Mid Project Report
Volume III

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Staff Paper #21

WATER LIFTING BY SAKIA: THE INCREMENTAL COST OF COW POWER

August 1980

Buffalo and baladi cows are a strategic part of the survival and self sufficiency of the Egyptian small farmer. Cows provide power for the farmer to extend his farming operations. Cows furnish meat, milk, some transportation and on some occasions home heat for the family. Cows are a source of capital when sold or traded. And to some extent the family cows are an ego support of the farmer.(3) For what the cow gives to farming she requires care and feeding. Care provided by family members and feed that is, for the most part, roughages and crop residuals not immediately useful as human food. To the Egyptian small farmer cows are a major capital resources that is as important as water and land.

The cow makes some input to nearly every crop enterprise by providing power for plowing, planting, and cultivation, pulling the sakia to lift water for irrigation, and providing transportation for the harvested crop. In short the cow is an extension of the farmer providing power to the farming operation as well as products of meat and milk for the family and the market. From the farmers' point of view, cows are of such obvious value that they are more important, and useful than money. Cows can be sold readily for money or "in kind" payment and are therfore similar to a store of capital. As a store of capital, cows are more desirable than bank deposits that lose value with inflation or changes in ruling governments. As a capital resource cows play a strategic role in survival of the subsistence farmer. During the bountiful years they consume residual roughage and grain crops and during more niggardly years they can be sold, traded or slaughtered. Cows are the "shockabsorbers" of the variances of the environment.(1) With the physical and financial characteristics just described the cow is to some extent a symbol to the farmer, as an extension of himself and an independence achieved through self-sufficiency.

INTRODUCTION AND SUMMARY REMARKS

The buffalo and baladi cow provide a number of different products and evaluating the cost of those products requires that some rational way be developed of accuring costs to those separate products from the general costs of feeding and care. In this analysis incremental or "add on" costing was used as a method for estimating the costs of using cow power to lift water with the sakia. Using this method incremental costs are calculated as the added costs that are necessary for the farmer to incurr if he is going to use his cows for the "added" job of powering the sakia. The incremental costs were broken roughly into three categories (1) Cost of reduced milk production, (2) Cost of additional feed and (3) cost of decreased

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1/ Forrest E. Walters, Professor of Agricultural Economics, Colorado State University, Egypt Water Use and Management Project, U.S. Agency for International Development, Consortium For Interantional Development, 22 Galaa St., Bulak, Cairo, Egypt

reproductive abilities.

Estimating energy (cow power) costs on an incremental basis resulted in energy costs per feddan and horsepower hour that are significantly lower than earlier estimates using rental rates as "opportunity" costs and using "average" cost estimates. The lower cost estimates would appear to reinforce the idea that diesel and electric powered pumps can not compete effectively with a sakia that is running efficiently. However, diesel and electric pumps probably have an advantage when canal levels are low and the sakia runs at 50% or 60% of practical capacity. It should also be noted that a farmer, who has or is nearing the point where the sakia is worn out, will more likely consider the purchase of a diesel or electric pump because he will not lose the value of the sakia investment. (9) In short programs, that make mechanical pumps available to farmers may find acceptance by the small farmer in areas of low canal water levels and selected farmers who must replace worn out sakias. More comprehensive programs that replace the sakia would force the issue with small farmers who have no financial (cost) reason for owning fuel powered pumps. Over time fuel powered pumps may become a symbol to the small farmer and if he gains affluence the small farmer may purchase fuel powered pumps as a convenience. In additional farmers may purchase diesel pumps to forego the drudgery of running the sakia and to provide more time for their children to attend school.[13/]

A comparison of the component parts of the incremental costs shows the majority of the cow power costs are associated with the reduction in milk production. Further the cost of reduced milk production is much greater for buffalo cows than it is for baladi cows. The unus difference between buffalo and baladi cows is due to a larger reduction in higher valued buffalo cow milk. Apparently, buffalo cow milk production is affected more by work than baladi cow milk production because buffalo cow milk has roughly double the butterfat content. From a farm management point of view lactating baladi cows are a cheaper source of power than buffalo cows. On the other hand, the difference, between non-lactating (dry) buffalo and baladi cow power costs, does not appear to be significant.

RATIONAL FOR INCREMENTAL COSTING

The idea of incremental or "add on" costs involves only those added costs that are necessary to perform the task. In practice the added or incremental costs can be calculated in a partial budget farmwork where costs are calculated for each of the added items necessary to perform the task and "opportunity costs" of revenues or products given up in order to perform the task. The concept of incremental costing comes from the Marshallian marginal cost concepts which are the costs on the margin -- the costs of producing the last marginal increment of a product.

Incremental costsing is often used when an evaluation is being made of a new or additional task or production -- to see if the revenues from the added task or function will pay for the cost of doing the task or making the product. In this case the major reason for keeping the cow is for meat and milk production and possibly for field power. Since a number of other means for lifting water (both mechanical and hand pumps) exist the task of lifting water is an "added" task given to the cow. As either the buffalo or baladi cow performs the task of pulling the sakia (1) milk production declines, (2) addition feed is required and (3) the calving rate declines.

The decline in milk production and calving rates represents lost production -- a lost opportunity (opportunity cost) to produce.(5) As a result one of the costs of operating the sakia is the cost (opportunity cost) or value of the lost production of milk and calves. The other cost is a direct add on cost of the additional feed required to supply the added energy needed for working the sakia. There is a complication with added feed requirements and the decline in milk production and calving rates. Milk production and calving rates for both buffalo and baladi cows on small farms in Egypt are abnormally low as a result of the off season feed deficit and expending energy in working the sakia further aggravates the problem.(1)(4) Consequently, most of the cost calculations are based on measuring the extent and the proportion that working the sakias adds to or aggravates the problem associated with the feed deficit.(7)(12).

In a broader perspective, the aggravation of the feed deficit problem represents a social cost to Egypt of reduced meat and milk supplies to the food system. Alternatively it should be noted that both diesel fuel and electricity are subsidized by the Egyptian government and extensive use of both energy sources represent a social cost to Egypt. No attempt was made in this report to measure the broader social costs and no conclusions are made as to their importance.

Other means of calculating cow power costs for the sakia include estimating the average costs for all the tasks performed by the cow and estimating the rental value of cows.(5) If average costs are used some costs are included that are also incurred for meat and milk production. If the rental rate is used it can be overestimated because farm producers may consider renting as yet another task for their cows that will cause an undue burden and unusal loses of milk and meat production.

COST COMPARISONS USING THE EWUP FARMWORK(10)

The buffalo and baladi cow power costs as calculated using incremental costing are used in the EWUP farmwork for the purpose of comparing irrigation costs per feddan and per horsepower hour.(1) As shown in table 1 and 2 the cost of water liting with baladi cows is from 33%-50% of that for diesel pumps. Even the higher cost buffalo drawn sakia runs less than 60% of that for diesel.

Table 1: Water Lifting Cost Comparison, EWUP (10) With Adjustments For Incrementalized Energy Costs on the 3-Meter Sakia.

Number of feddans	3-meter sakia using Baladi cows	3-meter sakia using buffalo cows	9 horsepower diesel pumps	7.5 horsepower electric pumps
		(L.E./feddan)		
1	49.29	56.47	96.99	199.93
2	28.41	35.62	61.36	112.74
3	21.45	28.67	49.49	83.68
4	17.98	25.19	43.55	67.15
5	15.88	23.10	39.90	60.43
6	14.50	21.72	37.61	54.62
7	13-50	20.77	35.92	50.46
8	12.76	19.98	34.64	47.35
9	12.18	19.40	33.65	44.93
10	11.70	18.87	32.86	42.78
15	10.32	17.54	30.49	37.18
20	9.60	16.78	29.28	34.27
30	---	---	28.11	31.37

Table 2: Water Lifting Cost Comparison, EWUP(10) With Adjustments for Incrementalized Energy Costs on the 3-meter Sakia

Number of feddans	3-meter Sakia using baladi cows	3-meter sakia using buffalo cows	9 horsepower diesel pumps	7.5 horsepower electric pumps
		(L.E./horsepower hour)		
1	1.96	2.24	3.85	7.94
2	1.13	1.41	2.44	4.48
3	.85	1.14	1.96	3.32
4	.71	1.00	1.73	2.75
5	.63	.92	1.59	2.40
6	.58	.86	1.49	2.17
7	.54	.83	1.43	2.00
8	.51	.79	1.38	1.88
9	.48	.77	1.34	1.78
10	.47	.75	1.30	1.71
15	.41	.70	1.21	1.48
20	.38	.67	1.16	1.36
30	---	---	1.12	1.25

The efficiency (water pumped per hour of work or horse power hour) of the sakia would have to decline importantly (40%-60%) before fuel powered pumps are comparable on a cost basis. Efficiency does drop to such lower levels in areas where the water level in the canal drops, reducing the amount of water available to the sakia. In those areas fuel power pumps may be a cost effective improvement. Also, fuel power pumps may become a status symbol in some areas and farmers may buy them to demonstrate their new found affluence -- a form of conspicuous consumption. Also, if the use of tractors or threshers becomes more widespread, pumps may be operated from the "power take off" mechanism(9). In this case tractor operated pumps may be cheaper on an incrementalized cost basis and a better replacement for the sakia. Again from a broader perspective as pumps become more common place the sakia manufacturing industry will decline. The infra-structure that distributes and sells sakias and sakia repairs (parts) might be used to distribute and sell other types of pumps and pump repairs.

