchasing a pump bear an additional cost of water that most upper-end farmers do not incur, some lower-end farmers do not have pumps and must rely on the availability of water from canals. These farms are both small and lack a reliable source of water.

Cropping Intensity

It was mentioned above that lower-end farms, especially those without alternative water sources, may tend to be operated more extensively. That is, farmers use fewer non-water inputs per unit of land in response to the absence of a reliable source of water. Further, they may select crops with lower water requirements, delay planting, and use less water and associated inputs per unit of land. Changes in cropping intensity associated with water shortage can be manifest in several ways. First, the amount of idle land would be expected to be greater on canal-end farms than is present on farms at the upper reaches of canals. Also, the number of crops per feddan per year may be less on canal-end farms. Farmers with water shortages are likely to practice less intercropping and multiple cropping. Further, the selection of crops used may be different. Water shortages would lead to growing fewer high value crops and selecting crops which are capable of withstanding some water-stress may be more common. Finally, the crop yields obtained per feddan are expected to be smaller on the farms near the canal ends.

Table 5 shows the summer season cropping patterns of farmers. Maize tends to be the dominant crop for all farmers, occupying between 50 and 60 percent of the land. Upper-end farmers and lower-end farmers with pumps grow about the same proportions of maize in their cropping patterns. Lower-end farmers without pumps grow a much larger proportion of maize relative to vegetables and other crops, however.

Upper-end farmers have a slightly greater percentage of vegetables than lower-end farmers with pumps. Likely, since lower-end farmers with pumps are much larger than upper-end farmers, labor availability may limit the amounts of vegetables (which are relatively more labor intensive) grown on these lower-end

Table 5. Summer Season Cropping Patterns of Farmers by Location and Water Availability

Crop	Location Along Branch Canal: Upper* End	Lower End: All Farms	Lower End: With Pumps	Lower End: Without Pumps
	(feddans of crop ÷ feddans of land)x100			
Maize	53	60	55	86
Vegetables	42	31	33	21
Other	19	10	11	7

*Totals may add to greater than 100 because of the practice of intercropping.

Table 6. Winter Season Cropping Patterns of Farmers by Location and Water Availability

Crop	Upper* End	Location Along Branch Canal: Lower end		
		All Farms	With Pumps	Without Pumps
	(feddans of crop	÷ feddans of land)x100		
Berseem	70	38	38	77
Wheat	7	25	28	7
Tomatoes	6	14	16	--
Hot Pepper	1	15	14	16
Other	22	12	14	--

*Totals may add to greater than 100 because of the practice of inter-cropping.

farms. Lower-end farmers without pumps have only about one-half the amount of land committed to vegetables as the comparable sized farms near the upper end of branch canals. In Appendix Table A-7 it is seen that maize is the only summer crop for five of the seven lower-end farms with pumps. This cropping pattern is not unique to them (see Tables A-8 to A-10), but most farmers who have access to pumps grow some vegetables during the summer season.

During the winter season there is a closer correspondence in cropping patterns between farms of similar size, Table 6. That is, upper-end farmers and lower-end farmers without pumps are more alike in their cropping patterns. Berseem claims most of the land, 70 and 77 percent, respectively. These two groups of farms with about 1.4 feddans of land have about the same amount of wheat as well. The lower-end farms do grow more hot peppers in the winter than the upper-end farmers. Correspondingly, the upper-end farms have more other crops; flax, eggplant, leak, parsley, and garden rocket being some of the more common other crops.

The cropping patterns of the much larger lower-end farmers with pumps differ markedly from the smaller farms. A much smaller proportion of total land is committed to berseem. Likely, they do not need to devote such a high percentage of their land to forage production for livestock. They are able to grow more wheat and tomatoes as cash crops than the smaller farms.

In addition to the crop mix, another possible difference in farming operations associated with water availability is cropping intensity. Cropping intensity is defined as the total number of feddans of all crops divided by the total feddans of land farmed. Crops also vary as to their use of inputs per unit of land. Some crops, such as vegetables may require much more fertilizer, water, and labor per feddan than grain crops. Further, any given crop can be farmed with different levels of input intensity. Maize may be more sparsely seeded and receive less fertilizer in the anticipation of it having lower water requirements per feddan. From Table 7 the cropping intensities (crops/unit of land/year) of the various groups of farmers can be compared. (See Table A-11 and A-12 for more details.) The greatest intensity is found on upper-end farms. However, farms at the lower end with pumps also achieve cropping intensities greater than 2.0.

Thus, as more water is available during the summer, farms tend to (a) grow more vegetables and (b) have less of the total available land committed to maize. But, during the winter season when water is more uniformly available, cropping patterns appear to be more influenced by size of farm than by location along a branch canal. Small farms have larger proportions of their land devoted to berseem than the larger, canal-end farms with access to pumps. On the other hand, the larger farms grow more wheat, tomatoes and other cash crops.

Cropping intensity, as measured by the ratio total feddans of crops to the total feddans of land, does not appear to be greatly influenced by size or by position along a branch canal. But, if the crop mix is considered, cropping intensity differences are more pronounced. Since vegetables (an input intensive crop) is associated with superior water availability, whether provided by the canal or by pump, a part of the increased cropping intensity is hidden in the choice of crops. The small farms without pumps near the end of branch canals choose to concentrate their efforts to growing maize during the summer season.

Table 7. Cropping Intensities of Farms by Location and Water Availability

Season	Location Along Branch Canal:			
	Upper End	Lower End		
		All Farms	With Pumps	Without Pumps
Summer	1.14	1.01	1.01	1.0
Winter	1.06	1.14	1.14	1.0
Annual	2.20	2.13	2.15	2.0

Table 8. Expected Maize Yields on Farms by Location and Water Availability

Farmer Group	Expected Maize Yield/Feddan
	(ardabs)
Upper end	10.6
Lower end:	
with pumps	8.9
without pumps	6.7

from the ground or from drains may be of lower quality than canal water.

Another measure of cropping intensity is the amount or extent of idle land. Farmers were asked how much or for how long they may leave land idle. Response to this question was rather limited, but 5 lower-end farmers indicated that they leave some land idle for a period of about one month. Two others indicated that they often delay planting of crops because of the lack of available water. Leaving land idle tends to be associated with farmers without access to pumps.

Anticipated Changes

The survey results presented thus far are measurements of how water availability is affecting farming operations. Differences in the organization and operation of upper-end and lower-end farms have been observed. We next turn to more "what if" kinds of issues. That is, if water were available according to schedule, how would cropping patterns, cropping intensities and expected yields change. Data on "what farmers would do if questions" are more qualitative than those data presented above, but they provide some additional information. The responses are detailed in Table A-13.

When asked how they would respond to water being available more on schedule during the summer, 12 lower-end farmers indicated that they would grow more vegetables, 5 would keep the same crops (two of these volunteered they would expect a higher yield) 2 would grow more maize and 2 would grow more of other crops.

The better delivery of water relative to the water rotation schedule and crop water requirements during the winter season is also reinforced in these data. During the winter season most farmers would maintain the same crops.

A further dimension of cropping intensity is that of expected production per feddan. Farmers were asked about their expected yields from crops. Comparable data were obtained for only one crop and these results are presented in Table 8. Important differences are shown in the farmers' expected maize yield depending upon their circumstance for water availability. Upper-end farmers expect a maize yield of 10.6 ardabs* per feddan. Lower-end farmers with pumps have expected maize yields of 8.9 ardabs and lower-end farmers without pumps expec yields of only 6.7 ardabs. Thus, another measure of intensity, the amount of production per unit of land, is also associated with water availability. Crop yields are decreased as water becomes less available.

One might expect farmers at the lower end with pumps to have yield expectations as least as great as those farmers at the upper end. Three possible explanations for their lower expected yields can be advanced. (a) Even with pumps lower-end farmers incur an additional cost for water. For economic reasons they may choose to apply less water per feddan of maize than do upper-end farmers The added costs they are incurring (pumping costs) do not justify as much water applied per feddan of maize as is the case when these pumping costs are less. (b) The soils near the lower reaches of branch canals are more saline than those at the upper reaches.[7] Perhaps because of inadequate deliveries of water to flush these salts from the soil, higher levels of salts have accumulated and these salts are deleterious to yields of most crops. (c) Further, water pumped

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*An ardab is a volume measure which varies in weight depending on the commodity measured; an ardab of maize is 140 kilograms or about 308 pounds.

[7]Dotzanko, A.D., M. Zanati, A.A. Abdel-Wahed, and A.M. Keleg, "Preliminary Soil Survey Report for the Beni Magdoul and El Hammami Areas." Egypt Water Use Project, EWUP Technical Report No. 2. 1979.

The differences observed between upper-end and lower-end farmers and between those with and without alternative water sources are supported by these indicated changes in improved water delivery. The amounts of summer vegetables are being limited by available water; more maize is grown than would be if the water situation were changed. Lower-end farmers without alternative water sources also expect lower maize yields because of the problems associated with water availability; several farmers indicated they would expect a higher yield if more water were available.

Given the adjustments farmers have made or are making to their circumstances of water delivery, it is appropriate to consider the potential benefits from actions to improve the distribution of water along branch canals. The following section discusses some of the potential benefits. The necessary data to demonstrate the benefits from alternative water distributions are not readily available. The data on which the following discussions are based do serve to illustrate the costs and benefits to improved water distribution. The material presented also illustrates the potential importance on the problem to the agricultural economy of Egypt.

Implications of Water Delivery Problems

The information presented above illustrate that differences are present between upper-end and lower-end farmers along branch canals. These differences are associated with the delivery of irrigation water. The availability of irrigation water according to schedule is important to (a) the income potentials of individual farmers and (b) to the area or district, measured as the extent to which agricultural output potentials are being reached. (c) Further, the problem has national significance to the government of Egypt and the agricultural sectors ability to contribute to national economic development goals.

Farmer Income

Farmers at the lower end of branch canals may be adversely affected by one or more ways. First, they may incur additional costs to supply water to their farms. Investments in pumps and wells and/or expenditures for pump rentals are being incurred by some farmers. Second, their cropping patterns are affected. Farmers are forced to choose crops which are relatively less sensitive to moisture stress and must forego the opportunity to produce vegetables (in the Mansouria district) with greater income earning potentials. Finally, even for the same crop mix, lower-end farmers cannot achieve the same yields per unit of land as their peers at the upper end.

Table 9 shows the amount of investment in pumps and wells reported by the farmers who responded. Total investments vary from L.E. 400 to L.E. 2,300; investment per feddan ranges from about L.E. 89 to L.E. 250.

Three of the farmers who own pumps also have wells; one of these farmers has two wells. Two others pump from a drain. The source of water for the remaining farmer is not known. One farmer indicated that he jointly owns the pump with two other farmers.

Farmer Number 2 rents his pump so that it serves about 25 feddans in addition to the 3 feddans he owns. His rental income on the pump is about L.E. 0.75 per hour; total annual income from pump rental is about L.E. 675.

Farmer Number 6, who jointly owns his pump with two others, also rents the pump to others. The pump serves 13.5 feddans for the three owners and is rented to provide water to another 4 feddans. The rental income is L.E. 0.60 per hour or about L.E. 60 per year. Thus, farmers who own pumps may be spreading the fixed costs of these pumps by providing either water or a pump for rent to his neighbors.

Table 9. Investments in Alternative Water Sources Reported by Lower-End Farmers Who Own Pumps

Farmer[a] Number	Investment	Land Farmed	Investment per Feddan
	(L.E.)	(feddans)	(L.E.)
1	2,000	17	117.65
2	700	3	233.33
3	400	2.5	160
5	1,500	6	250
6	400	4.5	88.89
15	2,300	11.5	200
Average	1,217	7.4	164.45

[a]Farmer numbers here correspond to those identified in Tables A-1 through A-13.

In addition to these investments, which must be amortized over several years, farmers must pay the operating costs for using these pumps. Upper-end farmers also have water lifting costs; the data obtained for this study are not sufficient to compare the costs of lifting water between upper-end and lower-end farmers, however. Reports are in preparation by other EWUP economists which examine the costs of lifting water by alternative means.[8] Appendix B-1 and B-2 provide some investment and operating cost data as reported by two farmers included in this study. This study was not designed to provide sufficient information about differences in water lifting costs between upper-end and lower-end farmers to make comparisons.

Other farmers rent pumps to offset canal water delivery shortfalls. Table 10 summarizes the average rental cost obtained from those who reported. Pump rental rates vary a great amount, from L.E. 0.50 per hour to L.E. 1.00 per hour. The average rental rate is L.E. 0.67. Likely, these variations are associated with size and flow rate but the data obtained do not include such measurements.

Farmers who neither own or rent pumps, and perhaps some who rent pumps only for certain crops or irrigations, have different kinds of costs. Their cost are opportunity costs of income foregone. It was shown earlier that the cropping patterns favor maize at the expense of vegetables. Further, expected maize yields are much lower than those expected by upper-end farmers and by lower-end farmers with pumps.

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[3] Quenemoen, M. E. and Shinnawi Abdel Atty El Shinnawi, "An Economic Analysis of Water Lifting With a Diesel Pump for a Farm at El Hammami." A paper presented at the UNESCO Training Conference on Irrigation Development. Egypt Water Use Project. 1979.

Table 10. Pump Rental Costs Paid by Lower-End Farmers Reporting

Farmer Number	Rental Cost per Hour
	(L.E.)
3	0.60
7	0.80
8	0.80
9	0.50
12	0.50
19	1.00
20	.50

First, consider the differences in income per feddan from vegetables versus maize. The EWUP Enterprise Cost Studies estimate the net return above all costs for cabbage in the El Hammami area are L.E. 351.36 per feddan.[9] In the same area, the net return above all costs for eggplant is L.E. 227.62 per feddan.[10] And for tomatoes in the Bemi Magdoul area, per feddan net returns above all costs are estimated at L.E. 52.54.[11] Currently available data do not permit direct comparisons to maize in the Mansouria district. However, enterprise costs and returns have been made for maize in the Abu-Raia area of the Kafr El Sheikh Governate. The yields reported in this estimate is 13 ardabs, slightly greater than the 10.6 ardab yield expected by Mansouria district farmers. Net return per feddan of maize above all costs is reported as L.E. 7.19.[12] It appears that net returns above all costs are considerably higher for vegetables than for maize. Income sacrifices per feddan may range from L.E. 46, comparing maize to tomatoes, to L.E. 344 when comparing maize to cabbage.*

Even if maize is produced, the opportunity cost of foregone income is great. Gross returns per feddan from maize yielding 10.6 ardab and priced at L.E. 8 per ardab is L.E. 84.8. The gross returns per feddan associated with the 6.7 ardab maize expected by lower-end farmers without pumps is L.E. 53.6. A difference of L.E. 31.2 in expected gross returns per feddan of maize exists

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[9] El Shimmawi and Farouk Abdel Al, "Crop Enterprise Cost Study, Cabbage at El Hammami Area". Egypt Water Use Project, 1979.

[10] El Shammai and Farouk Abdel A, "Crop Enterprise Cost Study, Eggplant at El Hammami Area". Egypt Water Use Project, 1979.

[11] Lotfi, Nasr and Farouk Abdel Al, "Crop Enterprise Cost Study, Tomatoes at Bami Magdoul Area". Egypt Water Use Project, 1978.

[12] Quenemoen, M. E., Yusef Yusef and Gamal Ayad, "Crop Enterprise Cost Study Maize at Abu-Raia." Egypt Water Use Project, 1978.

*These analyses hold true for individual farmers only; if all farmers increased vegetable production, additional supplies would cause prices to decrease and the net income differences to narrow.

between these two groups.

<u>Production losses along branch canals</u>. Differences in water costs and net income per feddan between farmers with adequate irrigation water and those with water shortages can be sizable. Here, it will be shown that for a given amount of water delivered to the head of a branch canal, total production can be increased by improving the distribution of water along the branch. That is, a greater total output can be reached by providing more water to lower-end farmers, even if this requires reducing water use of upper-end farmers.* Thus, if water use efficiency is measured as the amount of (or value of) agricultural output per unit of water, an improvement in water use efficiency would occur by providing a more uniform distribution of water along all branch canals. The potential benefits from a more uniform distribution are different depending on whether or not adequate amounts of water are being available at the head of branch canals to meet the crop water requirements for all land served by the canal. Here we assume adequate water is available at the head of the branch canal. The potential gains from improved water distribution then depend on the case if (a) upper-end farmers are using excessive amounts of water and thereby prevent the water from being delivered to lower-end users, or (b) upper-end farmers are not using water excessively but the water is being lost by seepages, weed growth, etc., from the branch canals. Water use efficiency cannot be considered in isolation from other input use. Suppose in either case that adequate amounts of all other inputs are available and are varied in correct proportions to the amount of water applied. Figures 2 and 3 illustrate these two cases.

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*If lower-end water shortages are caused by losses in the branch canal from seepage, weed growth, etc., reallocations may not be necessary. Upper-end irrigations would not affected by measures to reduce in-canal losses which would provide more water to lower-end users.

Figure 2 is based on a production response function for corn (maize) at Davis, California.[13] As for Egypt, little or no growing season precipitation occurred in the experiments on which the function is based. The functional relationship between water (W) in acre-inches, pounds of nitrogen (N) fertilizer, and pounds of maize production (M) per acre is:

$$(1)\quad M = 3294.4 + 367.2W + .52N - 7.06W^2 + .0038N^2 - .0458WN$$

Since it is assumed the levels of all other inputs but water are given, setting N=100 the production response equation reduces to:

$$(2)\quad M = 3852.4 + 366.7W - 7.06W^2$$

The maximum per acre yield occurs when 25.97 acre-inches of water are applied resulting in a yield of 8,614 pounds of maize per acre. Converting these measurements to cubic meters (m^3) per feddan and ardabs of maize, the maximum yield occurs when 2,770.8m^3 of water is applied and a yield of 29.03 ardabs of maize is reached. This yield is more than double the greatest of yields observed among the farmers sampled in this survey. The response function is fit to data from a controlled experiment and the cultural practices applied in California are different from those used in Egypt. The functional relationship given in equation 2 is adjusted for both the experimental and cultural practice effects and the following equation results:*

$$(3)\quad Y = 1926.2 + 183.4W - 3.53W^2$$

With equation 3, yields still reach a maximum at 2770.8m^3 of water; the maximum yield is 14.5 ardabs per feddan. Such is consistent with the survey data and other reports of maize yields in Egypt.[14]

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*Equation 3 is derived as Y = 1/2 (equation 2)

[13] Heady, E.O. and R.W. Hexem. Water Production Functions for Irrigated Agriculture. Iowa State University Press. Ames, Iowa. 1978. p. 92.

[14] Fitch, J.B., A.A. Goueli, and M. El Gabely, "The Cropping System for Maize in Egypt, Survey Findings and Implications for Policy in Egypt," Workshop on Improved Farming Systems for the Nile Valley. Ministry of Agriculture and UNDP/FAO. Cairo. 1979.

In Figure 2 we assume that upper-end farmers are not using excessive amounts of water. Shown along the water response curves for maize, are points corresponding to the possible water application rates for upper-end and lower-end farmers. First, Point A on the curve locates where lower-end farmers without pumps may be operating; they may be receiving only one-fourth the amount of water as upper-end farmers.[15] Point C locates where upper-end farmers may be operating; they are applying water at the level which maximizes their yields.

At A about 700 cubic meters of water are applied and at C, about four times as much or 2,800 cubic meters are applied. In equation 3 the maximum yield of 14.5 ardabs is reached with about 2,600m^3 of water per feddan. From equation 3 the estimated yield reduction resulting from reducing water application by, say, 500m^3 can be estimated. If W=2,100m^3, maize yields would be reduced by 0.30 ardab. If that 500m^3 were made available to lower-end farmers, water applications could be increased from 650m^3 per feddan (Point A) to 1,250m^3 per feddan and an additional yield of about 2.37 ardab would be forthcoming. A gain of 2.37 - .30 = 2.07 ardab of maize would be obtained on each feddan following this reallocation. Such redistributions could continue until the marginal increment in yield per unit of water is equated for the upper-end and lower-end farmers such as would occur at Point B. At B, the output of two feddans would be about 26.8 ardabs (13.4 x 2 feddans). But, prior to the redistribution with lower-end farmers operating at A and upper-end farmers at B, the output from two feddans would be only 24.5 ardabs (10.0 + 14.5). This distribution of the same amount of water, a total of 3,250 cubic meters for two feddans, would yield about 9 percent more maize.