ELEMENTS OF THE TOTAL ANNUAL COSTS OF SAKIA OPERATION

A further breakdown of the annual costs for the sakia as shown in the EWUP study with adjustments for incrementalized costing of baladi and buffalo cow power (energy) is shown in tables 3 and 4.

As shown in tables 3 and 4 incrementalized cow power or energy costs are an important part of the total annual costs of the sakia and become more important as the sakia is operated at higher levels. For example for baladi cows when the sakia is used for only one feddan energy costs are about 10% of the total annual cost and when the sakia is used for 20 feddans energy costs are 27% of total annual costs. For buffalo the percentages are even higher at one feddan energy costs make up 21% of total annual costs and at 20 feddans energy costs are almost 60% of total annual costs. In short total annual costs are a linear function of feddans irrigated and as feddans irrigated increase energy costs increase more than proportional to total annual costs. In other words the cost comparisons would be quite different on large tracts.

ELEMENTS OF THE INCREMENTAL COSTS OF COW POWER OR ENERGY

As shown by tables 5 and 6, the incremental costs of cow power or energy are based on the added cost of feed and the costs of reduced milk production and reproductive ability. Lower milk production costs are by far the most important added costs.

Table 3: Water Lifting Costs for 3-Meter Sakia, Data from EWUP (10), Energy Cost based on Incremental Costing Using Baladi Cows

Number of feddans	Annual fixed cost	Depreciation	Repairs	Energy cost	Grease	Operation cost	Total annual cost 1/	Annual cost	
								per feddan	per horsepower
	....	....	....	......(L.E./year)	....	....	....	....	....
1	39.50	1.813	.435	4.77	.054	2.720	49.292	49.292	1.957
2	39.50	3.627	.870	7.28	.102	5.440	56.819	28.410	1.128
3	39.50	5.440	1.306	9.79	.163	8.160	64.359	21.453	.852
4	39.50	7.253	1.741	12.31	.218	10.880	71.902	17.976	.714
5	39.50	9.067	2.156	14.82	.272	13.600	79.415	15.883	.631
6	39.50	10.880	2.611	17.33	.326	16.320	86.967	14.495	.576
7	39.50	12.693	3.046	19.84	.381	19.040	94.500	13.500	.536
8	39.50	14.507	3.482	22.37	.435	21.760	102.054	12.757	.507
9	39.50	16.320	3.917	24.87	.490	24.480	109.577	12.175	.483
10	39.50	18.133	4.352	27.22	.544	27.200	116.949	11.695	.465
15	39.50	27.200	6.528	39.93	.816	40.800	154.774	10.318	.410
20	39.50	36.267	8.704	52.13	1.088	54.400	192.089	9.600	.381

1/ Total annual costs can also be estimated as T_C = 41.7 + 7.52 (number of feddans)

2/ Annual cost per feddan has the following functioned form:

$$T_C/Fd = 7.52 + \frac{41.7}{\text{No. of feddans}}$$

3/ Annual cost per Horsepower Hour has the following functional form:

$$T_C/Hpr = 2.99 + \frac{1.656}{\text{No. of feddans}}$$

Table 4: Water Lifting Costs for 3-Meter Sakia, Data from EWUP (10), Energy Costs Based on Incremental Costing Using Buffalo Cows

Number of feddans	Annual fixed cost	Depreciation	Repairs	Energy cost	Grease	Operation cost	Total annual cost[1/]	Annual cost per feddan	Annual cost per horsepower
....................................(L.E. Per Annum)									
1	39.50	1.813	.435	11.95	.054	2.720	56.472	56.472	2.242
2	39.50	3.627	.870	21.70	.102	5.440	71.239	35.120	1.414
3	39.50	5.440	1.306	31.44	.163	8.160	86.009	28.670	1.138
4	39.50	7.253	1.741	41.18	.218	10.880	100.772	25.193	1.000
5	39.50	9.067	2.156	50.92	.272	13.600	115.515	23.103	.917
6	39.50	10.880	2.611	60.66	.326	16.320	130.297	21.716	.862
7	39.50	12.693	3.046	70.40	.381	19.400	145.420	20.774	.825
8	39.50	14.507	3.482	80.14	.435	21.760	159.824	19.978	.793
9	39.50	16.320	3.917	89.87	.490	24.480	174.577	19.397	.770
10	39.50	18.133	4.352	98.97	.544	27.200	188.699	18.870	.750
15	39.50	27.200	6.528	148.31	.816	40.800	263.154	17.544	.700
20	39.50	36.267	8.704	195.58	1.088	54.400	335.539	16.777	.666

1/ Total annual cost can also be estimated as $T_C = 41.8 + 14.7$ (number of feddans)

2/ Annual cost per feddan has the following functional form:

$$T_C/Fd = 14.7 + \frac{41.8}{\text{No. of feddans}}$$

3/ Annual cost per Horsepower Hour has the following functional form:

$$T_C/Hpr = .584 + \frac{1.660}{\text{No. of feddans}}$$

Table 5: Animal Power Costs for Lifting Water by Sakia Using Three Baladi Cows (Elements of the Incremental or Add on Costs)

Number of feddans	Hours worked per cow	Total hours worked by all cows	Baladi Cow Costs (Energy) For Water Lifting by Sakia: Reduction in milk prod.1/	Increased feed costs 2/	Decreased reproductive ability 3/	Total
	------(hours)	------	------	------(L.E./year)	------	------
1	18.1	54.4	2.12	.39	2.26	4.77
2	36.3	108.8	4.24	.78	2.26	7.28
3	54.4	163.2	6.36	1.17	2.26	9.79
4	72.5	217.6	8.49	1.56	2.26	12.31
5	90.7	272.0	10.61	1.95	2.26	14.82
6	108.6	326.4	12.73	2.34	2.26	17.33
7	126.9	380.8	14.85	2.73	2.26	19.84
8	145.1	435.2	16.99	3.12	2.26	22.37
9	163.2	489.6	19.09	3.52	2.26	24.87
10	180.1	540.4	21.08	3.88	2.26	27.22
15	272.0	816.0	31.82	5.85	2.26	39.93
20	360.0	1080.0	42.12	7.75	2.26	52.13

1/ Based on: M_c $(.13\ H_{AC})$ PM_c, where M_c = Value of Reduction in Milk Production, H_{AC} = Hours worked by all cows, and PM_c = Price per kilogram of cow milk or .30 L.E. in this case.

2/ Based on: $F_c = \left[\frac{(2.08\ Hp)\ Hc}{19698.5} \times A_c\right] N_c$, where Hp = horsepower expended by the cow per hour --.51 was used in the case, H_c = Hours worked per cow, AC = Total annual feed costs for the cow -- 133.30 L.E. was used in the case, and N_c = number of cows working -- 3 in this case.

3/ Based on: $R_c = \left[\frac{(208\ Hp)(H_c/Dw(Pnc)}{64.6(.49)}\right] V_c\ N$, when R_c = proportional cost of the cost of reproductive ability by working cows, Hp = horsepower expended by the cow – .51 was used in the case, H_c = hours worked per cow, Dw = days worked per cow, H_c/Dw was held at 3 in this case, P_{nc} = proportion of cows not calvery -- .3 in this case, V_c = value of a calf -- 25 L.E. in this case, and N = number of cows used.