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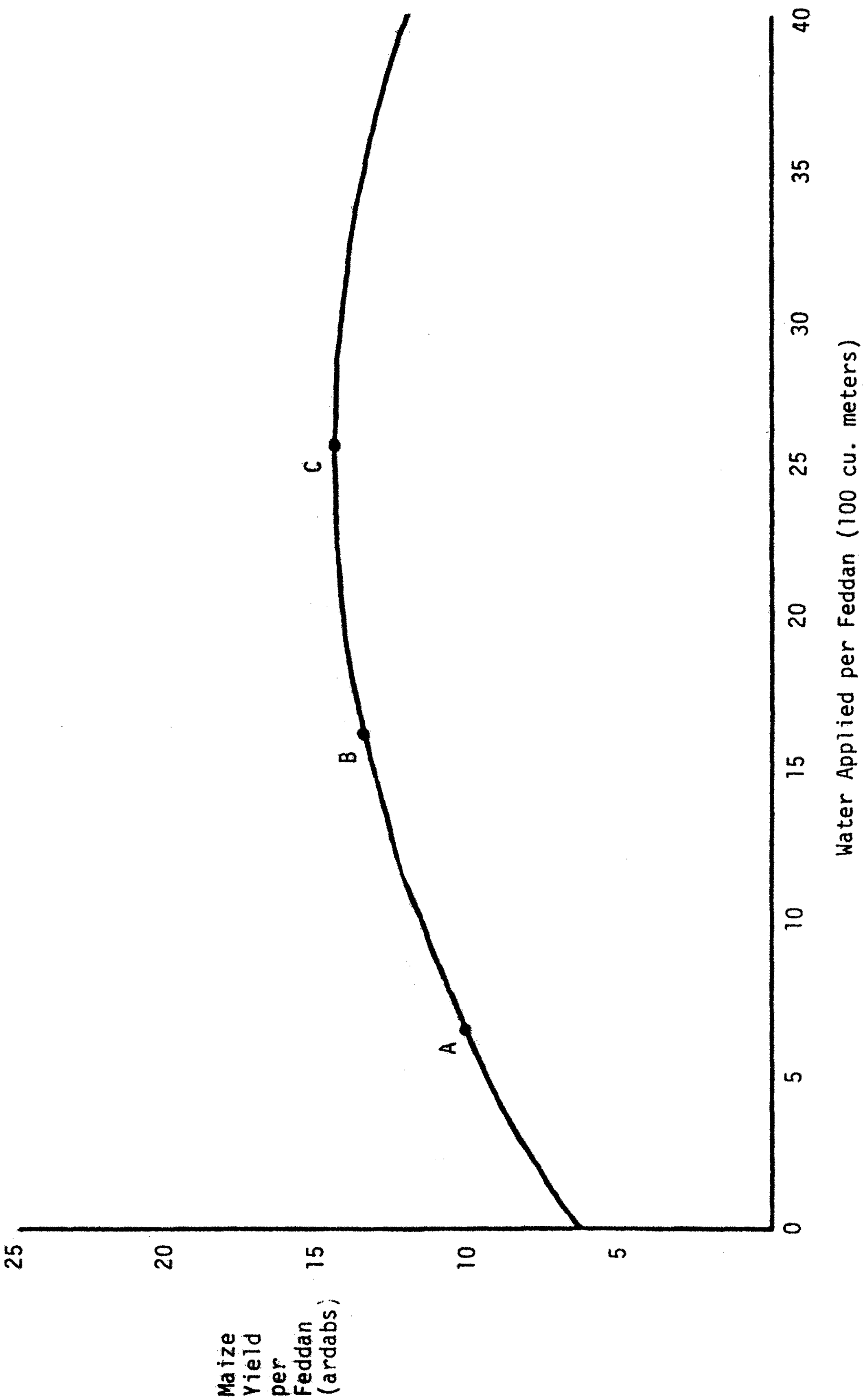
[15] op. cit., Wolfe, et al.

Figure 2. Hypotentical Water Response Curve for Maize; Upper-End Farmers Not Using Water Excessively



If, however, the situation is as depicted in Figure 3, the potential gains from redistribution are even more significant. Here it is assumed that (a) adequate amounts of water are being delivered to the head of branch canals and that (b) upper-end farmers are using water destined for lower-end users. The upper-end farmers are, in fact, using so much water that it is deliterious to their yields.* That some farmers may be using water excessively was cited as a possibility in an earlier study.[16] This report found some indication that as water applications increase, total yields decrease. Such is the case at Point C. In Figure 3, a total of about 2,500m^3 is provided for each feddan of maize, an amount which approximates its consumptive use requirements. The distribution is not uniform, however, upper-end farmers claim 4,000m^3 of water leaving only 1,000m^3 for lower-end farmers. Points A and C depict the lower-end and upper-end farmers operations, respectively.

Lower-end farmers are using 1,000 cubic meters of water (1/4 the amount of upper-end users) and are obtaining a yield of about 11.5 ardabs per feddan. Upper-end farmers are using 4,000 cubic meters and get a yield of 12.0 ardabs. Now, redistribution of water from the upper-end to lower-end will benefit both groups. If 1,500 cubic meters are taken from each upper-end feddan, reducing the amount applied from 4,000m^3 to 2,500m^3, yield would increase from 12.0 ardabs to 14.5 ardabs. A corresponding increase in the amount of water delivered to maize on lower-end farms would increase the water used per feddan from 1,000 to 2,500m^3 and increase their yields from 11.5 to 14.5 ardabs. Dividing the water

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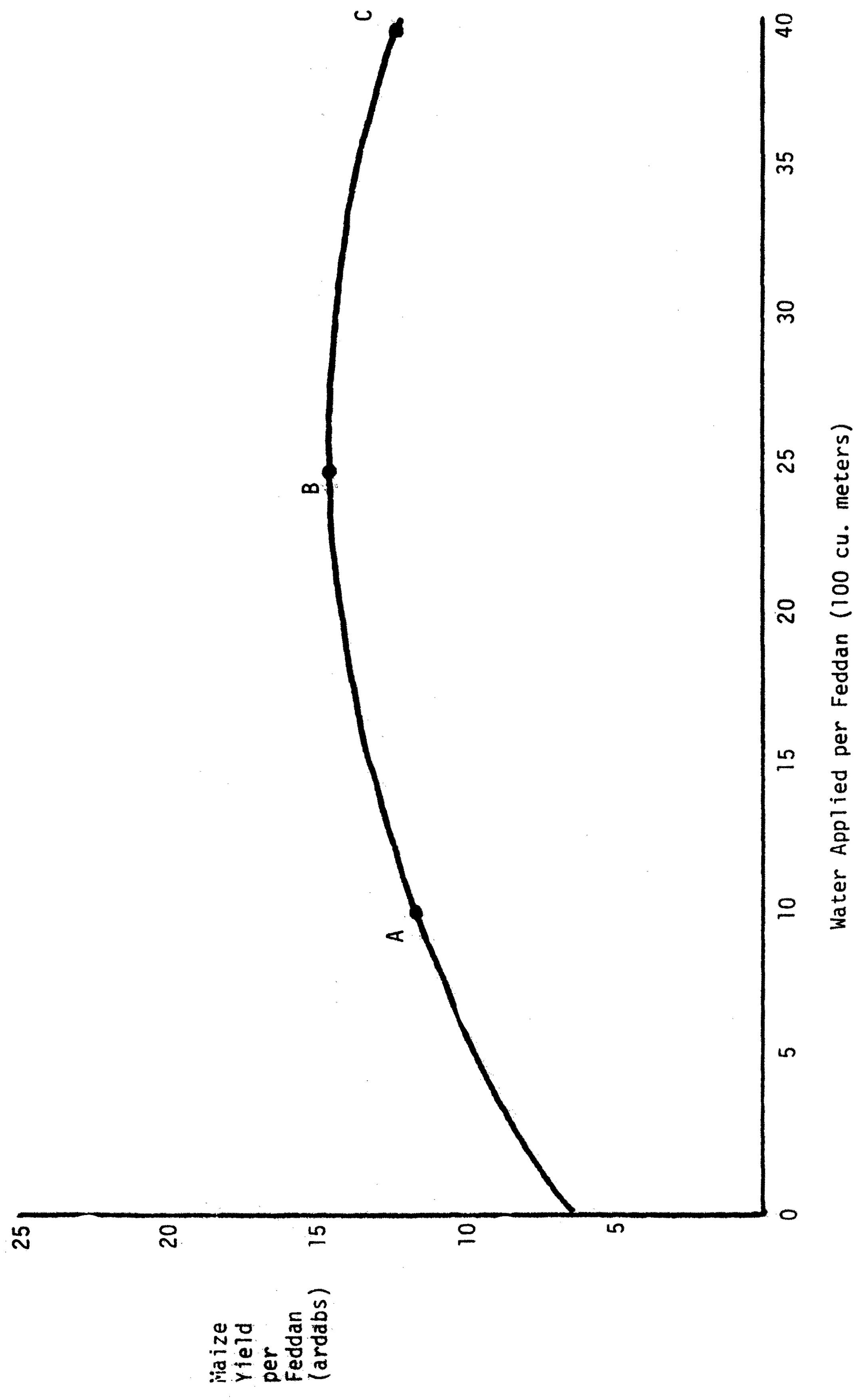
*Such water use practices appear irrational. They are rational, however, in that such input use practices often occur because of lack of knowledge, risk aversion, or are necessary to insure one's continued use of a resource.

[16] El Kady, op. cit., p. 54.

Figure 3. Hypotentical Water Response Curve for Maize; Upper-End Farmers Using Water Excessively



equally among upper-end and lower-end land, allowing 2,500m^3 for each feddan equates the yield increment per marginal unit of water. At this point (Point B in Figure 3) the yield would be 14.5 ardabs for both upper-end and lower-end lands. Thus, total output from two feddans, one located at the upper end and the other at the lower end, would increase from 11.5 + 12.0 = 23.5 ardabs to 29 ardabs. This is a 23 percent increase.

Depending on whether situation in Figure 2 or Figure 3 prevails, potentials to increase water use efficiency and agricultural output along branch canals are present. Output of maize alone could increase from 9 to 23 percent. Likely, changes would also occur in the cropping patterns as lower-end farmers would grow more vegetables. Thus, the benefits demonstrated by Figures 2 and 3 are on the conservative side. The potentials to achieve improvements in water use efficiency are even greater than the illustrations reveal.

Aggregate Effects

Just as the efficiency of water use along a branch canal can be increased by improved distribution of water and these efficiency gains are realized as a greater level of agricultural output, approximations can be made of the potential benefits to the agricultural output of the nation. Egypt has about 5.5 million feddans of land. In the Mansouria area, lower-end farmers without access to alternative sources of water have about 86 percent of the land in maize during the summer season. Their peers with water have only about 54 percent of their land in maize. Conversely, vegetables make up only 21 percent of lower-end without water farmers summer crops while those with water have between 33 and 42 percent (say 37 percent) of their land in vegetables. One-third of the land is being operated below its potential. The Mansouria district includes 27,745 feddans.[17] The lower-end farms produce only (27,745 ÷ 3 X .21) 1,942 feddans of vegetables while upper-end farms produce (27,745 ÷ 3 X .37) 3,422 feddans of vegetables. The difference in net farm income per feddan of vegetables and that of maize ranqed from L.E. 46 to 344. Assuminq a difference of L.E. 200, the income foregone from not producing vegetables in the Mansouria district alone could amount to L.E. 296,000 per year. It is very possible, however, that the amount of vegetables grown is constrained by labor availability. Thus, extrapolation like those presented here should be interpreted with some reservations.

In addition, the net income per feddan of maize grown by lower-end farmers is below potential. Increases in gross income per feddan of maize could range from 9 to 23 percent. Gross income per feddan of maize is about 13 ardabs at L.E.8 = L.E.104. Assume maize would occupy only 54 percent of the summer land, as with farmers with adequate water, and 4,994 feddans of maize are "below potential (27,745 feddans x 1/3 x .54). A 10 percent increase in gross income per feddan amounts to L.E. 51,938 (4,994 x .72); a 23 percent increase would increase gross farm income by L.E. 119,456.

Not all areas of Egypt possess the income potentials from vegetables as does the Mansouria district. Nevertheless, these analyses illustrate the potential gains which can be achieved by improving the efficiency of water distribution and use. Further, such estimates of the benefits from improvements in water use efficiency can serve as a guide as to how much can be spent to improve the efficiency of water delivery and use. Such is the goal of the Egypt Water Use and Management Project.

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[17] op. cit. Wolfe, et. al.

APPENDIX A

EGYPT WATER USE AND MANAGEMENT PROJECT
(ECONOMICS TEAM)
INTENSIVE (FARMER) SURVEY
EVALUATION OF WATER SHORTAGES
ON BRANCH CANALS

SITE AND GOVERNORATE: ____________

1. Name ____________ Age ____________

2. Family Members: Wife ____________

Children: Age Sex

Age	Sex
____	____
____	____

3. Location: Name of canal ____________

Canal start ____________

Canal end ____________

4. Amount of land farmed:* Number of feddans ____________

Number of feddans owned ____________

Number of feddans rented ____________

5. Livestock and Equipment Inventories:

a. Livestock

Livestock	No.	Age	Uses
Buffalo	____	____	____________
Cattle	____	____	____________
Donkeys	____	____	____________
Goats	____	____	____________
Sheep	____	____	____________
Chickens	____	____	____________
Other (specify)			
____________	____	____	____________

Data prepared by: ____________

Date: ____________

b. Equipment

Equipment	No.	Size
Sakia	______	______
Tambour	______	______
Shadoof	______	______
Plow	______	______
Tractor	______	______
Planter	______	______
Diesel pump	______	______
Electric pump	______	______

6. Source of water; number of feddans served by:

Canal only ______

Canal & drain ______

Canal & well ______

Well only ______

Other (specify) ______

7. Crops Grown:

a.

Summer Crops	No. of feddans	(expected) Average Yield
______	______	______
______	______	______
______	______	______

b.

Winter Crops	No. of feddans	(expected) Average Yield
______	______	______
______	______	______
______	______	______
		______

8. Water Rotation:

Summer; Days on ______ Days off ______

Winter; Days on ______ Days off ______

9. Canal Water Availability:

a. Summer season

(1) Usually available on schedule ______

(2) Available as scheduled about 3 times out of 4 ______

(3) Available as scheduled about one-half the time ______

(4) Available as scheduled about one-fourth the time ______

(5) Never available as scheduled ______

(6) Is water available at night? ______

Explain: ______

______

(7) Will you or do you irrigate at night: ______

Explain ______

______

b. Winter season

(1) Usually available onshedule ______

(2) Available as scheduled about 3 times out of 4 ______

(3) Available as scheduled about one half the time ______

(4) Available as scheduled about one-fourth the time ______

(5) Never available as scheduled ______

(6) Is water available at night? ______

Explain ______

______

(7) Will you or do you irrigate at night? ______

Explain ______

______

10. Changes in farming practices because of problems with water availabili

a. Leave land idle ______ if so, number of feddans ______, for how many months/year ______

b. Change crops grown from ______________ to ______________

c. Develop an alternative water source from ______________ (date) to ______________ (date)

11. If water was always available according to rotation, what crops would be grown?

Summer crops	No. of feddans	(expected) average yield

Winter crops	No. of feddans	(expected) average yield

12. Do you rent a pump? Yes ☐ No ☐

13. Do you own a pump? Yes ☐ No ☐

a. If yes on 12 or 13, source of power:

☐ Diesel

☐ Electric

☐ Other (specify) ______________

b. Pump characteristics:

Motor size ______________

Investment cost (if owned) ______________

Year purchased (if owned) ______________

Rental cost (if rented)

c. Number of months per year in which the pump is used ______________

14. Reasons for using pump:

a. Labor shortage ________________

b. Problem of feed for livestock used to turn sakia ______________

c. Can apply available canal water on a more timely basis ____________

d. Lower cost method of pumping water ______________________

e. Used as an alternative to taking water from canal ____________

f. Other (specify): ______________________________

____

15. Do you have a well to supply part of the water used on your farm?

Yes ☐ No ☐

a. If yes, year installed ________________

Investment cost ________________

Depth ________________

b. Number of months per year the well is used to supplement canal water ____________________________

c. Number of years in 10 the well will be needed to supplement canal water ____________________________

16. Reason for investing in well:

a. Better water ______________

b. Water is always available when needed __________

c. Needed because of water shortages from canal during some months ______

d. Other (specify) ______________________________

17. Do you obtain some water used on your farm from sources other than the canal or well? Please explain ______________________________

____

____

18. Is quality of water a problem at any of the sources available to you ?

Farm Location Map

Conversion from Kerates to feddans

K.	F.	K.	F	K.	F
1	0.04	9	0.38	17	0.71
2	0.08	10	0.42	18	0.75
3	0.13	11	0.46	19	0.79
4	0.17	12	0.50	20	0.83
5	0.21	13	0.54	21	0.88
6	0.25	14	0.58	22	0.92
7	0.29	15	0.63	23	0.96
8	0.33	16	0.67	24	1.00

Table A-1. Availability of Canal Water to Farmers at the Lower End of Branch Canals During Summer Season and Practice of Night Irrigation

Farm Number	Canal Water is Available: Usually on Time	About 3/4 of the Time	About 1/2 of the Time	About 1/4 of the Time	Never on Time	Night Irrigation Yes	No
1					X	X	
2					X		
3				X			
4		X					
5				X		X	
6			X			X	
7				X		X	
8				X		X	
9				X		X	
10		X				X	
11			X			X	
12			X			X	
13			X				X
14	X					X	
15				X			X
16			X			X	
17	X					X	
18	X						X
19				X		X	
20				X		X	
Number	3	2	5	8	2	14	3

Table A-2. Availability of Canal Water to Farmers at the Upper End of Branch Canals During the Summer Season and Practice of Night Irrigation

Farm Number	Canal Water is Available: Usually on Time	About 3/4 of the Time	About 1/2 of the Time	About 1/4 of the Time	Never on Time	Night Irrigation Yes	No
1	X					X(sometimes)	
2	X					X	
3			X				X
4		X				X	
5		X				X	
6		X				X	
7		X				X	
8		X					X
9		X				X	
10			X			X	
11			X			X	
12		X				X	
13		X				X	
14		X					X
15		X					X
16		X				X	
17	X						X
18		X				X	
Number	3	12	3			13	5

Table A-3. Availability of Canal Water to Farmers at the Lower End of Branch Canals During the Winter Season

Farmer Number	Canal Water is Available: Usually on Time	About 3/4 of the Time	About 1/2 of the Time	About 1/4 of the Time	Never on Time
1					X
2				X	
3	X				
4	X				
5		X			
6	X				
7		X			
8	X				
9			X		
10		X			
11		X			
12		X			
13		X			
14	X				
15	X				
16	X				
17	X				
18	X				
19	X				
20	X				
Number	11	6	1	1	1

Table A-4. Availability of Canal Water at the Upper End of Branch Canals During the Winter Season

Farmer Number	Canal Water is Available: Usually on Time	About 3/4 of the Time	About 1/2 of the Time	About 1/4 of the Time	Never on Time
1	X				
2	X				
3	X				
4	X				
5	X				
6	X				
7	X				
8	X				
9	X				
10	X				
11	X				
12	X				
13	X				
14	X				
15	X				
16	X				
17	X				
18	X				
Number	18				

Table A-5. Access to Irrigation Pumps by Farmers at the Lower End of Branch Canals

Farm Number	Rent a Pump	Own a Pump	Months Pump Used
1		X	12
2		X	10
3	X	X	3
4			
5		X	12
6		X	12
7	X		3
8	X		3-5
9	X		<1
10			
11	X		<1
12	X		<1
13			
14			
15		X	7-8
16			
17			
18			
19	X		<1
20	X		<1
Number	8	6	---

Table A-6. Access to Irrigation Pumps by Farmers at the Upper End of Branch Canals

Farm Number	Rent a Pump	Own a Pump	Months Pump Used
1			
2			
3			
4			
5			
6	Yes		1
7			
8			
9			
10			
11			
12			
13	Yes		<1
14			
15			
16			
17			
18			

Table A-7. Cropping Patterns of Farmers at Lower End of Branch Canals During Summer Season

Farmer Number	Total Land	Maize (grain)	Maize (forage)	Vegetables	Other
	---- no. of feddan ----				
1	17	8	3	6	
2	3	1		2	
3	2.5	1.25	.6	.6	
4	4.25	3.5	.75	1.5	
5	6	2			2.5
6	4.5	2	1	1.5	
7	3.5	1	1	1.5	
8	1.33	1	.33		
9	1	1			
10	1	1			
11	1.5	1		.5	
12	4.5		1.5	1.75	1.75
13	.4	.4			
14	1.4	.8	.6		
15	11.5	4		5	2.5
16	.63	.63			
17	1	1			
18	1.38			.63	.75
19	5	4	.67	.33	
20	2.5	.83		1.67	
Total	73.89	34.41	9.45	22.98	7.50
Average	3.69	1.72	.47	1.15	.38
Percent	----	47	13	31	10

Table A-8. Cropping Patterns of Farmers at Upper End of Branch Canals During Summer Season

Farmer Number	Total Land	Maize (grain)	Maize (forage)	Vegetables	Other Crops
	---- no. of feddan ----				
1	1.5	1.25		.38	
2	1.5	1.5			
3	.3			.3	
4	1.5	.5	.5	.5	.5
5	1.25	1.0		.5	
6	.67				.67
7	.83			.83	
8	.17			.17	
9	2	1.0	.25	.5	.5
10	2	.75		1.25	
11	2	2			
12	2.75	1		1.0	1.25
13	.63	.29		.34	
14	3	1.5		2.08	
15	.33			.33	
16	3	1.5			1.5
17	.5	.25		.75	
18	.92			1.5	.42
Total	24.85	12.54	.75	10.43	4.84
Average	1.38	.70	.04	.58	.27
Percent	-----	50	3	42	19

Table A-9. Cropping Patterns of Farmers at Lower End of Branch Canals During Winter Season

Farmer Number	Total Land	Berseem	Wheat	Tomatoes	Hot Peppers	Other
	----- no. of feddan -----					
1	17	5	10	8	2	
2	3	1	1			1
3	2.5	1.25	1.25			
4	4.25	3.5	.75			
5	6	1	.5	.5	2	2
6	4.5	1	2		1.5	
7	3.5	1	1	1	1	.5
8	1.33	.33		.5	.5	
9	1	.5	.5			
10	1	1				
11	2	1				1
12	4.5	3	1.5			
13	.4	.4				
14	1.4	.6			.8	
15	11.5	2.5		.5	2	
16	.63	.63				
17	1	1				
18	1.38	.58			.79	
19	5	2				3
20	2.5	.83			.20	1.33
Total	74.39	28.12	18.5	10.5	10.79	8.83
Average	3.72	1.41	.93	.52	.54	.44
Percent	-----	38	25	14	15	12

Table A-10. Cropping Patterns of Farmers at the Upper End of Branch Canals During the Winter Season

Farmer Number	Total Land	Berseem	Wheat	Tomatoes	Hot Peppers	Other
	----- no. of feddan -----					
1	1.5	1.25				.25
2	1.5	1.5				
3	.3	.3				
4	1.5	1.25			.25	
5	1.25	1.25				
6	.67	.67				
7	.83	.83				
8	.17	.17				
9	2	1.5		1.0		
10	2	1.5				.5
11	2	1				1
12	2.75	1.58	.33			.92
13	.63	.17				1.38
14	3	1.5		.5		1.0
15	.33					.33
16	3	1.5	1.5			
17	.5	.5				
18	.92	.92				
Total	24.85	17.39	1.83	1.5	.25	5.38
Average	1.38	.97	.1	.08	.01	.30
Percent	----	70	7	6	1	22

Table A-11. Cropping Intensity on Farms at Lower End of Branch Canals

Farmer Number	Total Land	Total Summer Crops	Total Winter Crops	Crop Intensity Summer	Crop Intensity Winter	Total Crop Intensity
	--- no. of feddan ---			--- ratio ---		
1	17	17	25	1	1.47	2.47
2	3	3	3	1	1	2
3	2.5	2.5	2.5	1	1	2
4	4.25	4.25	4.25	1	1	2
5	6	6	6	1	1	2
6	4.5	4.5	4.5	1	1	2
7	3.5	3.5	4.5	1	1.29	2.28
8	1.33	1.33	1.33	1	1	2
9	1	1	1	1	1	2
10	1	1	1	1	1	2
11[a]	1.5	1.5	2	1	1	2
12	4.5	5	4.5	1.11	1	2.11
13	.4	.4	.4	1	1	2
14	1.4	1.4	1.4	1	1	2
15	11.5	11.5	11.5	1	1	2
16	.63	.63	.63	1	1	2
17	1	1	1	1	1	2
18	1.38	1.38	1.38	1	1	2
19	5	5	5	1	1	1.23
20	2.5	2.5	2.36	1	.94	1.94
Total	73.89	74.39	83.25	1.01	1.13	2.13

[a]Farmer farms .5 feddan more in winter than in summer

Table A-12. Cropping Intensity on Farms at the Upper End of Branch Canals

Farmer Number	Total Land	Total Summer Crops	Total Winter Crops	Crop Intensity Summer	Crop Intensity Winter	Total Crop Intensity
	--- no. of feddan ---			--- ratio ---		
1	1.5	1.63	1.5	1.09	1	2.09
2	1.5	1.5	1.5	1	1	2
3	.3	.3	.3	1	1	2
4	1.5	2.0	1.5	1.33	1	2.33
5	1.25	1.5	1.25	1.2	1	2.2
6	.67	.67	.67	1	1	2
7	.83	.83	.83	1	1	2
8	.17	.17	.17	1	1	2
9	2	2.25	2.5	1.13	1.25	2.4
10	2	2	2	1	1	2
11	2	2	2	1	1	2
12	2.75	3.25	2.83	1.18	1.03	2.2
13	.63	.63	1.55	1	2.46	3.5
14	3	3.33	3	1.11	1	2.11
15	.33	.33	.33	1	1	2
16	3	3	3	1	1	2
17	.5	1.0	.5	2	1	3
18	.92	1.92	.92	2.08	1	3.09
Total	24.85	28.31	26.35	1.14	1.06	2.20

Table A-13. Expected Changes in Summer and Winter Crops if Canal Water Delivery was Improved

Farmer Number	Summer Crops	Would Grow More			Winter Crops	Would Grow More		
	Same Crops	Maize	Vegetable	Other	Same Crops	Wheat	Vegetable	Other
1	X				X			
2			X					
3			X				X	
4			X		X			
5				X	X			X
6			X		X			
7		X		X	X			X
8			X		X			
9			X		X			
10			X					
11	X							
12		X	X					
13			X					
14	X				X			
15	X				X			
16			X				X	
17			X			X		
18	X				X			
19			X		X			
20	X				X			
Total	6	2	12	2	12	1	2	2

APPENDIX B-1

The Cost of Lifting Water with a Stationary Horizontal Diesel Pump

Farmer Number 5

Basic information and assumptions:

1. The pump is Ruston - made in England.

2. Size 6/6" pump (9/10) horse power motor.

3. Average time to irrigate one feddan - 3 hours each irrigation.

4. Number of irrigations per year - 24 times.

5. Average lift is 1.5 meters from a major drain.

6. Area served is 11 feddans

7. Initial investment:

a. pump and motor (including installation)	LE 1,200
b. building and two intake types	LE 330
	LE 1,530

8. Expected useful life of investment - 20 years.

9. Interest rate is 10 percent.

10. Operating Expenses:
    Diesel fuel, 2.5 liters per hour @ LE 0.025 per liter.
    Oil, 0.37 Kg. per hour @ LE 0.450 per kg.
    Grease, annual cost LE 8.0
    Gaskats for pump, annual cost LE 5.0.
    Labor to operate the pump LE 0.05 per hour (this is the value of the farmer's time while operating the pump).
    Maintenance and repairs LE 50.0 per year.

Annual fixed costs:

Depreciation LE 1,530÷20 years	LE 76.5
Interest on investment $\frac{1,530}{2}$ x .10	LE 76.5
Total for 11 feddans	LE 153.0
Average per feddan LE 153÷11	LE 13.91

Variable cost per feddan:

Diesel fuel, 2.5 liters X 24 irrigations x 3 hours x LE 0.025	LE 4.50
Oil, 0.375 kg. X 24 irrigations x 3 hours x LE 0.45	LE 12.15
Grease, LE 8÷11	LE 0.73
Fibers, LE 5÷11	LE 0.45
Labor, 24 irrigations x 3 hours x LE 0.05	LE 3.60
Maintenance and repairs LE 50.0÷11	LE 4.54
Total variable cost per feddan	LE 25.97
Total annual fixed and variable cost per feddan	LE 39.88

(1 The oil consumption is high because this is a low speed pump oiled by a drop system.

This total cost is somewhat higher than the ordinary estimated water lifting cost (LE 25 - 30), because the farmer was obliged to construct this pump to serve only 11 feddans. But, in fact the farmer rents his pump to lift the drainage water to his neighbors to irrigate about 6 more feddans.

Added return:	6 feddans x 10 irrigations x 3 hours X LE 0.70 per hour	LE 126.00
Added cost:	Diesel fuel, 2.5 liters x 10 irrigations x 3 hours x LE 0.025	LE 1.875
	Oil, 0.375 kg x 10 irrigations x 3 hours x LE 0.45	LE 5.062
	Labor for operating	LE 1.500
	Maintenance and repairs	LE 1.891
	Grease and Gaskets	LE 0.491
	Total Added cost	LE 10.819

The net return is LE 126 - 10.819 = LE 115.181
The average return per feddan for his owned land is:

$$\frac{115}{11} = 10.45 \text{ per feddan}$$

Then the total annual fixed and variable cost per feddan becomes less (LE 39.88 - 10.45 = 29.43) which is approximately the usual cost of water lifting by a diesel pump.

APPENDIX B-2

Farmer Number 15

Basic information and assumptions:

1. The pump is a diesel Shobra - made at Helwan factory.

2. Size 6/6" pump - 11 horse power engine.

3. Average time to irrigate one feddan is 3 hours.

4. Number of irrigations per year is about 24.

5. Average area served by the pump is only 5 feddans.

6. Average lift is 2.5 meter from a well.

7. Initial investment:

Pump and motor	LE	980
Drilling the well 37 m. x LE 6.0		222
Type is 37 m. x LE 8.5		315
Casing is 18 m. x LE 10		180
Intake type 2 m. x LE 8.5		17
Discharge type is 1 m. x LE 11		11
Construction cost LE 45 (installation)		45
Small pump for bringing water at the beginning, LE 11		11
Building an installation is LE 400		400
It occupies 16 m^2, LE 19 (LE 5000/Fed)		19
The total fixed cost		2200

8. Except useful life of investment is about 20 years.

9. Interest rate is about 10 percent.

10. Operating expenses:

Diesel fuel, 1.7 liters per hour @ LE 0.025/liter
Oil, .05 kg. per hour @ LE 0.350 per kg.
Grease annual cost LE 2.0
The farmer operates the pump by himself
Maintenance and repairs, LE 20 per year

Annual fixed costs:

Depreciation LE 2200 ÷ 20 years	LE	110
Interest on investment $\frac{2200}{2}$ x .10		110
Total annual fixed cost for 5 feddans		220
Average fixed cost per feddan LE 220 ÷ 5		44

<u>Variable cost per feddan</u>:

Diesel fuel 1.7 liters x 24 irrigation x 3 hour x LE 0.025	LE 3.06
Oil .05 kg x 24 irrigations x 3 hours x LE 35	1.26
Grease LE 2 ÷ 5 feddans	.40
Maintenance and repairs LE 20 ÷ 5	4.00
Total variable cost per feddan	8.72
Total annual fixed and variable cost per feddan	LE 52.72

The dual figure shows us that the cost of pumping is about twice the ordinary cost. This means that the farmer will lose LE 23 - LE 29 per year when he obtains water from a well and pump.

Staff Paper #12

COST OF PRODUCTION OF IRRIGATED SOYBEANS AND COMPARISON WITH COTTON IN EGYPT

M. E. Quenemoen, R. J. McConnen and Gamal Ayad

September, 1979

Introduction

What are the economic consequences of growing soybeans on land which could be growing cotton? To an individual farmer this is a straightforward farm management question. To a nation it has other implications regarding such things as balance of trade, food security and water resource development.

This paper presents cost-return reports based on farmgate prices for soybeans, cotton and berseem (Egyptian clover). The data were provided by Egyptian farmers. Next partial budgets are prepared which compare returns from cotton and soybeans-berseem combination. Since soybeans require a shorter growing season than cotton, returns from berseem are added to the soybean alternative. Then the budgets are adjusted to show the effect on net income using estimated market prices for crops and market prices for inputs such as chemical fertilizers and insecticides. This permits us to examine the national implications of shifts between these competing crops.

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1/ Authors are respectively Agricultural Economist, Egypt Water Use and Management Project, Ministry of Irrigation, Cairo; Professor of Agricultural Economics, Montana State University Bozeman, Montana; and Agricultural Economist, Egypt Water Use and Management Project, Ministry of Irrigation, Cairo. The views expressed in this paper are those of the authors' and do not necessarily reflect those of the Ministry. Special acknowledgement is given to Elia Soryal and Youssef Mohamed Youssef for gathering data for the Enterprise Cost and Return Reports.

Literature Review

Crop enterprise reports have been standardized within the U.S.D.A. starting in 1974. Congress required a standardized procedure of computing production costs in order to administer a farm subsidy program based on "cost of production". Oklahoma State University produced the system currently in use and examples of costs of producing soybeans and cotton for several areas of the U.S. are available.1/ Each area of the world has its own unique system of production, however, and world prices limit the costs that can be incurred by any production system unless local governments are willing to subsidize the production. The crop enterprise reports in this paper follow standard procedures recognized by U.S.D.A.

Crop enterprise alternatives can be compared in a logically and concise way by the use of partial budgets. The process, as explained in detail by Martin Upton, will be followed in this paper.2/ The simplest form of partial budget involves the following questions:

(a) What extra returns (gains) can be expected?

(b) What extra costs will be incurred?

Where the proposed new activities substitute for something already existing, as when one crop substitutes for another or a machine substitutes for labour, we must also ask:

(c) What present costs will no longer be incurred?

(d) What present income will be sacrificed?

Hence the gain will be (a) + (c), the extra returns plus the saved costs, and the total cost will be (b) + (d), the extra costs plus the present income foregone. The total gain minus the total cost then represents the net gain or expected increase in profit.

The first step in partial budgeting should be a description and specification of the proposed change stating clearly what

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1/ Walker, Rodney L. and Darrel D. Kletke, User's Manual, Oklahoma State University Crop Budget Generator, Progress Report P-656, Agricultural Experiment Station, Oklahoma State University, November, 1971, Revised October, 1972.

2/ Martin Upton, Farm Management in Africa, the Principles of Production and Planning, Oxford University Press, London, 1973, Chapter 15, "Partial Budgets and Programme Planning", pg 282.

is involved and when it occurs. Secondly it is useful to list those items in the existing system likely to be changed when the new policy is introduced. This reduces the likelyhood of omitting possible indirect effects of the change.

Upton proposes the following format, Table 1, which will be used in this report:

Table 1: Partial Budget to Estimate Extra Net Gain From Soybeans at the Farm Level Under Existing Policies.

1. Specification:

Plant soybeans to replace cotton. Farm prices are used in the calculations. The government will give permission to substitute soybeans for cotton without any penalty. Soybeans require four months of growing season; cotton eight months. The four months of extra land available due to the shorter growing season for soybeans will be used to produce long-season berseem. Total water requirements for soybeans and long-season berseem are approximately the same as for cotton and short-season berseem. (see page 13 for water requirement information)

2. Items in the present system likely to change:

Cotton stocks will not be available for fuel. More berseem will be available for livestock or for sale. Labor requirements will be lower during peak cotton-rice harvesting season which is reflected in lower labor costs.

3. Estimated gains and losses.

Gains	Losses
(a) Extra returns: Income from soybeans. Income from long-season berseem.	(b) Extra costs: Producing soybeans. Producing long-season berseem.
(c) Reduced costs: Production costs for cotton.	(d) Reduced returns: Income from cotton. Cotton stocks

Net gain = (a + c) - (b + d)

The estimation of costs and returns is fraught with difficulties. The analyst simply has to make the best of resources at hand and be willing to regard the results as tenative. If better information becomes available, the analyst must be not only willing, but anxious to revise the partial budget.

Two partial budgeting problems should receive mention. First, there is usually different performance among farmers and the varability that exists around the figures used in a partial budget should be recognized. Secondly, the figures used in a partial budget are based on expected occurence. Actual occurences, especially for prices and yields, can vary considerably from expectations.

Crop Enterprise Reports

Before continuing with the partial budget analysis of shifts from cotton to soybean production let us review the data to be used in the partial budgets. The following tables 2 through 5 depict typical enterprise costs and returns for soybeans, cotton and berseem at Kafr El Sheikh Governorate. The data are based on interviews with farmers and observations by staff members assigned to the Egyptian Water Use Project. The crop enterprise cost-return reports are followed with partial budgets used to analyze shifts from cotton to soybeans.

The cost return reports use current Egyptian farmgate prices to determine income in the cost-return tables. These prices will be modified later in the analysis.

The variable costs purport to include all economic variable costs. We intend to include all costs actually paid by a farmer plus the market value of human labor and other inputs supplied by the farmer and his family. The gross margin can be explained as the "residual return to land, water, the farmer's management, and unpaid services such as may be supplied by government". Thus any land rent, taxes and return to management must be paid out of the gross margin.

Keep in mind the return to a farmer may exceed the gross margin if he pays no rent or taxes and if labor and animal power is supplied by himself, his family and his own animals. Each farmer's actual income from any crop will depend on his tenure status (whether he owns or rents), the amount labor supplied by himself and his family, and the amount power/organic fertilizer supplied from his animals.

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Table 2: Cost and Returns, One Feddan Soybeans Kafr El Sheikh Governorate.

Item	Unit	Number of Units	Price or value per Unit LE	Income or cost LE
Income:				
Soybeans	kg.	900	0.20	180
Variable Costs:				
1. Apply organic fertilizer	m^3	20	.60	12
2. Plow with tractor, (x3)	feddan	3	2.00	6
3. Smooth w/cows and drag	hour	2	.50	1
4. Furrow w/tractor	feddan	1	2.00	2
5. Clean ditch	man hr.	10	.20	2
6. Seed	kg.	40	.30	12
7. Plant seed by hand	woman day	4	.50	2
8. Irrigate	hour	4	.47	2
9. Reshape furrows w/donkey and small plow	hour	2	.27	1
10. Hoe	man hour	20	.20	4
11. Fertilizer (55 days after planting) 33-0-0	kg.	50	.05	3
12. Labor to spread fertilizer	boy hour	15	.06	1
13. Irrigate	hour	4	.47	2
14. Hoe	man hour	20	.20	4
15. Fertilizer 33-0-0	kg.	50	.05	3
16. Irrigate	hour	4	.47	2
17. Weed	man hour	10	.20	2
18. Irrigate	hour	3	.47	1
19. Weed	man hour	10	.20	2
20. Irrigate	hour	3	.47	1
21. Insecticide	kg.	3	1.00	3
22. Rent of sprayer, (x3)	feddan	3	.65	2
23. Labor for spraying	man hour	15	.20	3
24. Irrigate, (x2)	hour	8	.47	4
25. Cut by hand	man hour	30	.20	6
26. Transport by camel	load	6	.30	2
27. Labor to load camel	woman day	4	.60	2
28. Thresh w/tractor	hour	2	2.00	4
TOTAL VARIABLE COST				91
GROSS MARGIN PER FEDDAN				89
GROSS MARGIN PER MONTH				22

Assumptions for table 3:

1. The previous crop is berseem
2. Soybeans are planted April 1, harvested July 30.
3. The government shares equally the cost of insecticide. Thus the full cost would be LE 6.0.
4. Irrigation water is free except for the cost of lifting and distribution. These costs, on an hourly basis, are as follows:

Rent of 2 cows	LE 0.17
Labor to distribute water	0.17
Boy to chase cows	0.05
Rent of sakia	0.08
	LE 0.47 per hour

.../...

Table 3: Cost and Returns, One Feddan Cotton, Kafr El Sheikh Governorate.

Item	Unit	Number of Units	Price or value per Unit LE	Income or cost LE
Income:				
Seed cotton	kantar	5	35.000	175
Stalks	camel load	5	3.000	15
TOTAL FARM INCOME				190
Variable Costs:				
1. Apply organic fertilizer	m^3	20	.600	12
2. Plow w/tractor, (x3)	feddan	3	2.000	6
3. Smooth w/cows and drag	feddan	1	2.000	2
4. Furrow w/cows and plow	feddan	1	2.000	2
5. Clean ditch	man hour	10	.200	2
6. Smooth w/cows and drag	feddan	1	1.000	1
7. Seed	kaila	7	.300	2
8. Plant seed by hand	woman day	4	.500	2
9. Chemical fertilizer				
Super phosphate 0-15½-0	kg.	100	.022	2
Amonium Nitrate 33-0-0	kg.	200	.050	10
10. Spread fertilizer by hand	hour	10	.200	2
11. Irrigate	hour	6	.470	3
12. Thin by hand	boy day	3	.300	1
13. Hoe, (x2)	man hour	28	.200	6
14. Irrigate	hour	4	.470	2
15. Hoe	man hour	14	.200	3
16. Irrigate, (x7)	hour	28	.470	13
17. Weed, (x3)	boy day	6	.500	3
18. Pick insect eggs as needed	feddan	1	9.000	9
19. Chemical control of insects	feddan	1	8.00	8
20. Pick by hand (3½ kantar)	woman day	20	.500	10
21. Pick by hand (1½ kantar)	woman day	20	.500	10
21. Transport seed cotton	feddan	1	1.000	1
23. Cut stalks	man hour	25	.200	5
24. Transport stalks	camel load	5	.500	3
25. Labor to load stalks	man hour	5	.200	1
TOTAL VARIABLE COST				121
GROSS MARGIN PER FEDDAN				69
GROSS MARGIN PER MONTH				9

Assumption for Table 4:

1. The previous crop is berseem.
2. Cotton is planted March 1 and the stalks are removed from the field on October 31.
3. The government shares equally the cost of insect control. The full cost would be LE 34 per year.
4. Irrigation costs on an hourly basis are the same as for soybeans.

.../...

Table 4: Costs and Returns, One Feddan Short-season Berseem, Kafr El Sheikh Governorate.