Table 6: Animal Power Costs for Lifting Water by Sakia Using Three Buffalo Cows (Elements of the Incremental or Add on Costs)

Number of feddans	Hours worked per cow	Total hours worked by all cows	Buffalo Cow Costs (Energy) For Water Lifting by Sakia: Reduction in milk prod.1/	Increased feed costs 2/	Decreased reproductive ability 3/	Total
	------(hours)	------	------(L.E./year)	------	------	------
1	18.1	54.4	9.52	.21	2.22	11.95
2	36.3	108.8	19.04	.44	2.22	21.70
3	54.4	163.2	28.56	.66	2.22	31.44
4	72.5	217.6	38.08	.88	2.22	41.18
5	90.7	272.0	47.60	1.10	2.22	50.92
6	108.6	326.4	57.12	1.32	2.22	60.66
7	126.9	380.8	66.64	1.54	2.22	70.40
8	145.1	435.2	76.16	1.76	2.22	80.14
9	163.2	489.6	85.68	1.97	2.22	89.87
10	180.1	540.4	94.57	2.18	2.22	98.97
15	272.0	816.0	142.8	3.29	2.22	148.31
20	360.0	1080.0	189.0	4.36	2.22	195.58

1/ Based on: $M_b\ (.5\ H_{AB})\ P_{Mb}$, where M_b = Value of Reduction in Milk Production, H_{AB} = Hours worked by all (3) buffalo cows, and P_{Mb} = Price per kilogram of buffalo milk or .35 L.E. in this case.

2/ Based on: $F_b = \left[\frac{(2.08\ Hp)H_b}{30719.5} \times A_b\right] N_b$, where F_b = Increase feed costs due to energy expended while working, Hp = horsepower expended by the buffalo cow per hour, H_b = hours worked per cow, A_b = total annual feed costs for the cow -- 116.86 L.E. was used in this case, and N_b = number of buffalo cows working -- 3 in this case.

3/ Based on: $R_b = \left[\frac{(2.08\ Hp)(H_b/Dw)(P_{nb})}{(105.5).49}\right] V_b\ N$, when R_b = proportional cost of the loss of reproductive ability by buffalo cows, Hp = horsepower expended by the buffalo cow --.51 was used in this case, H_b = hours worked per cow, Dw = days worked per cow, H_b/Dw was held at three in this case, P_{nb} = proportion of buffalo cows not calvery --.3 was used in this case, V_b = value of a buffalo calf -- 40 L.E. in this case, and N = number of cows used -- 3 in this case.

As shown by the tables reduced milk production, when 10 feddans are irrigated, makes up 77% of the baladi cow power or energy costs and 96% of the buffalo cow power or energy costs. Only at the lower levels of irrigation of one or two feddans does reduced reproductive abilities (reduced calving rates) make a very large proportional contribution to power or energy costs. Reduction in reproductive abilities remains almost constant because once the estus cycle is interrupted it is not very likely that the cow will calve that year. Also, if pumping contributes further to under nutrition, the estrus cycle will likely be interrupted.

For both reduced milk production and reduced reproductive ability costs were calculated on a proportional basis to the contribution that energy expended in working the sakia contributed to the nutritional deficit. In other words, the milk and reproduction reduction was considered to be caused by under nutrition (2)(4)(11) and the porportion that added work contributed to under nutrition was considered as the proportion of all costs of under nutrition to be contributed to working the sakia. Feed costs were calculated simply as the amount or cost of feed necessary to meet the added energy requriements from working the sakia. In some sense there is some double counting of costs because if the added feed requirements were met, under nutrition would not occur and milk and reproduction would not be greatly reduced.

Relationships were developed for each of the incremental costs of reduced milk production, added feed costs and decreased reproductive ability. Each of the relationships are shown at the bottom of tables 5 and 6. The basis for each relationship is shown in spearate tables in the appendix.

SOME ENDING OBSERVATIONS AND OPINIONS

To an important extent the buffalo and baladi cow appears to be a major element in the small farm economy. So important that the small farm economy would collapse without the cow. Therefore, the activity of powering sakias is only an "add on" activity -- one of many activities that the cow performs. Further cost of the sakia powering activity is very low on small farms and fuel powered pumps must be justified on some other basis than cost. For example if the small farmer becomes more affluent he may buy a fuel powered pump simply for the sake of convience.

The overwhelming cause for low milk production and low calving rates appears to be under nutrition during the "off-bersheem" season (7)(8)(12). Very little of the low milk production or calving rates appear, in my opinion to be associated with working the sakia or even in the fields.

Programs to force fueled pumping versus sakia pumping, would in my opinion, alienate the small farm producer and probably destroy the sakia manufacturing industry. Further, very little labor would be saved by replacing the sakia with fueled pumps and no improvement would be made in the farm labor shortage. Fueled pumps replace animals not people[1/] A

1/ A salient point made by Dr. Sonia Mahamed Ali, Zagazig University.

far better part of valor would be to make fueled pumps available for small farmers to purchase as they see their convience. It is less alienating and more feasible to adapt fueled pumps to farmers than to adapt farmers to fueled pumps

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Appendix

The following tables show the basic relationships used to derive the incremental energy (cow power) costs associated with water lifting using the sakia. Most of the relationships are based on survey data or well known physical relationships. However in some cases the relationships are at best crude estimates. The reasoning followed that crude estimates at least indicate a magnitude which maybe somewhat informative.

Table A-1

Apparent Milk Reduction Associated with Water Pumping By Buffalo and Baladi Cows 1/

	Baladi Cows	Buffalo
Milk Reduction per year	40 kilograms	130 kilograms
Value of Milk Reduction at .12/kg for cows milk and .15/kg for buffalo milk	4.8 L.E.	15.6 L.E.
at .20/kg for cows milk .25/kg for buffalo milk	8.0 L.E.	32.5 L.E.
at .30/kg for cows milk .35/kg for buffalo milk	12.0 L.E.	45.5 L.E.

1/ Winrock International, Improved Utilization of Feed Resources for the Livestock Sector, 1980, p. 76.

Table A-2

Increased Energy Requirements of Bufflo and Baladi Cows When Used for Water Lifting

Energy Requency Item	Baladi Cows 400 kilograms, 3.6 kilograms of milk at 4.590			Buffalo 550 kilograms, 4.8 kilograms of milk, at 8%		
	(ME/day)	(days)	(ME/days)	(ME/days)	(days)	(ME/days)
Maintenance	44.7	365	16315.5	58.3	365	21279.5
Lactation	19.9	170	3383.0	47.2	200	9440.0
	64.6		19698.5	105.5		30719.5
Work:2/						
Pumping at 160 m^3/hr.	8.32	62	515.8	8.32	52	432.6
% increase over energy required without work	12.8%		2.6%	7.8%		1.4%
125 m^3/hr (.6 horsepower for 5 hrs.	6.24	62	286.9	6.24	52	324.5
% increase over energy required without work	9.7%		2.0%	5.9%		1.1%
57 m^3/hr	4.16	62	257.9	4.16	52	216.3
% increase over energy required without work	6.4%		1.3%	3.4%		.7%

1/ Energy required for maintenance, lactation and work are estimated based on the following relationships

Maintenance: ME/day = .091 W + 8.3
Lactation: ME/day = (1.23 B)M
Work: ME/day (2.08 Hp) hrs.
where ME/day = Mega colories per day
W = Weight (kilogram) of the animal
B = Butterfat content of milk
M = Milk (kilograms) produced/day
Hp = Horsepower required
Hr= No. of hours worked/day.

The relationship for maintenance and lactation is reported in A.M. Morgar Rees, T.E. Williams, A.J. Smith and B.S. Capper, A Report of an ODM Mission 20 Egypt 20 Undertake a Pre-Feasibility Study of Forage Production and Animal Feeds,Tropical Products Institute, Ministry of Overseas Development, London 1977, p. 142.

The relationship for work is reported in Winrock International, Improved Utilization of Feed Resources for the Livestock Sector, p. 10-14.

2/ A more detailed calculation of power required to run sakias can be made based on measurements of tractive force of the animal, mean rotation of the animal and diameter of the animal track. The relationship for the calculation of horsepower is shown in Engineering Research Bulletin, 1978, Vol. 1 part 1, "Field and laboratory Investigations for Various Types of Electrification Methods of Nile Irrigation in Menoufia Governorate by Dr. Abdel-Hady A. Nasser, p. 76.

Table A-3. Apparent Reduction In Reproductive abilities Associated With Water Pumping by Baffalo and Baladi Cows

As livestock are required to expend energy in working the estrus cycle is sometimes interrupted resulting in a reduced calf crop. In this case the reduction in the percent of cows calving is estimated at 3.6% for buffalos and 5.9% for Baladi cows. The resulting costs associated with the sakia operation are as follows:

	Baladi Calf	Buffalo Calf
Weight[1/]	25	40
Price	1.00 L.E.	1.00 L.E.
Value	25 L.E.	40 L.E.
Calf Crop Production	.059	.036
Cost to Sakia	1.48 L.E./year	1.44 L.E./year

Work does not directly interrupt the estrus cycle, but rather a combination of work and under feeding causes stress to the animals body.