Item	Unit	Number of Units	Price or value per Unit	Income or Cost
			LE	LE
Income:				
2 cuts in four months	tons	13	5.000	65
Variable Costs:				
1. Seed	Kaila	1.5	8.000	12
2. Chemical fertilizer				
Super phosphate (0-15-0)	kg.	50	.022	1
Ammonium Nitrate (33-0-0)	kg.	50	.050	3
3. Spread seed and fertilizer	man hour	4	.200	1
4. Irrigate, (x3)	hour	12	.470	6
TOTAL VARIABLE COST				23
GROSS MARGIN PER FEDDAN				42
GROSS MARGIN PER MONTH				11

Assumptions for Table 4:

1. The previous crop is cotton.

2. Short season berseem is planted in November and the second cut is taken in February.

3. Irrigation is on an hourly basis, LE 0.47 per hour.

4. Berseem is usually sold by the "kerat cut" as it stands in the field. One feddan has 24 kerat cuts to weigh 6.5 tons as green forage.

5. The market value of berseem in mid-winter is lower than fall and spring because supplies are abundant.

Table 5: Costs and Returns, One Feddan, Long-season Berseem, Kafr El Sheikh Governorate.

Item	Unit	Number of Units	Price or value per Unit LE	Income or Cost LE
Income:				
5 cuts in eight months	tons	33	6.000	198
Variable Costs:				
1. Seed	kaila	1.5	8.000	12
2. Chemical fertilizer				
Super phosphate (0-15-0)	kg.	100	.022	2
Ammonium Nitrate (33-0-0)	kg.	50	.050	3
3. Spread seed and fertilizer	man hour	4	.200	1
4. Irrigate, (x10)	hours	40	.470	18
TOTAL VARIABLE COST				36
GROSS MARGIN PER FEDDAN				162
GROSS MARGIN PER MONTH				20

Assumptions for Table 5:

1. The previous crop is soybeans.

2. Long-season berseem is planted in September and the last cut is taken in March.

3. Irrigation is on an hourly basis, LE 0.47 per hour.

4. Berseem is usually sold by the "kerat cut" as it stands in the field. One feddan has 24 kerat cuts assumed to weigh 6.5 tons as green forage.

5. Higher fall and spring prices result in a higher average value for long-season berseem than for the short-season crop.

6. Berseem is not usually planted in August because it does not grow well in the hot temperature typical for that month. It is also subject to damage from cotton leaf worms during that period. One might consider following soybeans with a crop of maize forage before planting berseem. This may or may not be profitable.

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Analysis of Shifts from Cotton to Soybeans - A Farmer's Point of View

Let us now turn attention to the question "would it benefit a farmer to shift from cotton to soybeans?" For this analysis it is appropriate to use farmgate prices as in the crop enterprise reports.

Cotton occupies the land from March 1 through October; soybeans from April 1 through July. When the land is not in these crops it can be producing any of a number of suitable fall and winter crops. This analysis assumes the off-season crop will be berseem.

Part 3 of the partial budget outline from Table 1 is now reproduced below. Values for cost and income changes, taken from tables 2 through 5, have been inserted.

Partial Budget:

Soybeans and Long-season Berseem
replaces
Cotton and Short-season Berseem

---

3. Estimated gains and losses:

a. Extra returns:
Income from soybeans LE 180
Income from 3 cuts berseem LE 133 1/

b. Extra costs:
Irrigation and fertilizer for long-season berseem 2/ LE 13
Producing soybeans LE 91

c. Reduced costs:
Producing cotton LE 121

d. Reduced returns:
Income from cotton LE 190

Total Gains LE 434

Total Costs LE 294

Net Gain = 434 - 294 = LE 140 per feddan

Given current prices paid to farmers, soybeans look profitable. It should be noted that of the total costs (LE 294), 65% are associated with reduced returns from cotton while of

.../...

1/ This value is the difference between gross income from long-season berseem and short-season berseem. It reflects a combination of yield and price differences.

2/ The only additional cost of producing long-season berseem over short-season berseem is for fertilizer and 7 extra irrigations.

the total gains (LE 434) 28% occur because cotton would not be produced and 31% occur because of the sale of berseem. If cotton is an alternative crop to soybeans, the cost and returns associated with cotton have a great impact on the cost of producing soybeans. Similarly if berseem production is increased as a result of shifting to the long-season variety then livestock price policy, which derives the price of berseem, is of considerable importance. Clearly the issue requires more than examination of existing prices for soybeans and cotton.

If all of the prices and costs used were generated by a market system and if no externalities existed, we could simplify and say, "What's good for the farmer is good for the nation." The reverse would also hold, "What's good for the nation is also good for the farmer." However, if government policies generate different prices for the outputs and inputs than would have occured under a competative market system, this congruence need not occur. Virtually every country in the world, including Egypt, has such policies. Therefore, it is appropriate to ask a second question which can also be dealt with by using a partial budget, "What is the cost at the national level of producing soybeans?" The question is broader now, but at least a start can be made by using a partial budget approach.

Analysis of Shifts from Cotton to Soybeans - A National Point of View

The accounting cost of any input should be based on the concept of opportunity cost. If a farmer purchases fertilizer to apply to a cotton crop, fertilizer cost should be based on what the farmer must give up to purchase the fertilizer. The price the farmer pays, even if it is a subsidized price, is usually a good indicator of the magnitude of that cost.

The price a farmer receives for a product - say cotton - is also a good estimate of the opportunity cost the farmer would incur if he didn't sell the product. For example, it would "cost" a farmer about LE 35.0 if he did not sell a kantar of seed cotton (or LE 222 per ton). However, these "farmer's buying" and "farmer's selling" values may not be the appropriate values to use at the national level. For example, if the farmer's price of fertilizer is a subsidized price, then the farmer's cost of fertilizer will understate the opportunity cost of fertilizer for the nation. If the farmer receives a price for his cotton which is half the equivalent export price, then the prices the farmer receives will understate the opportunity cost for the nation of not having a ton of cotton for sale. For example if the farm price for cotton is half the

.../...

export price of cotton and the farm price for soybeans is equal to the import price, it should be inappropriate to use these prices in constructing a national level partial budget for soybeans vs. cotton. While appropriate for the individual farmer, such prices would overvalue soybeans and undervalue cotton at the national level.

If soybeans are produced instead of cotton, a nation forgoes the opportunity of selling cotton and buying soybean products. Of course, other issues such as food security are involved, but even there, policy makers should have available information about the opportunity cost of additional amounts of something of real but intangible value such as food security.

The results of a national level analysis are different from the results considering the individual farmer's point of view. This is illustrated in Table 6. Whereas the shift of a feddan from cotton and short-season berseem to soybeans and long-season berseem would be desireable for a farmer, increasing his income LE 140, it would apparently be undesireable to the nation, reducing its income LE 49 per year for each feddan shifted. After accounting for the policy variables affecting the indirect tax imposed on cotton and the subsidies given to inputs, the advantage in Egypt of shifting to soybeans becomes questionable.

A high price for berseem helps to make the soybean alternative attractive since long-season berseem captures advantages of both greater yield and higher seasonal prices. It should be recognized, however, that a government policy of unrestricted importation of meat would cause a decline in domestic meat prices and subsequently in berseem prices. This is because the demand for berseem is at least in part derived from the demand for meat. Cheaper meat prices would reduce the demand for berseem and hence market prices of berseem would decline.

Water Requirements

Any analysis of cropping strategies for Egypt must consider water requirements. Since information about water use requirements for irrigated soybeans is not available the authors assumed it to be the same as for summer maize. Water use requirements for maize, cotton and berseem, taken from two sources, are summarized in Table 7.

Inspection of Table 7 indicates the data from the two

Table 6: Partial Budget to Estimate Extra Net Gain from One Feddan of Soybeans at the National Level.

1. Specification:

Planting of soybeans (an import crop) to replace cotton (an export crop). Prices of soybeans and cotton approximate net import prices and export prices respectively. Costs reflect market prices for fertilizer, insecticides, seeds, and machinery.

2. Items in the present system likely to change:

Costs will be incurred to produce soybeans and long-season berseem. Income will increase from these crops. Costs of producing cotton will be saved but the income from that crop will also be lost.

3. Estimated gains and losses:

Gains		Losses	
(a)	Extra returns Income from soybeans LE 180 Income from 3 cuts berseem LE 133	(c)	Extra costs Irrigation and fertilizer for long-season berseem LE 13 Producing soybeans 103 (LE 91 x 1.14) 1/
(b)	Reduced costs: Producing cotton LE 176 (121 x 1.46) 1/	(d)	Reduced returns: Income from cotton LE 422 (LE 190 x 2.22) 1/
	TOTAL GAINS LE 489		TOTAL COSTS LE 538

Net Loss = 538 - 489 = LE 49 per feddan

1/ Production cost and income values are adjusted by the coefficients as shown. These coefficients were estimated with the help of various people in the Ministry of Agriculture and the Ministry of Economics and Foreign Trade.

sources are in conflict i.e. source #1 indicates highest requirements for berseem-soybean while source #2 indicates highest requirements for berseem-cotton. Perhaps there is not enough difference in crop water requirements between the two crops to merit much concern at this stage of Egypt's land-water resource balance. By the time new lands are developed, however, and the land-water balance becomes more critical, additional crop water requirement data should be made available to assist policy makers. If soybeans are to become a more important crop in Egypt's future then studies should be started immediately to determine the crop's water requirements.

Table 7: Water Requirements Per Feddan for Alternative Cropping Systems.

Cropping System	Source #1 1/	Source #2 2/	
		C W R 3/	CWR + EL 4/
	m^3	m^3	m^3
Berseem, full season	2220	1961	3080
Soybeans (maize)	2500	3337	4909
Total	4720	5298	7989
Berseem, catch	1375	1230	1747
Cotton	3250	4650	6954
Total	4625	5880	8701

1/ El-Tobgy, H. A., Contemporary Egyptian Agriculture, The Ford Foundation, Second Edition, 1976.

2/ Kramer, C., "Agricultural Demand and Distribution Models - Users' Manual", UNDP/UNDTC, Project of Assistance to the Hydraulic Research Institute.

3/ CWR is Crop Water Requirements

4/ CWR + EL is Crop Water Requirements plus Conveyance and Efficiency Losses.

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Conversion Factors

1 feddan = 1.038 acre = 0.420 hectare

1 kantar seed cotton = 157.5 kilograms

1 kaila = 16.5 liters

1 camel load = 250 kilograms

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Staff Paper #13

SOCIOLOGICAL SURVEY FOR BENI MAGDOUL AREA

Farouk Abdel Al

Beni Magdoul Village

It is one of the villages of Embaba District, Giza Governorate. It is situated south of Giza City, at a distance of about 14.5 kilometers. It lies east of Nahia Village and west of Abu Rawah. Its southern boundaries are close to Kirdassa Village, which is separated therefrom by Beni Magdoul Drain. This village is characterized by its rural nature. All the houses consist of one floor. Each house contains 4 rooms in average, and its poles are found on stones and covered either by reed or reinforced concrete. The streets are narrow and curved, with the exception of only one in the village center and is considered the main street as it leads to Kirdassa Village. Government services in the village includes electric supply which was introduced 5 years ago, lifting pure drinking water which also serves the adjacent villages. The inhabitants of the village are of rural characteristics, as they are of good will, generous and courageous, though they deal cautiously with any foreigner.

The farmers of this village cultivate their lands which are adjacent thereto. They grow clover, wheat and linen. In winter, they grow certain vegetables, maize and sunflower, while in summer they grow certain vegetables. They depend on themselves in marketing these crops in the city, because it is near them.

The farmers of this village are habitually characterized by not being present in their farms in the early morning. This is due to the fact that their farms are situated near the village. In the meantime, the activity of a woman in the village is restricted only to housework, which appears to be her sole duty.

Administrative Division

Giza Governorate
(Security Officer)

↓

Embaba Police District
Police District Officer

↓

Kerdassa Police Station
Police Station Officer

↓

Mayor

↓

Assistant Mayor

↓

Telephone Operator

↓

Government Guard

Peoples' Local Division

Local Council of Giza Governorate

↓

Local Council of Osseim Police
District and City

↓

Abo-Rawash Village Council

↓

Beni Magdoul Village

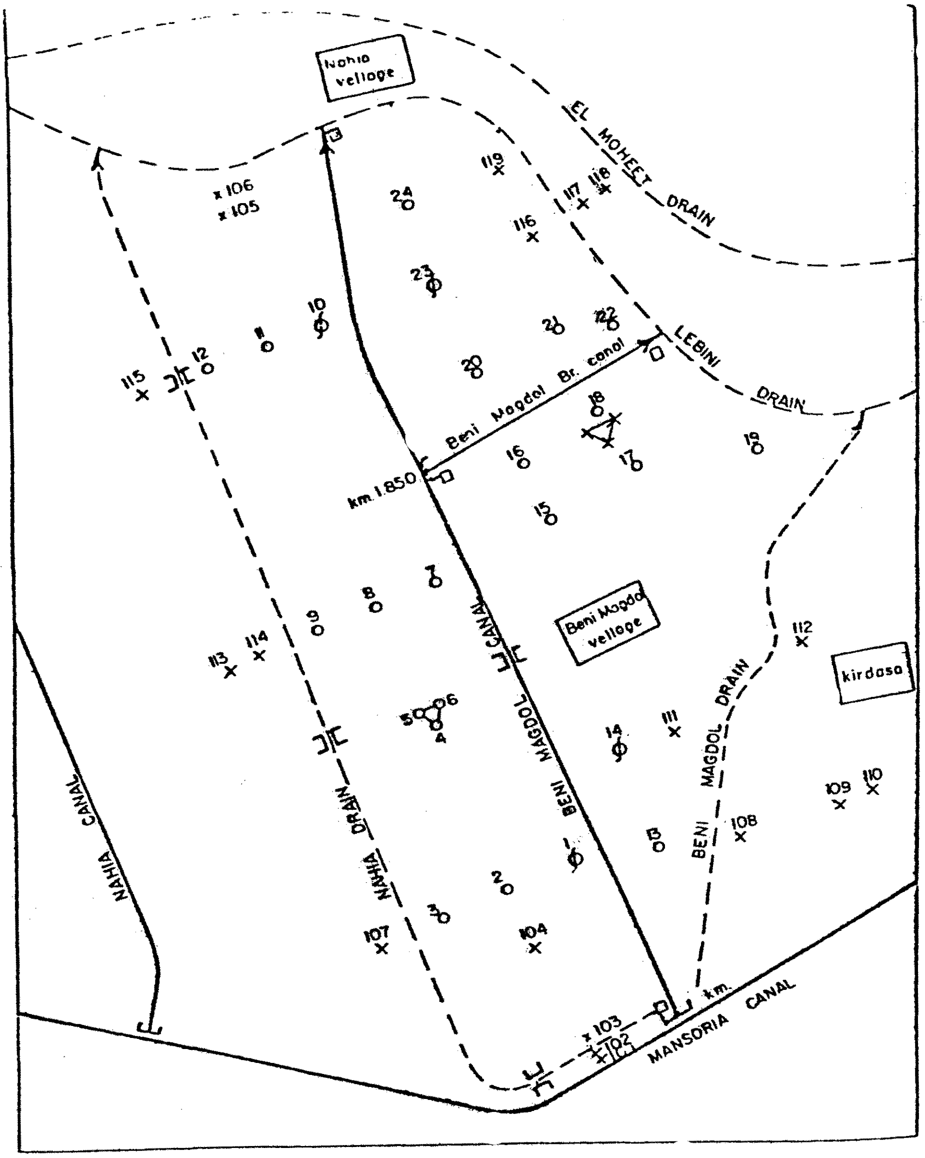
↓

Members elected from the village - the number of the village members is 14 including the Chief of Council

Table No. (1). Indicating the Peoples' Classification According to Their Professions and the Total Amount of People in the Village.

Agriculture			Government			Free Works			Not Working					Travellers		Total Amount		
									Aver-aged			Children						
Male	Female	Children	Male	Female	Children	Male	Female	Children	Male	Female	Housewives	Male	Female	Male	Female	Male	Female	Children
1034	710	–	288	2	–	120	30	–	200	150	817	1071	714	90	–	2803	2423	714

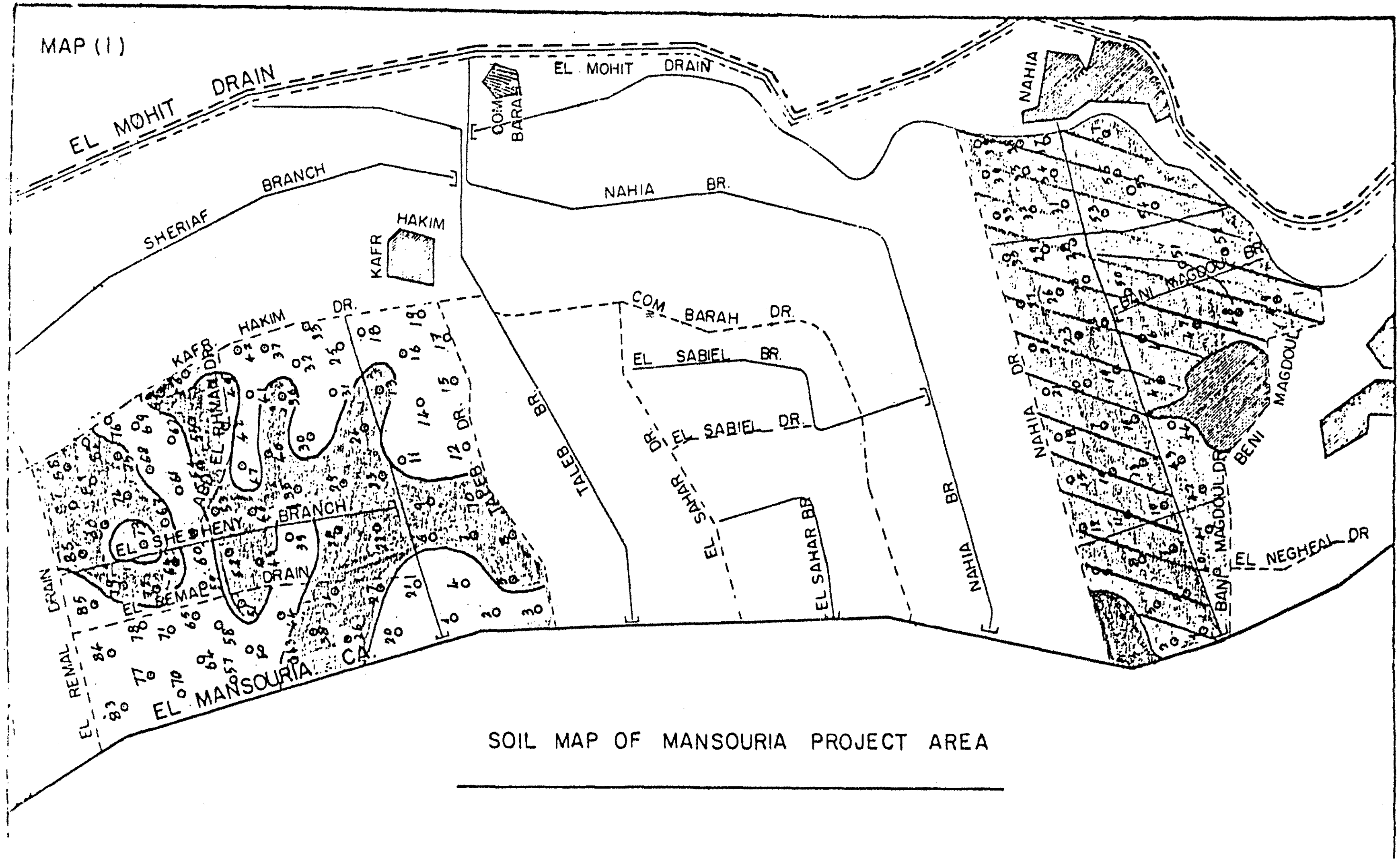
We may kindly attract your attention that we did not take into consideration the children of age under the primary stage.



BENI MAGDOL OBSERVATION WELLS

- CANALS
- DRAINS
- WELLS 2" DIAM.— DEPTH 5m.
- WELLS 6" DIAM.— WITH RECORDER.
- WELLS 3/4" DIAM.— DEPTH 2m.
- BATTERY OF WELLS 3.6 AND 9m 2" DIAM.
- BATTERY OF WELLS 1.2 AND 3m., 3/8" DIAM.
- AUTOMATIC RECORDERS

MAP (1)



SOIL MAP OF MANSOURIA PROJECT AREA

Table No. (2). Indicating the Number of Farmers and Their Propotional Distribution According to Their Kind of Work in the Agriculture Field.

Number	Land Service			Irrigation			Harvest		Pest Control	
	Tractor	Common plow	Hoeing	Water wheel	archem screw	steam engine	Machines	Manual ways	Motor	Common sprinkler
	979	765	—	1434	250	60	—	1744	304	144
1744	56.1%	43.9%	—	82.3%	14.3%	3.4%	—	100%	17.4%	82.6%

Table No. (3). Indicating the Peoples' Educational State According To the Different Stages of Education.

Kind of Stage	Grade (1)		Grade (2)		Grade (3)		Grade (4)		Grade (5)		Grade (6)		Total
Primitive teaching classes	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	
Primary school (1st stage)	25	20	50	23	62	20	42	10	40	10	32	10	344
Primary school (2nd stage)	50	37	40	37	30	11	30	19	50	18	30	12	344
Preparatory Stage	12	4	7	2	8	4							37
General Secondary Sch.	7	3	9	5	1								25
Commercial Secondary School	4	1	6	1									12
Agricultural &	4	—	2	3	4								13
Industrial Sec. Sch.	5	—	4	—	3								12
University Stage	2	1	3	1	3	—	2		1	1			14
Ignorants	—	—	—	—	—	—	—	—	—	—	—	—	725

Table No. (4). Governmental and Private-Owned Departments

Governmental Departments in the Village		General Activity	
No.	Name of Department	No	Name of Department
2	Primary schools for boys and girls	25	Groceries
1	Health unit	1	Consumptive society
1	Agriculture cooperative society	2	Small vegetable marketing places
1	Branch of the Village Bank	1	Corn-milling machine

Table No. (5). Classification of Agriculture Workers According to their Kind of and

No. of landlords in the agriculture coop. society		growing their lands		growing against many in the village		growing against many outside the village	
Male	Female	Male	Female	Male	Female	Male	Female
754	60	232	290	110	60	20	—

Table No. (6). Indicating the Cultivated Area, the Number of Basins, the Command Area and the Number of Water Wheels and Wells.

Total of cultivated area			Number of Basins	The Command area of Beni Magdoul Canal	No. of water wheels		Number of wells following the village
Sahm	Kerat	Feddans			Left side	Right side	
6	3	1148	16	169	33	44	7

Table No. (7). The Number of Farmers' Percentage According to Irrigation Times.

During the Summer Season						During the Winter Season					
In Early Morning		In the Evening		At anytime		In Early Morning		In the Evening		At anytime	
No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
502	48.5	232	22.4	300	29.1	250	24.2	160	15.5	624	60.3

Table No. (8)

A List of Number of Outputs, Water Wheels and Area on the Canal.

Right Side			Left Side		
No. of Output	Area		No. of Output	Area	
	Feddan	Kerat		Feddan	Kerat
1	22	1	1	9	1
2	6	7	2		41
3	19	47	3	2	34
4	14	14	4		49
5	19	12	5	17	41
6	—	10	6	16	35
7	19	4	7	6	57
8	16	8	8	17	20
9			9	12	25
10	–	10	10		41
11	1	4	11		35
12		143			
12	3	15			
13		11			
14	21	7			
15	20	29			

Table No. (9). Kinds, Numbers and the Ownership of the Agricultural Machines, Efficiency and Cost of Its Operation.

Kind of Machine	Power	No.	Name of Landlord	Efficiency of the Command Area	Costs of the Unit
Agricultural Tractor	55 H.P.	1	Beni Magdoul coop. society	Out of order	———
Agricultural Tractor	55 H.P.	1	Abo-Rawash coop. society	20% of command area	L.E. 3 per feddan
Agricultural Tractor	60 H.P.	1	Abdel Sabour Taha	40% of command area	L.E. 4 per feddan
Agricultural Tractor	50 H.P.	1	Galal Abdel Wanees	15% of command area	L.E. 4 per feddan
Agricultural Tractor	55 H.P.	1	Abdel Hai Abo Omeira	to transport sand from the mountain	L.E. 1 for every meter
Agricultural Tractor	65 H.P		Ahmed Hussein Abdel Hamid	Not used in the village	It works in Kafer Abo Hakeim
Permenant Irrigation Mach.	6.5-9 H.P.	1		7% of the total command area	L.E. 1.25 per hour
Motive irrigation machine	6.5-9		Amer Abdel Al	Farmers & his shareholders	70 piastres per hour
	—		Galal Abdel Wanees	Command Area	150 piastres

Table No. (10)

A List of the Population Structure
Through the Number of Families

No.	Kind
790	Family recently formed (2-3 persons)
250	A moderate family (3-5 persons)
25	Big family (5 or more persons)

Table No. (11). The Structure of the Farm Animals' Race.

Kind of Animals	Middle Aged		Young Aged		Total Number
	Male	Female	Male	Female	
Buffalos	1	800	100	250	1151
Cows*	–	50	200	100	350
Sheep	300	200	–	–	500
Goats	100	300	–	–	400
Donkies	350	150	–	–	500

The female cows are fecundated in El Barageil, Nahia and Kerdassa veterinary unit.

Table No. (12). Indicating the Heathly State and Spreaded Diseases in the Village*

Belharisia					Eskares					Inklistoma					Chest diseases					Other diseases				
	Youth		Children			Youth		Children			Youth		Children			Youth		Children			Youth		Children	
Adults	Male	Female	Male	Female	Adults	Male	Female	Male	Female	Adults	Male	Female	Male	Female	Adults	Male	Female	Male	Female	Adults	Male	Female	Male	Female
550	760	240	120	—	780	640	300	190	70	300	170	170	100	50	214	17	15	—	—	340	70	130	17	78

We may kindly attract your attention that these numbers were taken from the statistics of the healthy unit and there is an interference between them as from the diseases. This statistic was made depending on every villager visit to the healthy unit for treatment besides those side who do not go to it, we cannot calculate their number

Staff Paper #14

WATER BUDGET FOR BENI MAGDOUL AREA IN 1979

Wadie Fahim

INTRODUCTION

In May 1980, William O. Ree presented an accounting for the items of the water budget for the Beni Magdoul research area of the Egypt Water Use and Management Project. In this report the stated procedure will be followed to establish an accounting for one year.

In this report the consumptive use for all months was calculated by the agronomists and the items of outflow discharges to the adjacent area were estimated depending on the observations in the field and daily records of irrigation in the area.

* Water Budget Equation

Water budget equation for a bounded area states that:

$$\text{Inflow} = \text{outflow} \pm \text{change in storage}$$
$$I = O \pm \Delta S$$

The Beni Magdoul area is bounded by Nahia drain at North, Beni Magdoul drain at North, Beni Magdoul drain at south, Lebini drain at East and Mansouria and Nahia drain at west. The cultivated area in Beni Magdoul is about 748 feddans and the total area within the boundaries is 842 feddans. The soil is a clay soil to depth changes from 2 m at west to 7 m at east.

The inflow of the water budget equation is as follows:

$$I = I_M + I_A + I_P + P$$

Where I_M : is inflow from Mansouria Canal to Beni Magdoul Canal measuring daily at the outlet by Nyrpic gates calibrated in April 1979.

I_A: is the inflow from adjacent areas, where there is about 15 feddans are supplied with water from Mansouria by separate outlet and aquiduct crossing Nahia Drain. The flume measurements in 1980 get an estimation for this term as 2% of I_M

I_P: is the inflow supplied by pumps within the boundaries of the area. About 22 feddan are irrigated from the drains or deep wells. This term was estimated by 3% of I_M.

P: Precipitation on the bounded area measured at Guiza Weather station.

The outflow terms of the water budget equation are as follows:

$$O = U + E_V + O_G + O_{SD} + O_A$$

Where U: is the consumptive use as estimated by the Blanney-Criddle formula to be equal to the potential evapotranspiration. The crop coefficient "K" is based on the values reported in "Consumptive Use of Water by Crops in Arizona, Tech. Bult. 169"

E_V: evaporation from open water surfaces in the canals and meskas. The average area of these surfaces has been estimated to be 14600 m^2. The daily pan evaportation with coefficient 0.7 are applied to estimate this term.

O_G: is the net subsurface outflow which will be dependent variable.

O_{SD}: Is the surface outflow to drains. This term is very small and can be neglected. Due to the control of discharges in Beni Magdoul Canal no significant spilling from canals or meskas have occured. (O_{DS} = zero)

O_A: is the flow to adjacent areas which is estimated by about 3% of I_M based on the irrigation records in these areas.

Change in storage and soil moisture: ΔS & ΔS_S. The term of change in storage ΔS was estimated from the daily records of the ground water table from the observation wells. The specific yield was considered to be 0.04 for this area.

The change in soil moisture during the period of study was neglected. In this report the period is one year from Jan. 1979 to end of Dec. 1979.

The results of estimating each term were summarized in Table (1). It is noticed that:

1. The subsurface outflow O_G to the drain in some months + v_e that means may be inflow to the area from underground or not sucessful estimation for the terms of consumptive use or specific yield.

2. The net value of subsurface outflow in one year (1979) was 378100 m^3, that was about 7% of the inflow discharges to the area I_M.

*** The estimation of the subsurface flow in the next reports will be based on estimation of outlfow by Darcy s equation. The records from sets of observation wells were carried out . Hydraulic and specific yield will be determined since the needed apparatus arrived.

Table (1): Water Budget for Beni Magdoul Area in 1979

$$(I_M + I_A + I_P + P) = (V + E_v + O_A + O_{SD} + O_G) \pm \Delta S \pm \Delta S_S{}^*$$

Month	Inflow Components (m)					Outflow Components (m)				Change in storage	(5) ± (10) - (9)
	I_M (1)	I_A (2)	I_P (3)	P (4)	Total "I (1)+(2)+(3)+(4)+ (5)	U (6)	E_v (7)	OA (3% I_M)	O - O_G (9)	ΔS (m^3) (10)	
Jan.	89003	1785	2454		93,242	390,000[e]	100[e]	2670	392770	- 73557	- 225971
Feb.	360389	7228	11152	48095	426,864	375,000[e]	120[e]	10811	385931	+ 28291	+ 42642
Mar.	425251	8528	13159	12024	458,961	440,000[e]	190[e]	12757	452947	+ 24048	- 18034
Apr.	495057	9927	15319		520,303	505,000[e]	245[e]	14851	520096	- 2829	+ 3036
May	555736	10145	17195		583,076	571,215	275[e]	16672	588162	- 14146	+ 9060
June	586599	11763	18151		616,513	406,309	255[e]	17597	424161	+ 1415	+ 190937
Jul.	662065	13277	20486		695,828	572,556	344	19862	592762	- 1415	+ 104481
Aug.	577971	11591	17884		607,446	716,915	303	17339	734557	- 5658	- 121453
Sep.	248079	6981	10771		365,831	11,159	285	7442	18886	- 1415	+ 348360
Oct.	545951	10948	16893		573,792	403,673	221	16378	420272	+ 19804	+ 133716
Nov.	428837	8613	13269		450,719	391,055	137	12865	404057	+ 2829	+ 43833
Dec.	190791	8831	8998		305,620	383,584	85	8724	392393	+ 12731	- 99504
TOTAL	5,365,729	106,617	165,730	60,119	5,698,195	5,166,466	2650	160971	5329997	- 9902	+ 378100

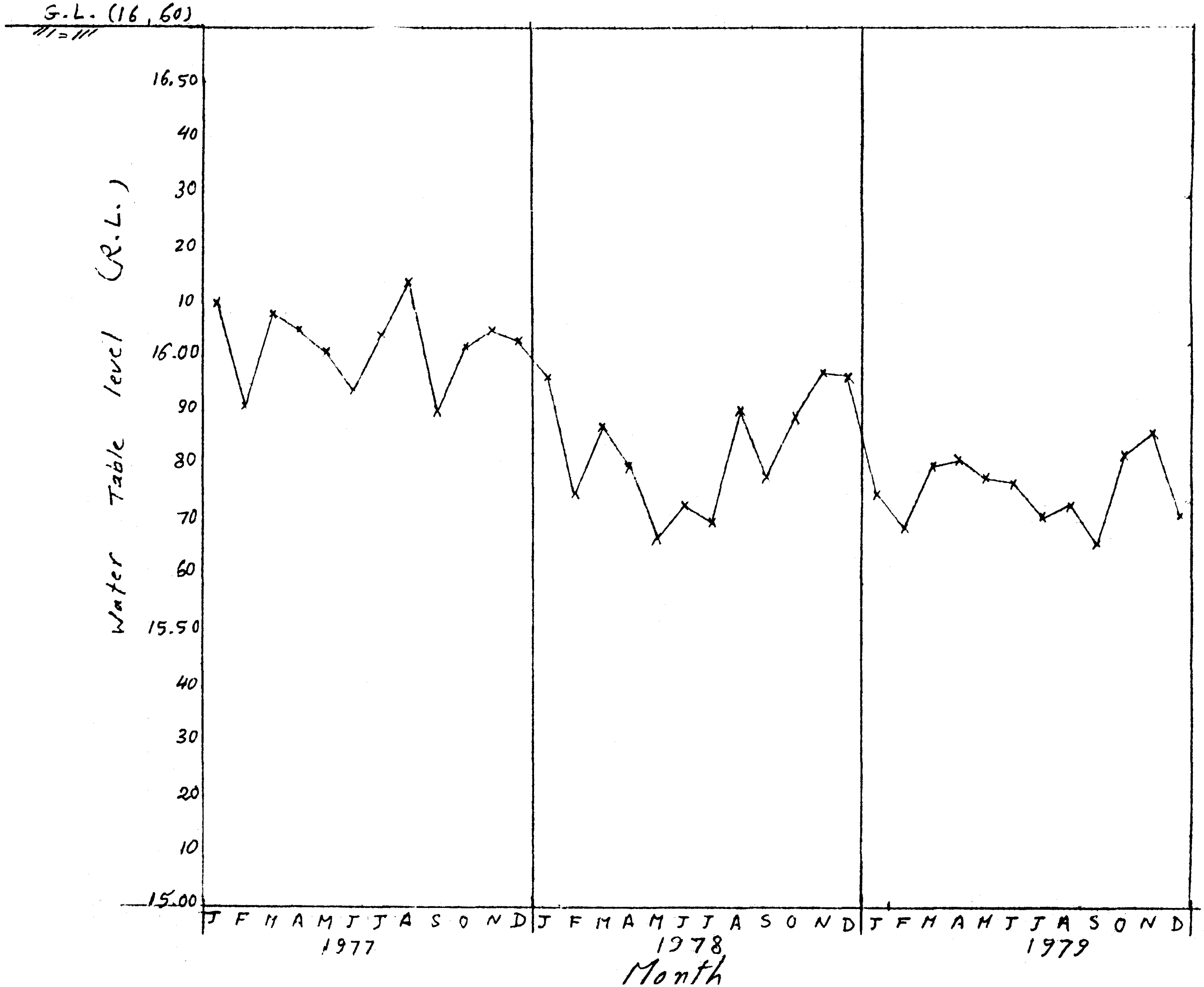
* : It is assumed that:

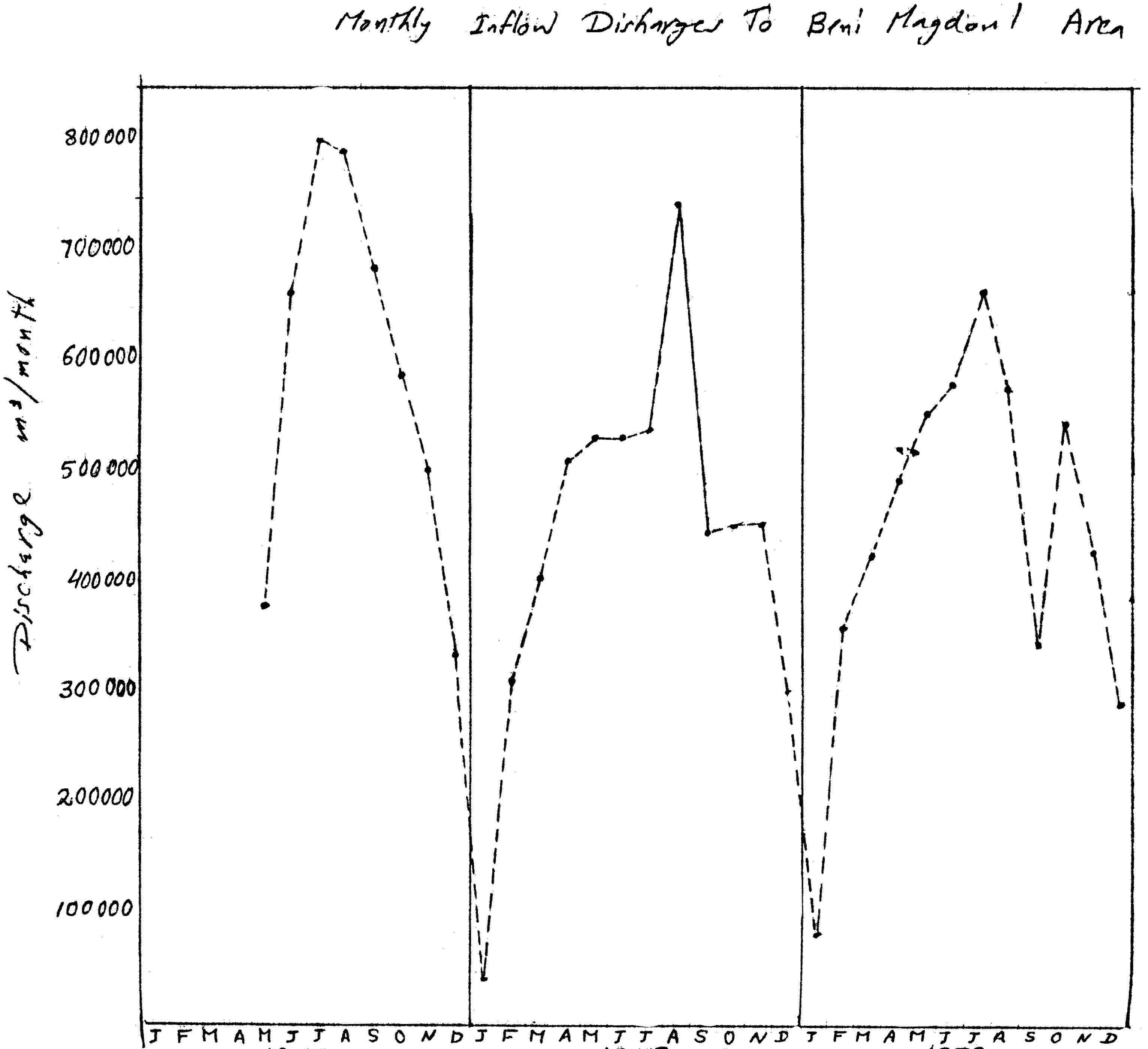
1. Outflow to adjacent area $O_A = 0.03\ I_M$ (inflow discharges in Beni Magdoul Canal)
2. Consumptive use estimated by agromist Mr. Semaika depending on Arizona Crop Coeff. & Blanney Criddle
3. Outflow surface drains O_{SD} and change in soil moisture ΔS_S negligible.

e: Estimated values by Mr. W. Ree (TDY in EWUP) in his report in May 1980

Monthly Average Water Table in

Beni Magdoul Area (1977 - 1979)




Monthly Inflow Discharges To Beni Magdoul Area
Discharge m³/month
800000
700000
600000
500000
400000
300000
200000
100000
J F M A M J J A S O N D
1977
J F M A M J J A S O N D
1978
J F M A M J J A S O N D
1979

Staff Paper #15

AN ECONOMIC ANALYSIS FOR SQUASH TRIAL AT EL HAMMAMI

M. Lotfy Nasr

An area about 2202 m^2 (0.50 feddan) had been selected to carry over some of the vegetables problems which had been identified. This area is located in site # 1 at El Hammami. Mansouria field team had conducted new practices on squash production. The following are some information about the situation:

- The area cultivated by Mr. Badel Sattar Baaror

- The new practices which were conducted concentrated on increasing plant population by narrow ridges and using triangle method in planting seed. Good bed preparation by using malboard plow and disking. Added organic fertilizer with pre irrigation. A new insecticide had been used at proper time and effective dose.

- Yield was weighed by agronmist helped by technician.

- Date were collected during the growing season by interviewing the farmer.

- A pratial budget was used in analysis, and all culculas based on one feddan.

- The compared field was the production of the same area , last agricultural year 1978-1979.

- A fixed price had been used in culculas for both years - prices of agricultural year 1979-1980

Conclusion:

Net farm income for one feddan cultivated by squash considering the new practices is about L.E. 244.5 feddan. The main source of added costs in pest control which contrasted by added yield. For more details see next page.