1. Winrock Interantional livestock Research and Training Center, Potential for On-Farm Feed Production and Utilization by the Egyptian Small Farm Sector, June 1980, P54.

Energy is used to maintain the body rather than ovary production. Under Egyptian conditions working animals are often underfed during the May-December period. Berseem or other forages are not available in sufficient quantities to suffice the energy and nutritive needs of animals. A rough approximation of the contribution of energy expendited through water lifting to decreased calving rates, can be calculated as follows.

	Cow	Buffalo
Additional Energy Required by lactating Cows When Water Lifting[1/]	9.7%	5.9%
	%	%
May-Dec. Feed Deficit[2/][3/]	49.0%	49.0%
Contribution of Water Lifting to Feed Deficity	19.8%	12.0%
	x	x
Proportion of Cows Affected (not calving)[4/]	30%	30%
Approximation of calving rate reduction that could possibly be contributed to water lifting	5.9%	3.6%

1/ Shown in Table A-2

2/ A.M. Moryan Rees; T.E. Williams, A.J. Smith and BS Copper, A Report of an DDM Mission To Egypt To Undertake a pre-feasibility Study of Forage Production and Animals Feeds, Tropical Products Institute, Ministry of Overseas Development, London, 1977, P65, Sakia report suggests that seasonal (June-November) energy deficits for livestock are as great as 61%.

3/ Winrock International Livestock Research and Training Center, Potential For On-Farm Feed Production and Utilization by the Egyptian Small Farm Sector, June 1980, P.G. This report suggest that seasonal (May-December) energy deficit for livestock in Zawiet Shazal and Ezeb Kabeel are 49% or less. Deneba grass and maize stripping were not used as part of the feed calculations.

Staff Paper #22

SURVEY OF PESTS INFESTING MANSOURIA VEGETABLES AND CROPS (BENI MAGDOUL & EL HAMMAMI AREAS) & THEIR CONTROL

Dr. Elwy Atalla

INTRODUCTION

In Egypt, it is estimated that the annual loss caused by pests to major crops, amounts to more than 60 million pounds.

Therefore, it is vital to put great consideration to pests in any integrated research because of the significance of pests on the yield of any crop.

Survey of pests infesting Mansouria vegetables and crops at Beni Magdoul and El Hammami areas was the first step to achieve this goal. The study included their main hosts, symptoms of infestation, life history, damage and control.

Object and Significance of the Study:

This work was found necessary for Mansouria farmers (Beni Magdoul and El Hammami areas) for the following reasons:

1. To give them a complete picture about pests infesting their crops.
2. To give them an idea about the main hosts infested, symptoms of infestation, life history of pests, damage and control.
3. This survey will help in preparing for the school of pest control which will start as soon as possible for the farmers at Mansouria's Project building, due to their lack of knowledge in pests problems.
4. To explore some cultural practices which may be useful in reducing damage due to the major pests. Water Management Is Vital.

Material and Methods:

Weekly trips to Mansouria (Beni Magdoul and El Hammamy areas) were arranged for a whole year. It started at July 1979 and ended at July 1980.

Random samples were collected from all vegetables and crops available at both areas. Samples were put in polethene bags and examined in my lab. at the Pest Control Dept. at Dokki under a binocular microscope. Results are tabulated in the following tables:

SURVEY OF PESTS INFESTING MANSOURIA

VEGETABLES & CROPS (BENI MAGDOUL & EL HAMMAMI AREAS)

THE MAIN VEGETALES' PESTS, THEIR MAJOR HOSTS, SYMPTOMS OF INFESTATION, LIFE HISTORY, DAMAGE AND CONTROL

Prepared by Dr. Elwy Attala

Main Pests	Major Hosts	Symptoms of Infestation, Life History & damage	Control
GRYLLOTAIPA GRYLLOTALPA (L). Fam.: Gryllo-talpidae Ord = (Mole Cric-kets).	F. Solanaceae: (tomato, Potato). F. Leguminoseae: (garden Pea). Tomato = " Lycopersicum esculentum" Pototo = "Solanum tuberosum" Garden Pea = "Pisum sativum"	Eats the roots and stems under the soil Wilting of plants. Removal of soil shows its passages. Migrates vertically due to the dryness of the surface layer of the soil Infest tubers also and destroys them by drilling holes in them. Rot of tubers due to the entrance of bacteria, fungie and other insects. Great damage to the crop yield. Population density increases in manured lands. Peak from March to October. Summer cultivation is more susceptible to infestation than the winter one. It has one generation per year.	poisoned bait of zinc-phosphide at the rate of 5% (0.75 kg.) + 15 kgs of crushed maize or rice wetted with water. Instead of zinc-phosphide, we can also use: BHC 20% or Andrin 19.5% or cotton-Dust, at the rate of 0.75 kg., 1.5 litres, 8-10 kgs; per feddan, respectively.
AGROTIS YPSILON (rott) = (The black cutworm). Fam.: Noctuidae Ordl: Lepidoptera EUPREPOCNEMIS PLORANS (charp) = (Grasshoppers) Fam.: Acrididea Ord.: Orthoptera	F. Solanaceae: (Tomato, Potato) F. Solanaceae: (Tomato)	Infest potato plants in the summer cultivation during March. Eats the stems above or beneath the soil. It has five overlapped generations per year. Eats leaves and blossoms. Peak from May to Mid June. It has one generation per year.	Poisoned bait of DDT/Lindane at the rate of 3 litres per feddan + 25 kgs. of fine yeast + 20 litres of water. Instead of DDT/Lindane, we can also use: Andrin 19.5% at the rate of 1.5 litres per feddan or cotton-Dust at the rate of 9 kgs. per feddan.

Main Pests	Major Hosts	Symptoms of Infestation, Life History & damage	Control
PHTHORIMAEA OPERCULELIA (Zeller) = (Potato tuber Moth) Fam.: Gelechiidae Ord.: Lepidoptera	F. Solanaceae: (Tomato, Potato, Eggplant). Eggplant = "Solanum melongena".	Occurs in temperate regions. It has about 21 hosts, mainly from the family solanaceae. Infests plants in field and tubers in store. Moths lay eggs individually or in masses of 3-4 eggs on the lower surfaces of leaves, or on stems and tubers in the field or storage. Eggs hatch after 4-15 days (due to fluctuation of temperature) into young maggots which drill their passage through the leaves. They live between the upper and lower surfaces of the leaf or in the leaf stem from which they travel to the plant stems and branches and eat the young leaves. They also drill their passage into the tubers, either in the field or in the store, leaving their faeces through the passages. They can be clearly seen in masses thrown out of tuber-buds, which indicates the infestation. The larva spends from 10 to 65 days (due to fluctuation of temperature from 35 to 18 C) until it enters the pupal stage. The pupa is found in a white cocoon between the dry leaves or on the sacks in the store. It needs from 6 to 44 days (due to the fluctuation of temperature from 38.5 to 13 until it enters adult stage (the moth). The moth has 10 generations (duration prolongs in winter) during the year and does not hibernate. The shortest period of generation is during June, July and August, while the longest occurs during November and December	Spraying potato plants in the summer cultivation with sevin 85% W.P. at the rate of 0.4% (1.5 kgs per feddan). Spraying should be repeated after 10 days before harvest. This treatment could be used for the control of both of: Phthorimaea operculella (Zeller) and Heliothes Zea (boddie) = H. obsoleta (F.). For the control of Phthorimaea operculella (Zeller) in stored potatoes, the following points should be followed: 1) The stores should be ventilated with their openings covered with fine wire to prevent the entrance of Phthorimai oerculella. (Zeller). (2) Before storage, the store should be cleaned with 1 liter of solar and 50 grms of soap melted in ½ litre of water. This emulsion should be diluted with water at the rate of 1:4. One litre of this dilution is sufficient to spray four square meters of the store. Afterwards, the store should be closed for four days before being used. (3) The tubers should be inspected from time to time, and those which are infested with Phthorimai operculella (Zeller) should be rejected. The sound ones should be

Main Pests	Major Hosts	Symptoms of Infestation, Life History & damage	Control
		Damage: (1) Leaf wilt. (2) Lessens the sratch in tuber whic becomes dry, (3) Entrance of fungi and bacteria which increases the damage. (4) Damage is greater in the summer cultivation more than the winter one. (5) Damage exists in the field (from March to May) as well as in the store (from May to September and October).	Dusted with a mixture of Seven 10% and Orthocid 50% (at the rate of 1:1) for every ton of the tubers. In all cases, DDT.W.P.and cotton dust should not be used in dusting to avoid toxicity. (4) When storing tubers in refrigerators for the Nille cultivatio they should be cleaned with solar and soap as mentioned before; then the sound tubers should b stored at 4 C and 85-90% R.H. In order to avoid potato rot, the tubers should not be mechnically damaged by leaving a spac of 5 cm. on the top of each basket. These tube should not be used for cultivation before a period of at least 15 days after storage.
HELIOTHIS OBSOLETA (F.) = H. ZEA (Boddie) = (the American Bullowrm). = (the tomato Fruit-worm) Fam.: Noctuiuidae. Ord.: Lepidoptera.	F.Solanaceae: (tomato)	Infests blossoms and tomato fruits. Damage was significant this year especially in Fayum Province. Female moth lays individual eggs. Egg small, roundish, can be seen by the naked eye, creamy-whittish when just laid, becomes dark before hatching. Eggs hatch into larvae which feed on different parts of the plant. Larva green or brown and moults 4-5 times before entering pupal stage within 15 days. Pupa in the soil for 12 days until it becomes adult Duration of generation about one month. It has 4-5 generations per year.	
EUSOPHERA OSSEATELLA (Treit.) = (the eggplant stem borer). Fam.: Puralidae. Ord.: Lepicoptera	F. Solanaceae: (potato, egg-plant).	The larvae enters the young branches and stems, and causes their death when severely infested. Symptoms: of Infestation and Damage: Larvae drilling holes in the branches and stems, on the surface of which appear masses of feaces and broken pieces of branches. Hibernation of	Spraying of potatoes (especially in the summer cultivation) at the beginning of March or after 80 days from cultivation (in the early summer cultivation) with Sevin 85% W.P. at the rate of 0.4% (1.5 kgs. per feddan). Spraying should be repeat at 10 days intervals if needed (in the normal

Main Pests	Major Hosts	Symptoms of Infestation, Life History & damage	Control
		Larvae inside the old stems left after harvest. Fruit-rot and gream damage to the yield. <u>Life History</u>: Female mohts lay eggs on the plant. After hatching, the larva enters the stem near the soil surface. It enters the pupal stage inside the infested part of the plant, where the pupa becomes adult (the moth).	summer cultivation). This treatment is a combined control of: <u>Phthorimaea</u> <u>operculella</u> (Zeller). & <u>Eusophera</u> <u>osseatella</u> (Trait) - Valexon 50% at the rate of 0.5% (2 liters per fedday) could be used instead of Sevin.
<u>SPODOPTERA LITTORALIS</u> (Boised.) = (the cotton leaf worm) <u>Fam.</u>: Noctuidae. <u>Ord.</u>: Lepidoptera.	All vegetable crops.	Infests all vegetable crops throughout the year, especially from July to November. It has 7 overlapping generations per year. <u>Damage</u>: (1) To the leaves: Eggs hatch into larvae which eat the epidermis of the leaf starting from the lower surface until it reaches the upper one. The leaves become totally eaten causing the plant's wilt and death. Great damage to the yield. (2) <u>To the blossoms and fruits</u> When severely infested, a great loss in the quality and quantity of the crop yield occurs. Fruits drop in some plants, such as egg-plant, pepper, water-melon and jews mallow.	This treatment is a combined control of : <u>Phthorimaea</u> <u>opercullela</u> (Zeller), & <u>Spodoptera</u> <u>littoralis</u> (Boisd.) - Spraying with one of the following pesticides: (A) Folaton (Valexon) 50% at the rate of 0.5% (2 litres per feddan). (B) Noltran 22.1% at the rate of 0.4% (1.6 litres per feddan). (C) Gardona 70% suspension at the rate of 0.4% (1.6 litres per feddan).
<u>SPODOPTERA EXIGUA</u> (Hb.) = (LAPHXGMA) EXIGUA, (Hb.) <u>Fam.</u>: Noctuida. <u>Ord.</u>: Lepidoptera	F. Solanaceæ (tomato pepper) and other vegetables. Pepper="<u>capsicum</u> frutescens"	Infests different vegetable crops, especially tomato and pepper. It has 7 overlapping generations per year.	This treatment could be used for the control of: <u>Spodoptera</u> <u>littoralis</u> (boisd.), & <u>Spodoptera</u> <u>exigus</u> (Hb.) i.e. (Laphygma exigus) (Hg.) It is not recommended to use Flaton (Valexon) on cabbage, cauliflower and flowering tomatoes unless there is sufficient humidity in the soil to avoid phytotoxicity. - Great care for cultural control especially weed

Main Pests	Major Hosts	Symptoms of Infestation, Life History & damage	Control
			control. - Colecting leaves infested with Spodoptera littoralis (Boisd.) and destroying egg masses before hatching. - To obtain good results, spraying should be conducted as soon as eggs hatch, spraying will be inefficient against late instar larvae - It should be noted, that the solution must cover all parts of the plant, using an average of 400-600 litres of water per feddan. High volume sprayers should be used. -In all cases, the minimum period between spraying and harvest should not be less than 15 days. - Fresh vegetables. consumers are advised to wash them carefully for removing residues of pesticides
APHIS SPECIES. Aphids = (Plant lice). Fam.: Aphididae Ord.:Hemiptera	F. Solanaceae: (tomato, potatoes, eggplant, pepper). F. Cucurbitaceae: (squash, sweet-melon, cucumber, water-melon). F. Leguminoseae: (common bean, cowpea).	Infests different vegetable crops with 2 peaks, one from February to May, and the other from September to November. Sucking piercing insect: it sucks the plant's sap, causing leaf curl. It has about 52 generations per year. Considered as an insect vector responsible for the transmission of virus diseas causing wilting and death of young plants if severely infested. Great damage to plants infested because of the secretions of honey-dew, fungi growth and accumulation of dust.	(1) In the case of infestation with aphids only: Plants should be sprayed with Malathion at the rate of 0.15%. or With water and soap at the rate of 0.45% of soap + nicotin sulphate 40% at the rate of 0.15% The solution should reach the insects on the lower surface of the leaf. Spraying should be stopped 2 weeks before harvest. The control of ahpids depresses the infestation with tobaco mosaic virus.

Main Pests	Major Hosts	Symptoms of Infestation, Life History & damage	Control
BEMISIA TABACI (Gen.) = (white-fly). Fam.: Aleyrodidae Ord.: Hemiptera	F. Crucifereae: (cabbage, cauliflower) Squash ="cucurbita pepo" Sweet-melon = "cucumis melo" Cucumber= "Cucumis sativus"	Infests idfferent vegetable crops. Abundant in tomatoes. Fly, yellowish green. Nymphs on the lower sruface of the leaf. Flies hidden between leaves. It has 10-12 overlapped generations per year. Considered as an insect vector responsible of the transmission of virus diseases causing young plant wilt and death if seriously infested. Honey-dew secretions, fungi growth and dust accumulation cause serious damage to plants infested.	(2) In the case of infestation with aphids, white-fly, Jassids, Thrips, Aulacophora forveicollis and Epilachna chrysomelina: The following treatment is a combined control of: Aphids, white-fly, Jassids; Thrips, Aulacophora foveicollis and epilachna chrusomelina:- Plants should be sprayed at an early stage with dimethoate 40% at the rate of 0.125%. Spraying should be repeated if needed.
JASSIDS (EMPOASCA SP.) = (leaf-Hoppers) Fam.: Jassidae Ord.: Hemiptera	Water-melon = "Citrullus Vulgaris" Common Bean = "phaseolus vulgaris" Cowpea = "Vigna sinensis	Infests different vegetable crops. Considered as an insect vector responsible for the transmission of virus diseases causing wilting and death of young plants severely infested. Great damage to vegetable crops; therefore it should be controlled early in the nursery. It has 3-4 generations per year (Empoasca discipiens Paoli.)	Spraying should be stopped at least 3 weeks before harvest. Plants severly infested with Aulocophora faveicollis (Lucas) should be collected and destroyed.
=THRIPS RABACI (Lind.) Thrips. Fam.: Thripidae Ord.: Thysanopa-	Cabbage "brassica oleraceae" Cauliflower = "brassica oleracea"	Infests leaves causing silver patches which become dark later. Affects different vegetable crops, and plants die when severly infested. Larvae are found in great numbers inside the plant. Infestation from October to April. It has about 15 generations per year.	
AULACOPHORA FOVEICOLLIS (Lucas). = RAHIDOPALPA FOVEICOLLIS (Lucas) Fam:Chrsomelidae Ord.:Coleoptera	F. Cucurbitaceae: (squash, sweet-melon, cucumber, water-melon).	The insect feed upon the leaves and blossoms of plants and destroys them. Plants severely infesed wilt and die. Larvae live inside the stems and roots. Active from March to November, then	