PARTIAL BUDGET FOR SQUASH
AT EL HAMMAMI ONE 1 FEDDAN

A.	Added returns	L.E.
	Squash fruit 4162 (4.2 tons) x L.E. 0.09	374.58
	Total	374.58
B.	Reduced costs	
	- plowing and furrowing one time (by area)	10.0
	- organic fert. 280 donkey load x L.E. 0.16	44.8
	- chem fert.	
	amonium-nitrate 33-0- 160 kg x L.E. 7.0/100 kg	11.20
	- weeding 1 time 6 hrs x L.E. 0.167	1.0
	- lifting water by sakia 20 hrs x L.E. 0.25	5.0
	- labor to pick fruit 12 hrs x L.E. 0.167	2.0
	- Packed rent (by season)	1.98
	Total	75.98
	Total added returns and reduced costs (A + B)	450.56
C.	Reduced returns	
	- Squash fruit 550 kg (5 ton) x L.E. 0.09	49.5
	Total	49.5
D	Added costs	
	- Plowing by malborad plow (area)	24.0
	- Disking time and furrowing	6.0
	- Organic fert. 320 donkey x L.E. 0.16	51.2

- chem fert.	
amon-nitrate 33-0-0 33 kg x L.E. 7.0/100 kg	23.1
- weeding 12 hrs x ..E. 0.167	3.0
- Insecticide	
Lannite 460 gm x L.E. 0.189	8.69
Bayfolan 220 cm x L.E. 0.09	1.98
Namroad 360 cm x L.E. 0.03	1.08
sulpher 15 kg x L.E. 0.75	1.125
- labor to spread 16 hrs x L.E. 0.167	3.0
- sprayer rent 18 hrs x L.E. 0.05	0.9
- Fuel for sprayer 22 liter x L.E. 0.11	2.42
- Lifting water by sakia 30 hrs x L.E. 0.25	7.5
- Labor to pick fruit 45 hrs x L.E. 0.167	7.515
- Packed rent (by season)	15.0
Total	156.51
II Total reduced returns and added costs (C+D)	206.01
Net farm Income 1-II	
L.E. 450.56 - 206.01	244.55

Staff Paper #16

AN ECONOMIC ANALYSIS FOR TOMATO TRIAL AT HAMMAMI

M. Lotfy Nasr

Tomato production is one of main vegetables cultivated at El Hammami, but during the recent years its yield decreasing with increasing rate. The main reasons for that, as seemed to agronomists, were pest control, weak nursery, bad preparation, way of planting and others. Considering all these Mansouria field team had been trying to carry over these problems

At site # 1 an area of about 1812 m^2 0.431 feddan had been selected and the following are some infromation explaining the situation.

- The area is cultivated by Mr. Abdel Sattar Baaror.

- Practices which were conducted by the team concentarted on plowing, a malboard plowing had been used, added organic fertilizer, disking, and then furrowing with narrow ridges. A specific and new insecticide had been used at the proper time and effective dose. An extension service had been taught to the farmer to pick out "Halook" with no effect on the plant growing.

- Yield was weighted by the agornomist helped by technician each picking time.

- Other infromation was collected during the growing season.

- Partial budget was used to analyze the data collected converted to one feddan basis.

- The compared field was the production of the same area in agricultural year 1978-1979 and calculated by using prices and costs of agricultural year 1979-1980 (year of conducted new practices)

CONCLUSION

Net farm income from area cultivated under Mansouria field team compared wih the farmer way is about L.E. 375.7, and the main source of added costs is insecticide which contrasted by yield increased. More details are in next page.

PARTIAL BUDGET FOR TOMATOE TRIAL AT EL HAMMAMI ON ONE FEDDAN

A.	Added returns	L.E.
	- Tomatoe fruit 10430 kg (10.4 tons) x L.E. 0.09	938.7
	Total	938.7
B.	Reduced costs	
	- Plowing and furrowing one time (by area)	10.0
	- Organic fertilizer 120 donkey load x L.E. 0.16	19.2
	- Chem. fertilizer:	
	amoni-nitrate .45-0-0 200 kg x L.E. 11.0/100 kg	22.0
	" " 33-0-0 100 kg x L.E. 7.0/100 kg	7.0
	" " 15.5-0-0 100 kg x L.E. 3.75/100 kg	3.75
	Super phos. 0-15.5-0 150 kg x L.E. 2.75/100 kg	4.125
	- Hoeing 2 times (6 labor x L.E. 1.0/time)	12.00
	- Weeding 1 time 24 hrs x L.E. 0.167	4.0
	- Insecticide: 2 liter malothyon x L.E. 1.0	2.0
	50 kg sulpher x L.E. 0.075	3.75
	labor to spread 6 hr x L.E. 0.167	1.02
	sprayer rent 6 hr x L.E. 0.042	0.25
	- Lifting water by sakia 26.0 hrs x L.E. 25	6.725
	- Labor to pick fruit 42 hrs x L.E. 0.167	7.014
	- Packed rent (by season)	18.00
	- Land rent 5 months x L.E. 10.0	50.00
	Total	170.834
	I Total added return and reduced costs (A + B)	11.9.934
C	Reduced returns	
	- Tomatoes fruit 4164 kg (4.16 tons) x L.E. 0.09	374.76
	Total	374.76

D. <u>Added costs</u>

	L.E.
- plowing by Malboard plow (area)	24.0
- disking 1 time and furrowing	6.0
- organic fert. 320 donkey load x L.E. 0.16	51.2
- Chem fert.:	
amonuim nitrate 33-0-0 660 kg x L.E. 7.0/100 kg	46.2
" " 15.5-0-0 80 kg x L.E. 3.75/100 kg	3.0
super phos. 0-15.5-0 50 kg x L.E. 1.75/100 kg	1.375
- Hoeing 3 times (6 labors x L.E. 1.0/time)	18.0
- weeding 72 hrs x L.E. 0.167	12.0
- Insecticide:	
Lannite 940 gm x L.E. 0.189	17.24
Bayfolan 3950 cm x L.E. 0.09	3.56
Dimethweat 680 cm x L.E. 0.30	2.04
Sulphar 70 kg x L.E. 0.075	5.25
Labor to spread 49 hrs x L.E. 0.167	8.18
fuel for sprayer 33 liter x L.E. 0.11	3.69
spray rent 49 hrs x L.E. 0.05	2.45
- lifting water by sakia 48.70 hrs x L.E. 0.25	12.18
- labor to pick fruit 168 hrs x L.E. 0.167	28.06
- Packing rent (by season)	45.0
- Land rent 7 months x L.E. 10.0	70.0
Total	359.425

II Total reduced return and added costs (C + D) 734.185

Net farm income (I - II)

L.E. 1109.934 - 734.185 = L.E. 375.749 375.749

Staff Paper #17

THE EFFECT OF SOIL AND PEST MANAGEMENT ON FARM PRODUCTION
1. Squash

M. Semaika and Harold Golus

Since we had our problem identification of El Mansouria area, it was very clear that the yield standards of the different crops and vegetables are below average, this could be due to incomplete soil management, low yielding varietyies, insufficient pest control (kind, rate) and irrigation practices. All those factors could be rated under famers limited knowledge.

When we tried to contact and work with some farmers we chose sites that represent the whole area, at the same time to gain their confidence, we tried to inform them of the well known identified problems as the first step, especially if the solution will not cost them too much. Secondly we might later handle some other serious problems such as fertilizers and irrigation application as these problems can not be dealt with, without getting the farmers confidence first. Third practices could be some improved agronomic techniques such as fertilizers foliar applications, using coated or slow release fertilizers, and micro-nutirent and growth hormons applications, which can be practiced through field experiments.

An economic study is hereafter attached, as it may be of use to our overall judgement.

SITE # 1 AT EL HAMMAMI

Site # 1 at El Hammami is about 40 kirates irrigated directly from El Hammami Canal by a sakia. Through our problem identification we found that most of the yield production was below the normal standard. Seed bed preparation includes ploughing, furrowing, weed control; especially the parasitic ones like "Hallok" pests and deiseases and fertilizers application had been practiced below the normal level or had been completely missed, it may be due to that the farmer has no ability to do it or he had taken it from the point of saving money and reducing the costs or he had no idea at all about it, the result is weak infested and poor plant population, poor vegetative growth and yield and poor income.

When we contacted the farmer he decided to cultivate three crops, squash, tomatoes and pepper, he completely refused our idea of just cultivating one or two crops maximum. From the very early contact we planned to practice the best soil management which gives a good seed bed and to recommend the effective pest chemicals, the time to apply it and the kind and rate avoiding infectation at the any time. The main idea of such a plan is to get the farmer to know that doing any proper step would improve his crop and that if he followed all our instructions, he would get a better yield.

Really we could have done more steps at one time, to get an ideal yield, but we thought it better to gain the farmer's confidence first. This could be done by carrying out some ideas that would end up with the best yield, at the lowest costs possible, yet within a longer time than it used to be. We also planned that next year we could make more achievements and some very serious problems, like fertilizer applications, that would give a better yield still. We would leave the farmer with a better idea of how to practice better farming without needing our help.

As his previous crop was maize forrage and it was harvested one month before the following corp, so we had enough time to prepare a good seed bed. In order to do so, we used firstly the malboard plough to turn over the 40 cm surface layer, as El Hammami land is of sandy soils and the farmer used to put animal fertilizers at least one time every year and by the time he had a (30 - 40 cm) layer of more water holding capacity than the lower layer which is completely sandy (that can be due to the clay content which he used to mix with the animal reseduals to make animal fertilizers) by turning over this depth and adding the animal fertilizers after malboaring we increased the depth of that more water holding capacity which also contains more clay contents as a direct effect of animal fertilizers application.

After adding the animal fertilizers we asked the farmer to pre irrigate his field , after the soil moisture content reached the friable stage we disked it and a slope of 0.5% was made.

To cultivate the squash, it is better to have a short discription of the same last season crop. At the same site at the same spot by the same farmer. A bad poor plant population is noticed clearly due to very abnormal very wide rigdes rate (130 - 120 cm) and large spacing between the hills and heavy pest infectation with white fly, spider mites and mildew. So when we Pland to cultivate squash we first try to avoid all the wrong agricultural practices which the farmer used to do before so we planned to make 95 cm ridges width instead of (120 cm)

First we faced the problem of that the farmer was not convinced with our point of view except when we garanteed his yield, his refusal came from the point that he and his neighbours used to make wide ridge, but when we explained to him the idea of decreasing the width just to save some more areas and some more plant population and so more yield with the minimum increase in the costs, for example he would not pay more for the tractor if he asked for decreasing the ridges width at the same time this decrease will be to a certain limit without affecting the leaf area index heat and light requirements which can cause a decrease in yield production. On the day of planting we were in the field to show the farmer how to put his seeds in a triangle plating method in order to have a good plant distribution which in the same time would give an increase in the plant light heat requirements. Plant germination was 98%, from the first day of germination. We went to visit the field every day watching any infectation to recommend the effective chemical, to show the farmer how to spray it at the right time that is very early in the morning and how to mix it by the right recommended dose and rate, at the same time we informed him that any delay in spraying may affect the spraying efficiency and may lead to a decrease in yield production.

At the beginning we faced some objection from the farmer to use same very effective chemicals like lannate because he believed that this material may kill him as he had heard from his friends, not to use lannate because it killed a man in our village, but when we said to him that we are going to spray it by ourselves, and that he can keep out the the way but only watch when he noticed the effect of spraying he asked to spray next time by himself and all the people were gathered to watch what will happen. Throu-out the whole growth season, we were faced by a severe white fly, mildew and spider mits. Infectation by continuous spraying we succeeded to overcon any infectation. Really we sprayed more times than normal, but that was because most of the infectation came from the neighbouring fields which the farmer never sprayed. Through the whole growth season the plant seeds were very healthy and dark green.

As to fertilizers, we never applied the recommended standars rate in a complete practice, because it would have been very hard to get the farmer confidence by a direct contact with these problems. All what we did was an indirect touch for nitrogen fertilizers application. For example we explained to the farmer that it is better to put the nitrogen fertiliz in very small amounts, immediately after the irrigation as he used to put his nitrogen fertilizers one or two days before irrigation and even if he puts it before irrigation the uptake efficiency would be very small due to the high inflitration rate of the sandy soils and the over irrigat /which the farmer used to do, to practice such work we aksed the farmer to leave one strip or a very small basin in order to put the nitrogen fertilizers in it after the irrigation direct and by applying the half amount which he will be using for the other strip or basins, at the beginning he was totally satisfied, but when he followed our insturctions in one corner of his field and found the results wonderfu he became very satified because all the difference he found between his basins and ours was the waste of the nitrogen fertilizers, his neighbours also tried to do the same without any contact with us. Although it was not a complete fertilizer application practice, but still it was the first step to make a good step for any coming contact with the farmers.

At the end of the growth season we collected all the data about squash this year (our work) and some of the data last year (his work) these data are shown in the table below.

		Year 1978-1979	Year 1979-1980
Average distance between ridges cm		120	95
Number of ridges for the same width		17	21
Fertilizers application	animal	140	160 donkey load
	nitrogen	80	115.5 kgN/F
	phosphorus	--	--
Plant population/F		4848+	5989
Yield kg/F		275	4162*

* This total yield was first quality, it could be more and may be should if the farmer tried to postpone each picking one day or more but he prefered to pick it very small to take to the market sooner and build up a good name there

+ No calculated plant population because we have no previous data.

Our comments as the agronomy field team

1. Really we have achieved some success (in doing some of all good we could recommend). First we tired to get the farmer's confidence which is the first step. He specially becomes convinced if it would not cost him more money. Although we got a high yield, this yield could be increased if he accepted our recommendation in the proper time, for example when we recommend the lannate as a very effective pest chemical, he did not accept to spray except when we asked him to go with us to see a completely damaged field, but it was somewhat late (20 days after the proper time) which for sure had its effect to reduce the yield.

2. The success of our limited work could be seen as a direct reflection of the farmer's feeling, who said "I am ready to do what you will recommend to me or order me to do next year. Moreover, his neighbours and even the other farmers far from his site who also asked for our help.

3. Although we did not deal directly with the fertilizers but all what we might say that the fertilizers application efficiency incraesed from 3.43 to 36.03 kg yield /kgN that is from the point of yield increase.

Staff Paper #18

ROTATION SYSTEM OR CONTINUOUS FLOW SYSTEM FOR IRRIGATION CANALS IN EGYPT

Mona El Kady, John Wolfe, Dr. Hassan Wahby

This paper gives an evaluation of changes made in design and operation of Beni Magdoul branch canal, Egypt. A change from a canal rotation system to continuous flow system was a step to make a comparison and evaluation of the existing rotational system in Egypt.

A description and the history of rotation system in Egypt and its effect on canal design were discussed, as well as the advantages and disadvantages of the continuous flow system.

Recommendations to improve the complicated distributory system of irrigation in Egypt, to insure good control, efficient operation, water saving, high productivity and fair distribution, were the concluded.

I. Introduction:

[2]"Without irrigation there could be no Egyptian people, certainly no civilisation in Egypt. The influence of irrigation prevails Egyptian economics, politics, social life, agriculture, legislation and even religion."

1.

2. Sir W. Willcocks, and others "Egyptian Irrigation" Vol. 1, Third Edition, 1913.

.../...

A mean of control water distribution according to the available supply in the extensive Egyptian irrigation system is irrigation rotation. What is a rotation?

The canals, and its served areas are divided into divisions (two or three). Each division in turn is permitted to receive its supply of water during a number of days (working period or on period), while the rest of the divisions remian empty (closure period or off period).

The rotation system was used in the past (before building the High Aswan Dam) mainly to rationalize between the Nile water supply in summer which is less than the water requirements and the Autumn supply which is more.

Moreover the rotation system has the following advantages:

1. The closure period is beneficial in lowering the groundwater levels and thus avoiding the deterioration of the adjacent lands.
2. Less use for the drainage system, since the canals are operating as drains during the closure period.
3. Smaller cross section of the main canals, though more cross sections of the distributory canals.
4. Less maintenance for the distributory canals which are operating only during the working period.
5. With the shortage in Egypt's irrigation engineers, this system helps an engineer to organize his time and enables him to supervise a bigger area served. Meanwhile, this system also organizes the farmers time.

The disadvantages of the rotation system:

1. The plant does not get its water according to its requirement, but only on the working period, which can be a reason for low yield.
2. The farmer is using more water during the working period, since he is afraid that his plant will suffer during the closure period.
3. More cross sections for the distributory canals which serve all its area only on the working period, though the distributory canals represent the extensive part of the irrigation net work in Egypt.

Types of rotation:

1. According to the number of turns: 2 turn or 3 turn rotation.

   In the 2 turn rotation, the area served by the main canal and its branches, is divided into 2 equal parts, to be irrigated one after the other, whereas, in the 3 turn rotation, the area served is divided into 3 equal parts. It should be noted that in planning the rotations, the area served in a turn might not be all in one location.

2. The duration of a rotation is according to the time of year or seasonal rotations: (before High Aswan Dam)

According to the yearly season, rotations are divided into:

1. Summer rotation: (the supply of water is less than needed).
2. Nile rotation: Period when water levels are high and the water available exceeds needs and therefore rotations are carried out according to needs.

3. Spring rotation: Period which needs almost to coincide with supply therefore rotations are taken according to supply.

4. Winter closure: Least water needs period, and least evapotranspiration losses.

Each of these rotations has its own system.

I. Summer rotation: It starts on the 16th of April, with exception of Fayoum, where it starts on the 1st of April and goes until June.

The system of applying summer rotations depends on the types of soil (clayey, sandy or silt) and crop planted.

1. Cotton planted in clayey soils:

   Cotton planted in clay soils is irrigated once every 18 days in a 3-turn rotation (6 on-days & 12 off-days).

2. Cotton planted in silty soils:

   Irrigation is once every 14 days in a 2 turn rotation (7 on-days & 7 off-days).

3. Cotton planted in sandy soils:

   (Such as the Delta lakes) irrigation is once every 12 days in a 3 turn or a 2 turn rotation.

4. Rice cultivated zones:

   Irrigation is once every 8 days in a 2 turn rotation.

5. Special summer rotations:

   (for some crops, ex: vegetables and orchards) where irrigation is once every 9 days in a 2 turn rotation.

.../...

6. Overlapping summer rotations:

It is usually done at the flood time, 2 days are shared by each 2 successive turns (keeping a 18 day rotation).

The critical period:

Canals are designed according to this period when the flood water increases to the extent that no rotation system is required (this occurs in August).

II. Nile rotations: (August 16 to November 28)
The purpose of which is the protection, of canals from sedimetations, the cultivated lands from seepage also to prevent the irrigation water from filling the drains.

II. Winter rotations: (Nov. 29 to March 16)
It is a 3 turn rotation, least need of irrigation water and least water losses where this is compensated for by the atmosphere humidity and some water applications, before and after winter closure.

IV. Spring rotations: (March 17 to April 15)
Deficiency of water if any is compensated for by the water stored in Gabel El Awlia reservoir.

After the completion of the High Aswan Dam since the supply is controlled to fit the need, main factors affecting the rotational system are type of soil and crops planted. Thus the main rotations now are:

1. 2-turn rotation (7 on-days and 7 off-days for cotton area).
2. 2-turn rotation (4 on-days and 4 off-days for rice areas).
3. 3-turn rotation (4 on-days and 8 off-days for most of the crops).

.../...

In the past many irrigation engineers and research workers asked to stop the rotations to give the supply according to the demand. On 1967 Eng. M. E. Aub run an experiment for four months, in two areas in Lower Egypt, one planted cotton and the other planted rice. (see Table 1). His results were saving water by the rate of 8% for rice area and 9.3% for cotton area.

On 1974 Eng. A. S. El Bana also carried out a research where he recommended to stop the rotations in Egypt.

II. Objectives and Scope of this Study:

The objective of this study is to evaluate the rotational system in Egypt through a big program of water management carried out by EWUP in El Mansouria area, Guiza Governorate, Egypt. Where Beni Magdoul Canal was chosen, as one of the distributory canals serving about 749 fed, for different types of improvements

1. Lined sections instead of alluvial, thus reducing areas of cross sections.

2. Continuous flow instead of rotational system, meanwhile modified delivery on demand basis thus, restricted controlled inflow to Beni Magdoul Canal which causes a lower water level in the canal.

Comparative bases for evaluation of results:

1. **Water Saving:**

   Total inflow to the canal, per feddan, comparing a continuous flow canal with a rotational one under similar conditions.

2. Farmer acceptance of the continuous system instead of the rotational system

Table (1): Irrigation Trials for the minimum need from the beginning of September until the end of December
by Eng. M. E. Aub

Field	Surface by Feddan	Total Water applied to Field in Sept.	in Oct.	in Nov.	in Dec.	Feddan's Share: Irrigation with rotation	Irrigation without rotation	Rice %	Remarks
		per 1000 3 m	per 1000 3 m	per 1000 3 m	per 1000 3 m	3 m	3 m		
First: Rice Area									
Bashteel Al Kadima for irrigation without rotation	3630	2.507	2.037	1.590	1.238	-	2050	35%	
Bahteirah for Irrigation with rotation	9100	9.418	6.602	5.924	2.442	2800		35%	
Al Khalig Al Abassi for Irrigation without rotation	32775	21.886	17.381	17.934	10.470	-	2000	30%	
Al Batounia for Irrigation with rotation	28800	15.552	13.838	8.726	7.946	1600	-	20%	
Average of Feddan's Share in Rice Area						2200	2025		
Second: Cotton Area									
Habs Al Bagouria for Irrigation without rotation	12500	7.920	9.460	8.025	6.300	-	2536		
Talawana for Irrig. without rotation	11500	7.700	8.650	9.487	6.279	2792	-		

Conclusion: Irrigation without rotation caused a decrease of water used of 8% in rice area and 9.3% in cotton area

3. Equity of water shares delivered especially on canal and ditches tails.

4. The influence of the rotational schedule on irrigation interval.

5. Affect on water table over 3-year period.

6. Saving land by reduction of cross section area.

7. Seepage from canals and meskas (ditches).

8. Weed growth in canals: Does continuous flow necourage weed growth since there is not drying period?

9. Crop yield and soil salinity comparison.

** It should be noted that the changes observed are not necessarily due only to the bases of delivery, but could be due to the canal lining also.