Main Pests	Major Hosts	Symptoms of Infestation, Life History & damage	Control
		hibernates. At the end of hibernation, the adult female lays its eggs on the plant's stem or on the soil surface around it. After eggs' hatching, the larvae penetrate the stem near the roots, drill inside it and eat the stem's and roots' contents. The larva creamy in colour and 1.5 cm in length:	
EPILACHNA CHRYSOMELINA (F) Fam: Coccinellidae Ord: Coleoptera		The insect is dark red with 12 black dots on its sheild. It eats the plant's leaves which ends by the plant's death if severely infested. When the leaves become dry, it migrates to the fuits, penetrates into them and causes their destruction. Afterwards it enters the hibernation period as adult hidden in different places. The adult female lays its elongate eggs on the lower surface of the leaf. After hatching, the small maggots, which are green-yellowish and covered with spines, become pupae after moulting for 4 times. The adult completes its life cycle in one month. It has 5 generations during the year, ending by hibernation.	
DACUS CILLIATUS (Loew) Fam:Trypetidae Ord:Diptera	F.Cucurbitaceae: (squash, sweet-melon, cucumber, water melon)	One of the most important pests infesting melons. The larvae live inside the fruits causing great damage to them. Its first record in Egypt was in 1947 at Aswan. It was introduced to Egypt from Sudan. It was spread from Aswan to Qena Assiut, Minya, BeniSuef, Guiza and canal zones. Symptoms of Infestation: Very tiny holes in the fruit	For the plant protection; spraying with: Diptrex 80% at the rate of 0.5% or Baitox 100% at the rate of 0.2% should be repeated if needed in the areas infested with Dacus cilliatus (Loew). Fruits infested should be collected and destroyed before spraying.

Main Pests	Major Hosts	Symptoms of Infestation, Life History & damage	Control
		infested, covered with gummy yellowish secretion. When severely infested, the fruit becomes small, yellowish and rotten by bacteria and fungi. The larva lives inside the fruit and eats its tissues and seeds. The immature fruits are susceptible to its attacks, as well as the mature ones. <u>Degree of infestation in the Different cultivations:</u> Melons are cultivated in Egypt throughout the whole year. Therefore, their infestation with <u>Dacus ciliatus</u> (Lowe) is serious, but the degree of infestation differs between the different cultivations as follows: (1) <u>The late Nilee cultivation</u> The fruits of the Nilee cultivation (especially in cucumber and squash) appear in October and November. These fruits are highly susceptible to the <u>Dacus ciliatus</u> attack espacially at Guiza, Beni Suef, El Minya and canal zones, whereas at these zones, the summer cultivation is not seriously attacked. (2) <u>The early Winter Cultivation:</u> This is the main period of cultivation at Aswan, Kom-Ombo, and Qena zones and it is seriously attacked. The fruits appear in January and February. At these zones, the summer cultivation is not severely attacked. (3) <u>At Guiza, Beni Suef,</u>	

Main Pests	Major Hosts	Symptoms of Infestation, Life History & damage	Control
		Minya and canal zones: cucumber and squash are seriously infested. (4) At Aswan: Melons (except squah) are generally attacked. Life History: The fly is always found around melon plants during the day. It is dark yellowish, and the female lays its eggs (5-50) underneath the surface layer of the fruits skin. The eggs hatch in 4 days and the young maggots penetrate into the fruit tissues making. Passages, feeding upon the fruit juice and destroying the seeds. They complete their full growth within two weeks, then they leave the fruit through wide openings uncovered with the soil. After three weeks, the pupa develops into adult fly and another generation begins. This fly could be red through the year.	
VASATES LYCOPERSICI (Massee) =(The Bud Mite) =(Eriophyid Mites). Fam: Eriophyidae Ord: Acarina	F.Solanaceae: (tomato)	Infests tomato plants, causing leaf curl. The leaf also loses its colour, becomes smaller than usual and wilts, causing a great loss of the yield. All stages of this mite larvae, nymphs and adults, have two pairs of legs only. This mit is specific.	Spraying of tomato plant with micronized sulphur at the rate of o.25% (1.5 kgs. per feddan).
TETRANYCHUS ARABICUS (Attiah):"The green form" TETRANYCHUS CUCURBITACEARUM (Sayed):"The red from = (The common red spider	F.Solanaceae: (egg-plant, potato pepper). F.Leguminoseae: (common bean cowpea, garden pea) F.Cucurbitaceae:	Mites are very small creatures, the majority of which are difficult to see with the naked eye. For that reason, magnified lenses are necessary tools for people working with them. Mites are more closely related to	Spraying with microniwed Kelthan 35% at the rate of 0.15% (600 grams per feddan) for the control of: T. arabicus (Attiah) T. cucurbitacearum (Sayed

Main Pests	Major Hosts	Symptoms of Infestation, Life History & damage	**Control**
Mite)=T. telarius (complex)	(squash, sweet-melon, cucumber, water-melon) F.Compositae: (Artichoke) Artichoke= "Cynara scolymus"	spiders and scorpions than to insects. They differ from insects in many respects: (1) they have neither wings nor antennae, nor compound eyes; (2) their body is formed of two pieces, a thoracic head and an abdomen, while the body of an insect is divided into three parts, head thorax and abdomen; (3) the majority of mites have four pairs of legs in the adult stage. Yet, mites in general resemble insects in their economic value to man. They like insects, affect his health, his animals and his plants. Development in mites is of the imcomplete metamorphosis type. Females lay separate eggs, they hatch into larvae which resemble their mothers except in possessing three pairs of legs. Larvae transfer to nymphs which carry four pairs of legs, and then to adults which repost their life cycle. Females lay a great number of eggs, around 150 in many species, and the life cycle takes around 10-15 days in many of them under favourable conditions. For these reasons, mites reproduce quickly. In the last few years, spider mites have created great problems in many parts of the world. The extensive use of the new insecticides against many injurious insects has been very harmful to beneficial insects and mites which prey on red-spider mites. Consequently, in the absence of their natural enemies following insecticides'	and Eutetranychus orientalis (Klein). Spraying should be repeated if needed. Kelthane should be added to Sevin used for the control of Phthorimaes Operculells and Euzophors osseatells in order to prevent damage by spider mite infestations.

Main Pests	Major Hosts	Symptoms of Infestation, Life History & damage	Control
		applications, spider mites build up rapidly. The common Red-Spider Mite infests vegetable crops from May to September. It lives on the lower surface of the leaf. All stages from egg to adult, live uder its web. It sucks the plant's sap, causing droppin of leaves and great damage to the yield. The adult is green or red in colour with 2 dark dots on the two sides of the body. The green form:"T. arabicus Attiah" is more resistant to pesticides than the red form:"T.cucurbitacearum Sayed". It has been established by mating experiments, that they are two different species. The citrus Brown Mite "Eutetranychus orientalis" (Klein); on the contrary of the common Red-spider Mite, prefers the upper surface of the leaf, and all stages can be seen on this surface. It has 18-19 generations, whereas the Common Red Spider Mite has about 27 generations per year.	
MELANAGROMYZA PHASEOLI. (Tryon). = (The Bean-Fly) Fam:Agromyzidae Ord: Diptera.	F.Leguminoseae: (common bean, cowpea)	A serious pest of the common bean and the cowpea from seed germination till yield collection. Symptoms of Infestation: Plant-wilt and death and great damage to the yield. Aggregations f larvae and pupae under the epidermis of stem causing tumours between stem and root and also under leaf base. Great damage to young plants due to their soft tissues, and infestation contains even after the developing of green pods. The older plants are not susceptible to the fly's attack and have the ability of	Spraying of plants at an early stage for protection. (In the Nilee Cultivation only) with Sevin 85% W.P.at the rate of 0.4% (1.5 kgs. per feddan) once every fortnight until the plant becomes two months old. Spraying should be stopped before blossoming.

Main Pests	Major Hosts	Symptoms of Infestation, Life History & damage	control
		revewing th infested branches continuing their growth. <u>Degree of Infestation in the Different Cultivations:</u> (1) <u>The Nilee Cultivation:</u> Highly infested, especially in late cultivation. Cultivated for dry beans from mid-August in Lower Egypt and a week or two later in Upper Egypt. (2) <u>The Winter Cultivation</u>: Infestation less than the Nilee one, cultivated for green pods from mid-November. (3) <u>The Summer Cultivation</u> Little infestation in the early cultivation and becomes higher in the late one. Cultivated for green pods from mid-February or later in April and early May. <u>Life History:</u> The fly is bright black, 2.5 mm in length, found in great numbers in the early morning and sunset on the upper surfaces of leaves. It disappears from the bright sunshine during the day. It lays its eggs under the lower epidermis of the young leaf, and they hatch in its tissues giving small maggots. Those penetrate between the two epidermis making silvery passages during their penetration through the leaves to the branches and stem until they reach the part between stem and root near the soil surface. The duration of the larval stage is about one week. The larva pupates under the epidermis of the plant's stem causing tumours in it. The silvery passages of larvae under the epidermis of stem and the tumours of pupae around the plant's stem are important	

Main Pests	Major Hosts	Symptoms of Infestation, Life History & damage	Control
		symptoms of infestation. The pupa penetrates into the soil around the stem and also under leaves' bases which become dark, swollen and easily broken. The pupae are also found in dry leaves. The pupa becomes adult (fly) in a period which differs from season to season The duration of generation is about 3 weeks in average and is prolonged in winter. It has about 10-12 overlapped generations per year. Damage: (1) Damage to plant tissues due to penetration of larvae. (2) Plants wilt when seriously infested. (3) Plant severly infested can have about 50 maggots and pupae in its stem. Some plants which are apparently sound, could have few maggots in their stems. (4) Young plants are more susceptible to the fly's attack than the older ones. (5) Great damage to the yield due to the interruption of green pod formation. (6) Plants seriously infested, are easily broken and without or with very few green pods.	
ETIELLA ZINKENELLA (Treitschke) Fam: Pyralidae Ord: Lepidoptera	F.Leguminoseae: (cowpea, lima bean).	Infestation of cowpea's and Lima bean's green pods by larvae which feed upon seeds before they become dry. The larva penetrates into green pods and spends about 3 weeks before entering the pupal stage. It leaves the pod and pupates in the soil at 2-5 cms depth and at a distance of 20-30 cms from plant's stem. After 3 weeks, the moth gets out of the pupa. After mating, the female moth lays its eggs	Spraying with Sevin 85% at the rate of 0.4% (1.5 kgs. per feddan). Spraying should be done at the first sign of infestation.

Main Pests	Major Hosts	Symptoms of Infestation, Life History & damage	Control
		on the plant's blossoms. The young maggots feed upon the causing droppings to plenty of them. Nilee cultivation is seriously infested more than the summer one. This pest is always found from March to September and infests different hosts. It has 6-7 generations per year. The hibernation period is spent as pupa. This pest is spread allover the world.	
DELLA ALLIARIA (Sp.n.) Fam: Muscidae Ord: Diptera =(The Onion Maggot) =Hylemia antique	F.Amaryllidaceae (Garlic) F. Liliaceae (onion) Garilc ="Allium sativum" Onion="Allium Cepa"	The adult female lays its eggs near the plant's base. The eggs hatch into young maggots which crawl beneath the leaves, then penetrate into the bulbs. The maggots feed upon the leaves' contents causing wilt from top to bottom. They make passages near the leaves' bases, destroy them, and in the severe infestation cause the plant's death. They pupate in the soil around the plant. The fly resembles the house fly in shape and colour. The duration of generations is about 40 days. The peak of infestation is from Nobember to March.	Spraying with Folaton (Valexon) 50% or DDT/Lindane at the rate of 0.5% at late January for the control of Delia alliaria, and at mid-February for the control of Thrips. Another spray
HELLULA UNDALLIA (Fabr) Fam: Pyraustidae Ord: Lepidoptera	F.cruciferae: (cabbage, Cauliflower)	One of the most serious pests of cabbage and cauliflower, especially in the nursery. It causes great damage to these plants allover the country. The larvae penetrate into the plant's stem and feed upon its contents. They make passages inside the stem and roots. The severe infestation causes the plant's rot and death. The duration of generation is about one month	(1) Spraying of plants twice in the nursery at 1 week interval, with Gardona 50% W.P. at the rate of 0.4% (1.5 kgs per feddan). (2) the selection of sound plants before transfer to the field. (3) This treatment is a combined control of: Hellula undalis (Fabr.), Pieris rapae (L.),

Main Pests	Major Hosts	Symptoms of Infestation, Life History & damage	Control
			Autographa sp., Spodoptera littoralis (Boisd). (4) Spraying should be stopped at least one week before harvest.
PEIRIS RAPAE (L.) Fam: Peiridae Ord: Lepidoptera		Larvae feed upon the leaves of cabbage, cauliflower, lettuce, radish and turnip, causing holes with different shapes in them. The white butterfly is always found around these vegetables from the beginning of October till the early summer. The larva (25 cm) has a soft green skin wity a yellow long-tudinal line on its dorsal side. On both sides of the body there are another two yellowish lines. There are small black dots covering other parts of the body. The insect has about 9 generations per year. It is more active in the winter than in summer.	
AUTOGRAPHA SPECIES =(phytometra species) =(the semi-looper worms). Fam:Noctuidae. Ord:Lepidoptera.		Larvae infest leaves of cabbage, cauliflower; lettuce, potato, garden peas, beans, garden beet, and berseem. The larva is green, 3 cms in length with 3 pairs of ventral legs near to the body end. During walking, the dorsal and ventral legs become close to each other causing the bending of abdomen and afterwards it stretches. The adult female lays its eggs on the plant's leaves which hatch into larvae. The larvae feed upon the leaves causing different holes in them	

Main Pests	Major Hosts	Symptoms of Infestation, Life History & damage	Control
VANESSA CARDUI (L.) Fam: Nymphalidae Ord: Lepidoptera	F. Mavaceae: (Egyptian mallow) F. Compositae: (artichoke) Egyptian mallow ="*Malva parviflora*".	The adult female lays its eggs individually on the plant's leaves which hatch into larvae. The larvae feed upon the leaves and spin a tiny net of spreads to live under it. They eat the leaves of Egyptian mallow and artichoke causing great damage to the leaves and yield. The fully grown larvae is 4 cms long, brown in colour with two pale yellow strips on both sides and has plenty of spines on its dorsal side. The butterfly is large, brown with different colours on its wings. It is always found in winter and spring around Egyptian mallow plants.	Spraying with valexon 50% at the rate of 0.5% or Noltran 22.1% at the rate of 0.4%. This is a combined control of *Vanessa cardui* (L.) and *Spodeptera Littoralis* (Boisd.)

Staff Paper #23

A PROCEDURE FOR EVALUATING THE COSTS OF LIFTING WATER FOR IRRIGATION IN EGYPT

Hassan Wahby, Gene Quenemoen and Mohamed Helal[1/]

The purpose of this report is to (1) present a procedure for computing water lifting costs for Egyptian farms and (2) identify the most important factors which determine these costs.

These factors may be classified as economic, technical and governmental policy. Economic factors reflect the dynamic world economic situation and are expressed in terms of international prices for such things as energy, machines and food. Technical factors reflect the state of the arts and innovations regarding machines, energy sources, pumps and methods of production. Policy factors refer to such things as government pricing of energy, policies regarding scheduling water among farmers, rotation turns, crop production quotas, and taxes on imported water lifting equipment. Since all these factors tend to change through time and through deliberate action of government it is more important to understand the components of water lifting costs than the absolute values shown in this or any other study.

This report is intended to assist government decision makers evaluate water lifting alternatives. As capital becomes available for implementing new agricultural and irrigation schemes it is important to use it wisely in order to realize

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the maximum benefit for the Egyptian people. Proposals should be evaluated according to their potential rate of return and how well they fit the values and cultural patterns of Egyptian people.

BACKGROUND

As a general rule irrigation distribution systems in Egypt are designed to deliver water 50 to 60 centimeters below the surface level of fields. Farmers lift the water from the delivery canals. There are exceptions. Some farmers are able to take water from delivery canals and apply it directly to their fields by gravity. Studies conducted by the Ministry of Irrigation, however, show that "free flow irrigation has caused an extra-vagance in the use of irrigation water."1/ It is currently government policy to design all delivery systems such that farmers must lift the water onto their fields.