III. Rotational System or Continuous Flow System:

1. Water Saving:

The Beni Magdoul Canal, prior to 1977, was a typical branch canal in Egypt. It received water from the Mansouria Canal on a rotation basis, usually for only four days out of each twelve, so that most farmers were eight days without water. It was unlined and had an enlarged cross section. The cross section was affected by animal access to the canal, by removal of sediment for making bricks, by weeds and siltation, and by access for washing clothe and dishes.

Water flowed eastward by gravity through a sluice gate into the Beni Magdoul Canal. From there it continued by gravity down the canal and through pipes to each of ten private ditches (meskas) on the north side, and to   on the south side. In the original design, the size of pipe entering each meska was chosen according to the area of land served by it. Each pipe was supposed to have a 25 cm head over the crest. A smaller canal branched to the south, and three meskas were supplied by it. It too had an enlarged cross section and banks that sometimes overflowed.

In accordance with the plan of the experiment, the inflow to Beni Magdoul was controlled by the engineer in charge, after the canal was lined and supplied with continuous flow. Each day he gave instructions to the gate keeper to adjust the gate to maintain a specified water level just downstream from the gate in the morning, and to cut back flow to a lower specified level in the evening. The specified levels were chosen to discharge a particular size of stream through a calibrated Nerpic gate. The total daily inflow was calculated as the consumptive use of the entire cropped area, plus about 10 percent. The consumptive use was estimated by the Blanney- Criddle method, using weather data from previous years. If any significant spill was observed from the end of the canal or its branch, or if the level in the canal, especially near the end, was too low to serve the meskas, an appropriate adjustment was made for the next day. This procedure permitted the canal to fill completely during the night, so that those at the far ends of the remote meskas could obtain water at that time at least. Table (2) shows monthly discharges to Beni Magdoul area in agricultural years 1977/1978 and 1978/1979 where the first year a continuous flow system was followed without control from the irrigation engineer, while on the second year the above mentioned control was followed. The results was saving more than 1.000.000 m^3/year.

There are no records available of the water delivered per feddan by the Beni Magdoul Canal before the lining. Therefore an assumption was made that the characteristics of the Nahia Canal could represent the Beni Magdoul Canal before lining. The Nahia Canal serves 850 feddans compared with 748 feddans, net, for Beni Magdoul. It has a large, irregular cross section. It is situated so that a few fields can occasionally be irrigated by gravity, like Beni Magdoul was previously. It is the first canal north of Beni Magdoul. It receives water on the 4-days-on, 8-days-off rotation. The comparisons of canal inflow per feddan served have thus been made between the present-day Beni Magdoul Canal and the present-day Nahia Canal.

.../...

Table (2): Monthly Discharges to Beni Magdoul Area in Agricultural Years 1977/1978 and 1978/1979

Month	Discharges in m^3/month	
	1977/1978	1978/1979
Oct.	590 932	588 743
Nov.	505 250	444 347
Dec.	340 891	278 485
Jan.	43 986	25 000
Feb.	313 260	360 385
March	406 330	444 123
April	513 276	602 391
May	891 920	549 520
June	679 207	602 392
July	726 192	641 547
Aug.	892 218	476 010
Sept.	468 765	348 892
Total	6 372 227	5 360 840
Water duty per feddan in year	8 275	6 962

Methods of measuring discharge

- Nahia Canal

The discharge of the Nahia Canal was measured with a current meter near the intake of the canal. Only one reading was made each day. During many of the on-periods, a measurement was made during each of the four days. However in some of the periods measurements were made only three or two or one day out of four. Since the variation in discharge among the four "on" days of a rotation is great, an on-period represented by only one or two measurements could be considerably in error. It was arbitrarily decided to smooth out these variation by calculating the daily mean for any on-period as the mean of all the daily measurements during that period plus those from the period immediately preceding and the period immediately following.

There was also considerable variation in the measured daily flow during the off-periods. Since only one measurement was made during some off-periods, and arbitrary decision was made to use the mean value of all 60 measurements as the average daily flow during each off-period. This procedure masks out any variation of the off-period flow with season, if any such relationship exists.

Another possible source of error stems from the diurnal head fluctuation of the canals. Variations in upstream and downstream head will cause variations in the discharge throughout the day. The discharge was not measured more than once per day. However, similar measurements made in the El Hammami Branch Canal, a few kilometers farther north, were found to be made at a time when the head was about average.

It was assumed that the sum of the errors in these measurements, some of which may be compensating, will be less than $\pm$ 20%, based on the judgement of experienced engineers who examined the data.

.../...

- Beni Magdoul Canal

A Nyrpic gate with seven separate slide gates was used as a measuring device at the intake of Beni Magdoul. The structure was calibrated against current meter measurements with several combinations of gate openings. The range of heads used in calibration included both the weir flow and the orifice flow stages. The discharge was not submerged, so one recorder on the upstream side was sufficient. Recorder charts were processed on a digitizer, and the flow calculated by equations derived from the calibrations.

The maximum error in these measurements is estimated not to exceed $\pm$ 10% for the 12-day periods, and less than that for the 6-month total.

Discharge comparisons

The total discharge measured in the Beni Magdoul Canal during the last 6 months of 1979 was 3,815 m^3 per feddan. This compares with 7,107 m^3 per feddan measured in the Nahia Canal. These figures say that the discharge per feddan in the Nahia Canal was 86% greater than in Beni Magdoul. If the combined measurement error were as much as $\pm$ 30%, the measured difference is still very great.

Shorter term figures are compared in Table 1. Each figure in the table represents a 12-day period including 4-days-on and 8-days-off in the Nahia rotation schedule. The off-days were divided with 4 days on each side of the on-period. The same figures are also shown expressed as mm per day.

These results are shown graphically in Figure 1. Also shown in Table 3 and in Table 4 are estimates of consumptive use. These were calculated from the Blaney-Criddle equation, using actual weather data and cropping patterns in Beni Magdoul for that period. The canal discharge in Beni Magdoul appears to dip below the consumptive use in August and again in December and part of November. The reason for this is not known, but it was not intentional. A different set of weather data was used for the two computations. Sometimes the level in the Mansouria main canal went down after the gate had been set for the day, thus

.../...

reducing the flow until corrected the next day. The authors are not aware that crops suffered because of insufficient water in the canal during these periods. Crops can go long periods between irrigations in the winter because the water table tends to be a bit higher, and the low consumptive use rate can be more easily supplied by the upward capillary flow. The margin of possible error in the measurement of water applied, combined with a greater possible error in the estimate of consumptive use do not permit a firm conclusion that insufficient water was applied during these periods. However, if such were the case, the principal result could be only a slight lowering of the water table.

These figures and graphs do show quite conclusively that after the basis of delivery of water to Beni Magdoul was changed to continuous flow, or irrigation on demand, it was possible to make a substantial reduction in the canal inflow to the area without any apparent adverse effect on the crops.

Table 3: Measured Average Daily Discharge in Nahia and Beni Magdoul Canals Per Unit of Net Cropped Area Served During the Last Half of 1979

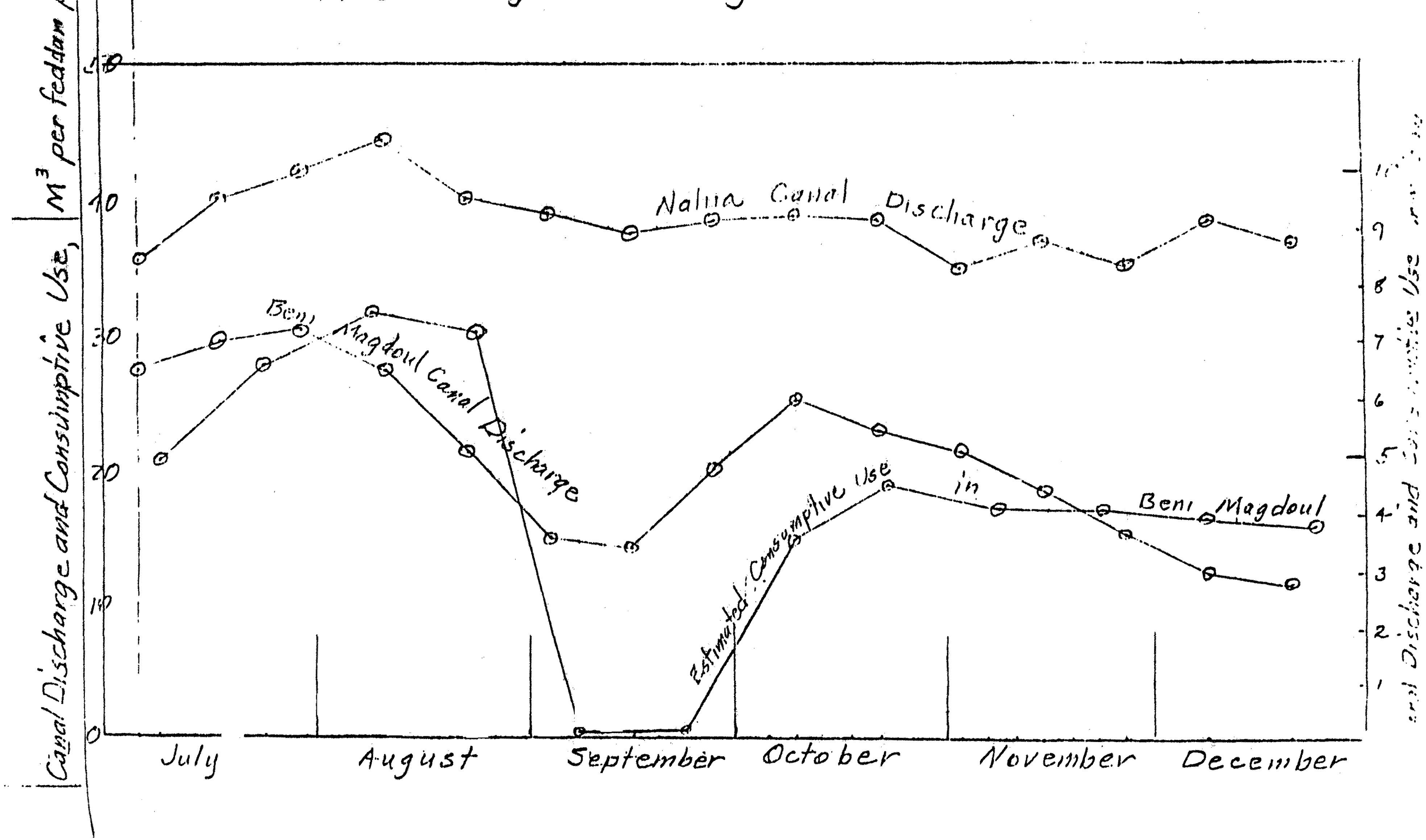
	Nahia Discharge		Beni Magdoul Discharge	
	M^3/feddan per day	mm/day	M^3/feddan per day	mm/day
June 29 - July 11	35.75	8.51	27.71	6.59
June 12 - July 23	39.98	9.52	29.78	7.09
July 24 - Aug. 4	42.02	10.00	30.25	7.20
Aug. 5 - Aug. 16	44.18	10.51	27.52	6.55
Aug. 17 - Aug. 28	40.02	9.52	21.72	5.17
Aug. 29 - Sept. 9	39.10	9.31	15.14	3.60
Sept. 10 - Sept. 21	37.71	8.97	14.43	3.43
Sept. 22 - Oct. 3	38.15	9.08	20.16	4.80
Oct. 4 - Oct. 15	38.80	9.23	25.13	5.98
Oct. 16 - Oct. 27	38.32	9.12	23.00	5.47
Oct. 28 - Nov. 9	35.13	8.36	21.61	5.14
Nov. 10 - Nov. 21	37.03	8.81	18.56	4.42
Nov. 22 - Dec. 3	35.27	8.39	15.50	3.69
Dec. 4 - Dec. 14	38.39	9.14	12.44	2.96
Dec. 15 - Dec. 26	36.69	8.73	11.86	2.82

.../...

Table 4: Estimated Average Daily Consumptive Use Over the Net Cropped Area in Beni Magdoul During July through December, 1979

	M^3 per feddan per day	mm per day
July 1-15	21.00	5.00
July 16-31	28.16	6.70
Aug. 1-15	31.87	7.59
Aug. 16-31	30.02	7.15
Sept. 1-15	0.46	0.11
Sept. 16-30	0.52	0.12
Oct. 1-15	15.11	3.60
Oct. 16-31	19.16	4.56
Nov. 1-15	17.38	4.14
Nov. 16-30	17.06	4.06
Dec. 1-15	16.71	3.98
Dec. 16-31	16.00	3.80

Figure 1. Comparisons among the discharge in the Beni Magdoul Canal, the discharge in the Nahia Canal, and the estimated consumptive use in Beni Magdoul during the last half of 1979



2. Farmer acceptance of the continuous system instead of the rotational system:

Farmer opinion in Beni Magdoul area was taken into consideration as a judgement of how successful the system is? The results of a sociological survey carried out by the sociology team of EWUP and the on-farm activity team in El Mansouria area were: 55% of the farmers prefer the continuous system and 45% prefer the rotational system on one condition. This condition is to attain a higher water levels in the canal on the working period.

A higher water levels in the canal will mean a gravity fed for the low lands in the area (Egyptian irrigation system is a lift system by law) and more discharge available on the working period which means more availability of water for those farmers on the tail of the canal or excessive use of water for the first reach. Meanwhile low water levels in the canal with the continuous system made the farmers started to think about the need of an irrigation schedule which they never followed before.

3. Equity of water shares delivered in the continuous system:

One of the major problems*, identified in El Mansouria delivery system (under rotation), was irrigation water delivered by the Mansouria canal system is not distributed equally among all the land it serves. The problem is illustrated in Fig. (2) where accumulated discharges is plotted as a function of time for the main canal and several of its laterals. Water available per feddan decreases with increasing distances from the intake of either a canal or a branch. As a result some land receive more water than it needs, while some gets an insufficient amount. This was the main reason for the complaining of the farmers on the last reach of El Mansouria Canal.

* EWUP Technical Report No. 1, "Problem Identification Report for Mansouria Study Area." Cairo, ARE, Ft Collins, Colorado, USA. March 1979.

.../...

During the last three years of experience with the continuous flow system in Beni Magdoul area, no complain came from the unequity of water shares on the tail of Beni Magdoul Canal. But there were always a complain in two areas, the first area on the tail of Beni Magdoul Branch (El Ashmawy Br.). The farmers are complaining mainl because they did not clean their private ditches to the level which permits enough water to reach their land, meanwhile they believe that because the government already lined Beni Magdoul Branch, it should line their private ditches which is very short and will not cost too much money, and continuous complain is their way (balck mailing).

The second area is the area on the tail of ditch No. (3) R. H. S. of Beni Magdoul Canal. This ditch is almost two kilometers long and those farmers on the tail are not able to clean the whole 2 km. Those on the first reach have enough water thus they are not helping in cleaning the ditch which is the core of the problem. EWUP cleane this ditch on the beginning of this year 1980. After cleaning those farmers on the tail were able to get the same share as those on the first reach, but the question now is how long the farmers will keep the ditch clean.

Therefore the problem lies mainly in the private ditch cleaning but not the water shares equity or availability.

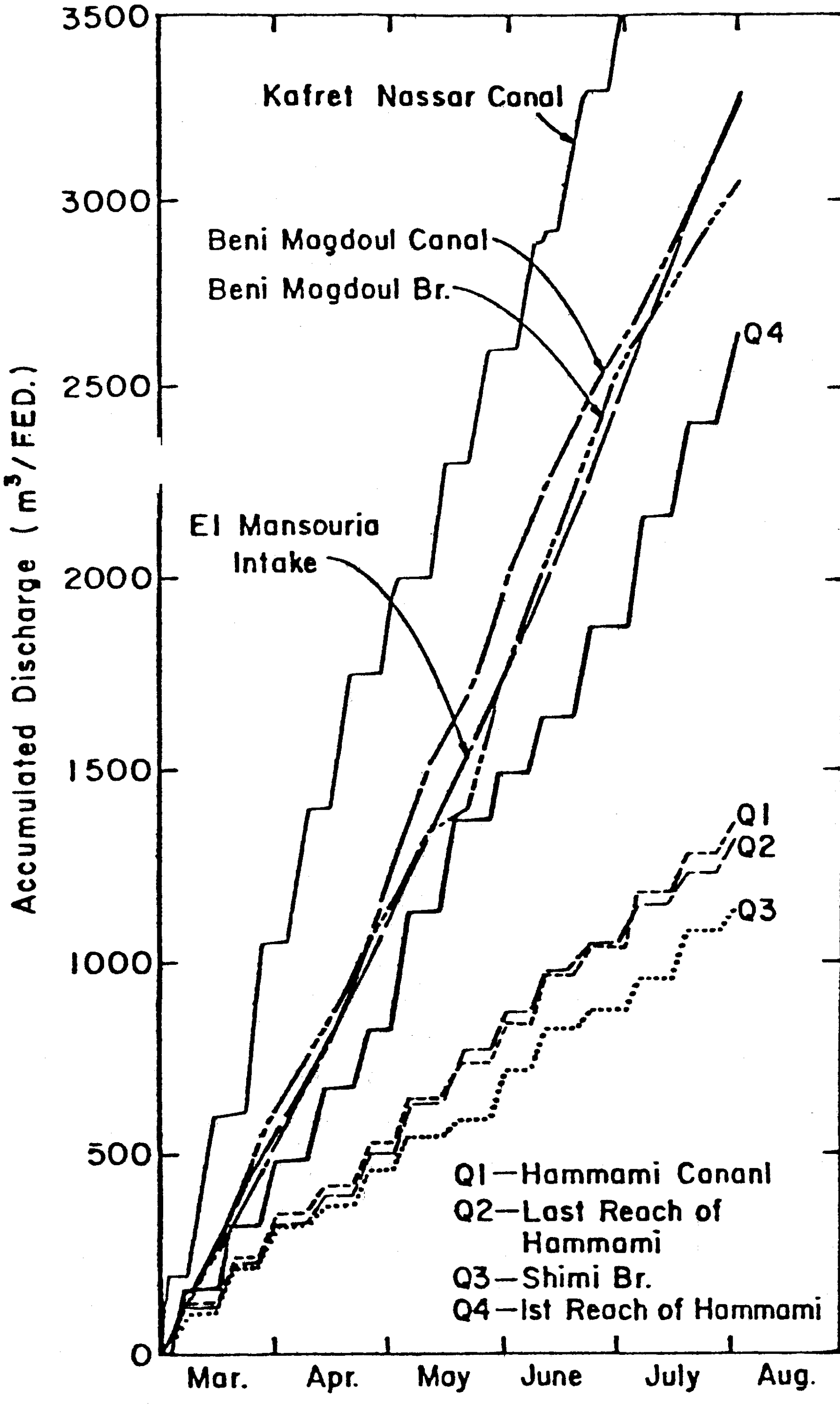


Figure (2) Accumulated dischargecas measured at the upstream head gates for the Mansouria Canal and three of its laterals as a function of time for 1978.

4. The influence of the rotational schedule on irrigation intervals:

Table (5): Irrigation Intervals for the Two Systems in El Mansouria Ar
1978

Irrigation intervals in days	Intervals			
	Continuous flow	System canal	Rotational flow	System c
	No.	%	No.	%
1-4			31	25
5-8	25	21	17	14
9-12	37	33	41	33
13-16	23	20	19	16
17-20	24	21	3	2
21-24	6	5	8	7
25-28	1	1		
29-32	1	1		
33-36			1	1
37-40				
40			3	2
	117	100	123	100

On continuous system (Beni Magdoul Canal) farmers may irrigate whenever they feel their crops need water. Under the "demand" system, the median irrigation frequency was 9 to 12 days. Furthermore, no farmers used to irrigate during the interval of four days or less. The longer intervals between irrigations, 28 percent of irrigations were 17 or more days apart which represent irrigations early and late in the cropping season or during the interval between crops.

On rotational system (four working days and eight days closure), farmers used to irrigate at the beginning and end of the four-day period when water was available. 25% of the irrigations come at intervals of four or less days, 14 percent at five to 8 days the media frequency was still 9 to 12 days with one-third of the irrigations coming during this

.../...

time interval. In principle, all irrigations on the rotational system should have come in the 9 to 12 or 21 to 24 days intervals since those are the intervals on the rotation. See table (5)

Since 57 percent of the irrigations came at intervals other than a multiple of 12 days, then the water came from canal storage (or gate leakage), drains, groundwater, and water made available outside the official rotation.

5. Affect on water-table over 3 years period:

Fig. (3) shows the average water table levels during the last three years in Beni Magdoul area. The first year after implementing the continuous flow system the average water-table levels drop down remarkably between min. 11 cm in January which is affected by the winter closure, max. 42 cm in March and April and with an average of 29.67 cm.

The second year data show that water table levels still gowing down in January, February and from August through December, while there is a slight increase than the year before during March through July.

The resultant is a low water table levels by almost 30 cm during three years.

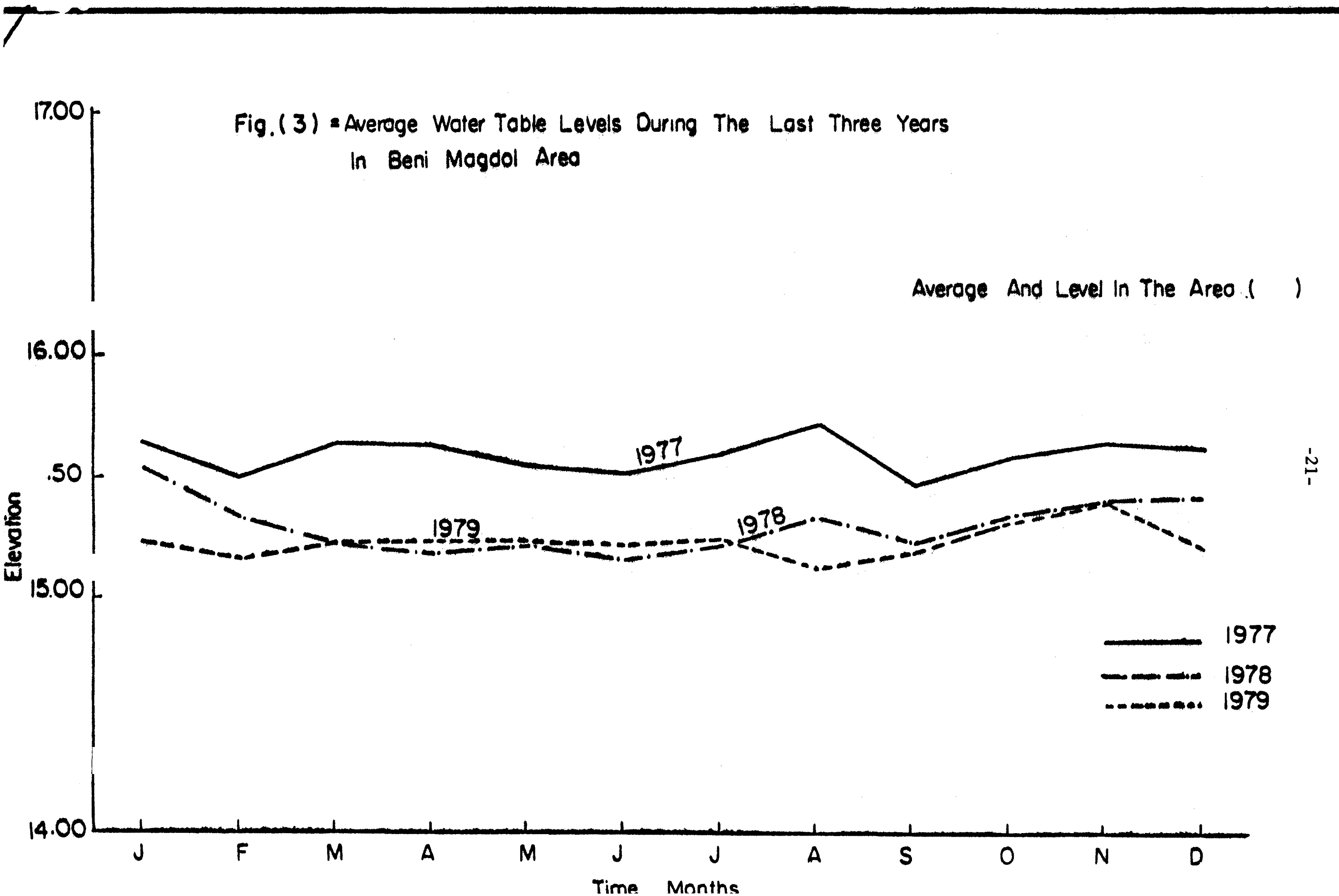


Fig. (3) = Average Water Table Levels During The Last Three Years
In Beni Magdol Area
Average And Level In The Area ( )
17.00
16.00
.50
15.00
14.00
Elevation
1977
1978
1979
J F M A M J J A S O N D
Time Months

6. Saving land by reduction of cross section area:

Cross section before and after 1977 are indicated by Table (6). These reductions in the cross sections were mainly due to canal lining. But no doubt a continuous flow system means that the area of Beni Magdoul Canal will be served not only during 4 days (working period) but also during the 12 days. Thus one third of the cross section required for the three turn rotation is required for the continuous flow. In an expensive old agricultural land as El Mansouria area, this means a considerable benefit. In a new project also to start with a continuous system, means smaller cross section for the distributory canals, thus less in construction cost exceeding land saving.

Table (6):

/ls	Beni Magdoul Canal	
	Before lining	After lining
1. Cross-section area	6.20 m^2	2.75 m^2
2. Water cross-section area	4.0 m^2	1.30 m^2
3. Bed width		
From km 0.00 to km 0.85	3.0 m	1.25 m
km 0.85 to km 1.90	3.0 m	1.0 m
km 1.90 to km 2.94	2.0 m	0.75 m
4. Side slope	3:2	1:1

7. Seepage from canals and ditches:

The lining of Beni Magdoul Canal gives no chance to make a comparison study for water losses by seepage in the continuous flow system and the rotational system. Thought it was concluded* that the losses increase appreciably with the increase of water elevation in the water courses, and decreases and may deminish as the water levels go more

* F. Shahin, M. Saif and others, "Conveyance losses in Canal", Ministry of Irrigation, EWUP, Cairo, Egypt. 1978. This study was carried out in the same area which is El Mansouria.

below the ground surface.

No doubt, the continuous flow system in Beni Magdoul area enable the irrigation engineer to lower the water levels in the canal more than the rotational system, thus minimize the seepage losses.

Moreover the smaller sec. of the distributory canal also will help in minimizing the seepage losses in spite of the water availability all the time.

More data and measurements are needed for seepage losses in representative alluvial water courses.

8. Weed growth in canals:

Does continuous flow encourage weed growth since there is no drying period"

Continuous flow system gives less cross sec. for the distributory canals, low water levels and no drying period. Meanwhile the rotational system gives larger cross sec., higher water levels and a drying period. The question here is the drying period is it dry enough to prevent weed growth?

All the observations in El Mansouria area indicated that due to the storage in the canal.after closure and the leakage from the gates, this doesn't give enough time for drying (out of 8 days only 3 days or less are dry) which causes an unremarkable change on weed growth.

With a case like this the continuous flow system with its smaller cross sec. and low water levels is better. Though no significant changes in weed growth was observed.

9. Crop yield and soil salinity comparison.

A comparison between the average yield of the corn crop, which is the main summer corp in Beni Magdoul area, in EWUP study farms shows:

Year	Average yield ard./fed
1977	9.13
1978	10.71

This means an increase of crop production with the implementation of the continuous flow system.

As a result of the smaller cross sec. of Beni Magdoul Canal, most of the farmers along the canal were able to reclaim some lands which were occuppied before by the large cross section of the canal or had a very high water table.

The following problem was idnetified* also with the rotational system "High Ground Water Levels Affect Crop Growth by Affecting Soil Aeration and the Crop Rooting Zone". High crop yields can be obtained under high water table conditions provided that there is a low level of salinity in the ground water and that the level of ground water does not fluctuate during the growing season. In the Mansouria area the ground water quality is good but the level fluctuates markedly." This water table fluctuation is mainly due to the on and off period of the rotational system.

IV Summary and conclusions:

A description and history of rotation system in Egypt and its effect

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on canal design were discussed, as well as the advantages and disadvantages of the continuous flow system.

A comparison study was carried out to evaluate the existing rotational system in Egypt. Beni Magdoul Canal, El Mansouria area, Guiza Governorate was chosen, as one of the distributory canals serving about 749 fed, for continuous flow instead of rotation system.

Comparative bases for evaluation:

1. Saving water:

The total discharge measured in the continuous flow distirbutory canal the last 6 month of 1979 was 3 815 m^3 per feddan. This compares with 7107 m^3 per feddan measured in the rotational system distributory canal. The figures indicate that the discharge per feddan in the rotational system was 86% greater than the continuous flow system. Data do show quite conclusively that after the basis of delivery of water to Beni Magdoul was changed to continuous flow or irrigation on demand, it was possible to make a sbstantial reduction in the canal inflow to the area without any apparent adverse effect on the crop.

2. Farmer acceptance of the continuous system instead of the rotational system:

55% of the farmers prefer the continuous system and 45% prefer the rotational system on one condition. This condition is to attain a higher water level in the canal on the working period

3. Equity of water shares delivered:

A major problem of unequity of water shares was identified on the Mansouria main canal under rotational system. Though no problem of unequity of water shares was raised on Beni Magdoul distributory canal under continuous flow.

4. Influence of the rotaional schedule on irrigation intervals:

Under the continuous "demand" system, the median irrigation frequency was 9 to 12 days on rotational system 25% of the farmers irrigated at the beginning and the end of the four-day period water was available, i.e. irigations intervals of four or fewer days.

5. Effect on water table over 3 years period:

After the bases of delivery of water to Beni Magdoul was changed to continuous flow, water table levels went down by almost 30 cm during 3 years.

6. Saving land by reduction of cross section area:

One third of the cross section required for the three turn rotation distributory canal is required for the continuous flow.

7. Seepage from canals and ditches:

More data and measurements is needed for seepage losses in representative alluvial water courses.

8. Weed growth in canals:

Observations show no significant changes in weed growth.

9. Crop yield and soil salinity comparison , more yield for corn as one of the main crops in Beni Magdoul area. Low salinity due to lowering the water table levels in the continuous system, though more fluctuation of the water table.

due to the on and off period of the rotational system.

V Recommendations

1. The delivery system of irrigation in Egypt on the distributory canal level should be changed from rotational system to continuous "on demand" system.

2. New canals should be desinged for continuous flow which means:

   a. Smaller corss sections
   b. Better irrigation schedules
   c. Better adapted to requirements
   d. Better adaptation to possible changes to new irrigation system (sprinkler irrigaton, drip irrig., buried pipelines etc

3. More control for discharges and water shares for the canals under the rotational ssytem is needed.

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Staff Paper #19

AN ECONOMIC ANALYSIS OF CABBAGE TRIAL AT EL HAMMAMI FOR ONE FEDDAN

Mohamed Lotfy Nasr
Gamal Fawzy

A trial had been done by Mansouria field team on cabbage production at El Hammami, the following are some of the new practices done under the supervision of the agronomists.

- Malboard plow had been used to overcome the thin layer fertile on land surface.
- Narrow ridges and less distance between plant in order to increase plant population and help in good head constructed.
- Special pest control had been done to overcome the problem of insects.
- An area of 1 feddan had been selected, to carry out the above practices.
- The farmer, whom his land chosen, try himself to follow this new practices on another parcel of his land (to imitate).
- A pratial budget was used to analyze the data collected from the area cultivated under field team control and the area cultivated under the farmer's control (imitated) compared with an equal area cultivated by traditional way.
- The culculs used the same price for each case.

Conclusion:

Net farm income is increasing by changes from traditional to imitate and new practices of cultivating cabbage. The net farm income from case # 1 is about L.E. 208.75 compared with L.E. 121.222 from case # 2 and he added net farm income between the two cases is about L.E. 87.52.

An additional change has started of farmer thinking about following and adapting the new practices offered by EWUP team. It is very important to have the farmer acceptance to follow and adapt by himsdlf the new practices which means that he can do it himself after EWUP team left him. For more details see next page.

PARTIAL BUDGET FOR CABBAGE TRIAL AT EL HAMMAMI ON 1 FEDDAN

First Case — Cabbage controlled by Mansouria Team

A. Added returns	
- Cabbage heads 19,167 x ..E. 0.526	L.E. 498.342
B. Reduced costs	
- Plowing and furrowing (area)	L.E. 9.0
- Planting 32 hrs x L.E. 0.167	L.E. 5.34
- Organic fertilizer 50 donkey load x L.E. 0.16	L.E. 8.00
- Insecticides	
Dimethweat 4 liter x L.E. 3.35	L.E. 13.40
Sprayer rent 16 hrs x L.E. 0.167	L.E. 0.672
Labor to spread 16 hrs x L.E. 0.167	L.E. 2.672
Total	L.E. 39.520
I Total added return and reduced costs (A+B)	L.E. 537.394
C. Reduced return	
- Cabbage heads 10,213 x L.E. 0.026	L.E. 265.538
Total	L.E. 265.538
D. Added costs	
- Plowing by Malboard plow (area)	L.E. 24.0
- Disking time and furrowing	L.E. 6.0
- Organic Fert. 150 donkey load x L.E. 0.16	
Insecticide	
Lannite 205 gm x L.E. 0.189	L.E. 3.76
Bayfolan 1205 gm x L.E. 0.30	L.E. 1.11
Labor to spread 10.5 hrs x L.E. 0.167	L.E. 1.75
Fuel for sprayer 8 liter x L.E. 0.13	L.E. 1.04
Spray rent 10.5 hrs x L.E. 0.05	L.E. 0.53
Total	L.E. 63.11

II	Total reduced return and added costs (C+D)	L.E. 328.648
	Net farm income (I - II) L.E. 537.394 - 328.648	L.E. 208.746

The Second case — Cabbage cultivated by the same farmer (imitated)

A. Added returns

-	Cabbage heads 15.437 x L.E. 0.026	L.E. 401.362
	Total	L.E. 401.362

B. Reduced costs

-	Plowing and furrowing (area)	L.E. 9.0
-	Planting 32 hrs x L.E. 0.167	L.E. 5.34
-	Organic fert. 50 donkey load x L.E. 0.16	L.E. 8.00
-	Insecticides	
	Dimothweat 4 liter x L.E. 3.35	L.E. 13.40
	Sprayer rent 16 hrs x L.E. 0.04	L.E. 0.64
	Labor to spread 16 hrs x L.E. 0.167	L.E. 2.672
	Total	L.E. 39.052

I	Total added returns and reduced costs (A+B)	L.E.440.414

C. Reduced returns

-	Cabbage heads 10,213 x L.E. 0.026	L.E. 265.538
	Total	L.E. 265.538

D. Added costs

-	Plowing 2 times and furrowing	L.E. 13.0
-	Organic fert. 100 donkey load x L.E. 0.16	L.E. 16.0
-	Insecticides	
	Dimothweat 6 liter x L.E. 3.35	L.E. 20.10
	Sprayer rent 22 hrs x L.E. 0.04	L.E. 0.88
	Labor to spread 22 hrs x L.E. 0.167	L.E. 3.674
	Total	L.EA 53.654

II	Total reduced returns and costs (C+D)	L.E. 319.192
	Net farm income (I - II) L.E. 440.414 - 319.192	L.E. 121.222

Net farm between two cases

Net farm income of case 1 - net farm income of case 2
= 208.746 - 121.222 L.E. 87.524

Staff Paper #20

AN ECONOMIC ANALYSIS FOR WHEAT TRAIL AT BENI MAGDOUL

Mohamed Lotfy Nasr

A what trial had been done at Beni Magdoul on meska #3, left hand side of Beni Magdoul canal. The following are some infromation:

- The area cultivated under the supervision of El Mansouria field team is about 4091.3 m^2 i.e. 0.974 feddan, which was managed by three relative farmers.

- The compared field was selected on the same meska, almost the same data of planting and harvesting for an area of about 1750 m i.e. 10 kerats, and managed by the farmer traditional way.

- The conversion was done for both on 1 feddan.

- The practices which were conducted by the team started from plowing (3 times) disking (1 time) by EWUP tractor, basining, hand planter machine and ended with the recommended unit number of nitrogen, which was about 80 units per feddan, and applied zinc sulphate.

- Half of the area cultivated under Mansouria team, was treated by zinc sulphate.

- Samples had been taken at harvesting and used to estimate the yield. Other kind of data had been collected.

- By recording all operations done by the farmers during the growing stage till harvesting and after till winning.

- A partial budget was used to analyse the data collected, considering a fixed price (local price) for both kinds of wheat grain and straw.

CONCLUSION

Net farm income from area cultivated under Mansouria field team supervision is relative to compared area, but it is more high in case # 2 (wheat without zinc suplphate) than in case # 1 (wheat treated by zinc sulphate) by about L.E. 62.705. For more details see next pages.

PARTIAL BUDGET FOR WHEAT AT
BENI MAGDOUL

First case wheat treated by zinc sulphate

A. Added returns

- Wheat grain 20.39 ardab (3058.5 kg) x L.E. 12.0 = L.E. 244.68
  wheat straw 18.32 camel load (4580 kg) x L.E. 15.0 = L.E. 274.80
  Total = L.E. 519.48

B. Reduced costs

- Plowing two times (by area) = L.E. 7.5
- Making basin (by axes) 4 hr x L.E. 0.25 = L.E. 1.0
- Cost of baladi wheat (seed) 6 kela x L.E. 0.75 = L.E. 4.50
- Planting wheat (broadcast) 3 hrs. x L.E. 0.25 = L.E. 0.75
- Chem fertilizer (15.5-0-0) 200 kg x L.E. 7.50
- Organic fertilizer donkey load (0.0) = L.E. 0.00
- Lifting water by sakia 24 hrs x L.E. 0.30 = L.E. 7.20
  Total L.E 28.45

I Total added returns and reduced costs (A+B) = L.E. 547.93

C. Reduced returns

- Wheat grain (baladi) 14.13 ardab (2120 kg) x L.E. 12.0 = L.E. 169.56

- Wheat straw (baladi) 16.52 camel load (4130 kg x L.E. 247.80

Total = L.E. 41/.36

D Added costs

-	Plowing 3 times (area	= L.E. 11.0
-	Disking 1 time	= L.E. 4.0
-	Making basin by machine	= L.E. 0.50
-	Costs of Guiza seed 50 kg x L.E. 0.70	= L.E. 3.50
-	Planting by hand planter 6 hrs x L.E. 0.25	= L.E. 1.50
-	Chem fert.	
	Phosphate (0-40.0) 200 kg x L.E. 2.75/100 kg	= L.E. 5.50
	Nitrogen (33-0-0) 200 kg x L.E. 7.0/100 kg	= L.E. 14.0
	Nitrogen (15.5-0-0) %) KG X L.E. 3.75/100 kg	= L.E. 1.875
-	Organic fertilizer 130 donkey load x L.E. 0.20	= L.E. 26.000
-	Applied zinc sulphate .70 kg x L.E. 0.36	= L.E. 0.25
	- sprayer cost 2 hrs	= L.E. 0.23
	- fuel for sprayer 1.5 liter x L.E. 0.11	= L.E. 0.165
	- labor to carry sprayer 2 hr x .25	= L.E. 0.50
-	Lifting water by sakia 28 hrs x L.E. 0.30	= L.E. 8.40
	Total	= L.E. 77.42
II	Total reduced returns and added costs (C+D)	= L.E. 494.78
	Net farm income (I - II) L.E. 547.93 - 494.78	= L.E. 53.15

SECOND CASE WHEAT WITHOUT ZINC SULPHATE

A. Added returns

- Wheat grain 22.77 ardab (3415.5 kg) x L.E. 12.0		L.E. 273.24
- Wheat straw 20.52 camel load (5130 kg) x L.E. 15.0		L.E. 307.80
	Total	L.E. 581.04

B. Reduced costs

- Plowing two times (by area)		L.E. 7.5
- Making basins (by axes) 4 hrs x L.E. 0.25		L.E. 1.0
- Cost of baladi wheat (seed) 6 kela x L.E. 0.75		L.E. 4.50
- Planting wheat (broadcast) 3 hrs x L.E. 0.25		L.E. 0.75
- Chem fert. (15.5-0-0) 200 kg x L.E. 3.75/100 kg		L.E. 7.50
- Organic ferti. donkey load (0.0)		L.E. 0.00
- Lifting water by sakia 24 hrs x L.E. 0.30		L.E. 7.20
	Total	L.E. 28.45

I Total added returns and reduced costs (A+B) L.E. 609.49

C. Reduced returns

- Wheat grain (baladi) 14.13 ardab (2180 kg) x L.E. 12.0		L.E. 169.56
- Wheat straw (baladi) 16.52 camel load (4130 kg) x L.E. 15.0		L.E. 247.80
	Total	L.E. 417.360

D. <u>Added costs</u>

- Plowing 3 times (area)	L.E. 11.0
- Disking 1 time	L.E. 4.0
- Making basins by machine	L.E. 0.5
- Cost of Guiza seed 50 kg x L.E. 0.70	L.E. 3.50
- Plowing by hand planter 6 hrs x L.E. 0.25	L.E. 1.50
- Chem fert.	
Phosphate (0-40-0) 200 kg x L.E. 2.75/100 kg	L.E. 5.50
Nitrogen (33-0-0) 200 kg x L.E. 7.0/100 kg	L.E. 14.00
Nitrogen (15.5-0-0) 50 kg x L.E, 3.75/100 kg	L.E. 1.8‾
- Organic fert- 130 donkey load x L.E. 0.20	L.E. 26.00
- Lifting water by sakia 28 hrs x L.E. 0.30	L.E. 8.40
Total	L.E 76.275

II Total reduced returns and added costs (C+B) = L.E.493.635

Net farm income (I - II) L.E. 609.49 - 493.635 L.E.115.855

Net farm income between the two cases:
= NF1 of case 2 - NFI of case 1 = L.E.11.5-53.15 = L.E. 62.705