At the same time there is interest in the government sector and among farmers in lifting water with machine driven pumps to replace human and animal power.2/ Because of increasing costs of human labor and animal power, farmers feel economic pressure to consider alternative methods of lifting water to their fields. Some farmers are installing animal driven water wheels to replace human powered tambours while others are shifting to diesel and electric driven pumps.

1/ The Ministry of Irrigation, The Minister's Office, "National Program in Irrigation and Drainage - General Policies," Cairo September 1978, page 16.

2/ Ibid. p.18.

Human power is used to operate the shadouf (bucket and counter balance weight on a pole) and the tambour (archimedes screw). Only the tambour is currently important in Egypt's commercial agriculture. The shadouf, now virually obsolete, is used only by gardeners and a few very small farmers. Neither of these systems will be considered further in this report. Although the use of tambours may continue for some years their cost is almost entirely a function of labor wages or value determined by the principle of opportunity costs. Only a few small farmers who assign very low opportunity cost to their own labor find it economically advantageous to use tambours.

Animal power is used to operate various types of sakias (water wheels). In rare cases animals are used to power tambours and other miscellaneous types of pumps. The cow is the most important source of animal power for turning sakias but water buffalo, donkeys, and camels are also used.

Electric and diesel motors are most frequently attached to various types of low pressure pumps. In the lower delta some large sakias are powered by stationery diesel motors and sometimes tractors. Also available is a small electric motor with a transfer reduction system to provide power for sakias.

There have been several studies during the past five years to evaluate alternative water lifting systems for Egyptian farms. Various technical relationships and assumptions have been used regarding present and future energy costs, the value of labor, capacity of lifting devices, irrigation frequency, crop requirements and the number of hours per day that farmers can be expected to use any given irrigation system. This study offers a flexible analytical device that decision makers can use now and in the future as more and better data become available. Egyptian planners need such a model to help them make profitable decisions and conversely to help them avoid making commitments to long range capital investment projects which fail to maximize the benefits from scarceresources.

THEORETICAL CONSIDERATIONS

Each system of lifting water has a limited physical capacity to deliver irrigation water to a field. This limit depends on the lift head (vertical distance from the water source to the field distribution system), the capacity of the driver and pump system, the crop needs for water at the peak season of use and the maximum number of hours that farmers will operate the system on any given day.

Each system is subject to fixed and variable costs. Fixed costs are not related to the amount of use the lifting system is given. Once a decision is made to own any specified lifting system there are fixed costs such as taxes, interest on investment, and insurance which accrue each year whether the system is used or not. The variable costs, on the other hand, are directly related to the amount of time the system is operated. For example each unit of output requires some combination of fuel, oil, grease, labor, repairs and wear-out depreciation.1/

1/ Theore tically every machine has a finite life which is a function of the amount of use given the machine. In some situations machines may be expected to become obsolete before their wear-out life is reached. Then depreciation should be treated as a function of time and the depreciation for one year should be considered as annual fixed costs. However in systems such as water lifting characterized by slow rates of technological change, it is probably appropriate to consider depreciation to be a function only of use since technological obsolescence is unlikely.

The relationship between fixed and variable costs per unit is shown in Figure 1. In this report units of work are measured in terms of output horsepower (HP) hours and also, in the Tables 2 through 7, in terms of number of feddans irrigated. Output HP hours is defined in equation 12 on page 14a. From this equation we can deduce that one output horsepower hour measures the work required to lift 270 cubic meters of water 1 meter in 1 hour. If one feddan requires 270 cubic meters of water for one irrigation, lifted one meter, then we know it requires one HP hour of work. With a known irrigation requirement, equation 12 allows easy substitution between "HP hours" and "number of feddans irrigated" as a measure of work.

Variable cost (VC) is the variable unit cost per HP hour and it is constant for each HP hour the water lifting system is used. Total cost (TC) represents the variable unit cost per HP hour plus the fixed unit cost per HP hour. The unit fixed cost, for any given number of HP hours, is the vertical distance between the lines VC and TC in Figure 1. Since the unit fixed cost per HP hour declines as the number of HP hours increases it can be observed in Figure 1 that the total unit cost per hour also declines. From this we can conclude there is no single total unit cost that can be assigned to any water lifting system without specifying the amount of annual use for which the system is to be employed.

AN ANALYTICAL MODEL

An analytical model for computing water lifting cost functions has been developed to assist in evaluating alternative systems.[1/] Twenty-three variables have been identified and integrated into the model. Each variable is subject to change through time as a result of economic, technical or political considerations.

Each variable, included in the DATA INPUT FORM - WATER LIFTING COSTS, shown on page 5a, is discussed below. It is

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1/ This model is an adaptation of previous EWUP work reported in McConnen, R.J., Mohamed Helal, Ahmed Bayoumi, Gamal Ayad, James Loftis, and M.E. Quenemoen "Calculation of Machinery Costs for Egyptian Conditions", Staff Paper #8, Egypt Water Use and Management Project, Cairo, December 1979.

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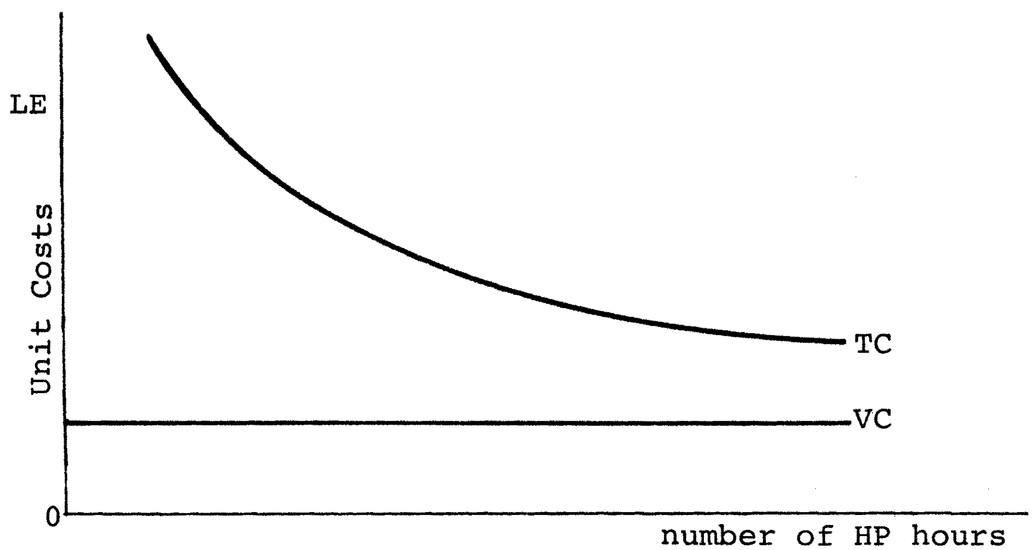

Figure 1: Hypothetical Relationship Between Fixed and Variable Unit Costs.

DATA INPUT FORM - WATER LIFTING COSTS

Data prepared by ______________________ Date ______________

Tape ; Track ; File

A$ (*)	
1. Name of machine ....(19)	1. ________
2. Make ....(19)	2. ________
3. Model ....(9)	3. ________
4. Size ....(9)	4. ________
5. Power source (DIES. ELEC. ANIM.)	5. ________
6. Date (day, month, year) DDMMYY ....(12)	6. ________
A *	
1. Present replacement price in Egypt, LE ....(12)	1. ________
2. Wearout life, hours ....(12)	2. ________
3. Expected average repair cost, LE/hour ....(12)	3. ________
4. Fuel consumption, liters/hour ....(12)	4. ________
5. Fuel cost, LE/liter ....(12)	5. ________
6. Oil cost, LE/100 hours ....(12)	6. ________
7. Grease cost, LE/100 hours ....(12)	7. ________
8. Electric energy required, kilowatt hours 2/ ....(12)	8. ________
9. Electricity cost, LE/kilowatt hour ....(12)	9. ________
10. Salvage value at end of wearout life, LE ....(12)	10. ________
11. Taxes, license, permits, rent, etc., LE/year ....(12)	11. ________
12. Interest rate, percent ....(12)	12. ________
13. Operator or labor cost, LE/hour ....(12)	13. ________
14. Discharge of pump, cubic meters/hour ....(12)	14. ________
15. Animal energy cost, LE/hour ....(12)	15. ________
16. Overall efficiency, decimal from .01 to 1.0..........(12)	16. ________
17. Engine efficiency, decimal from .01 to 1.0...........(12)	17. ________
18. Static head, meters 3/ ....(12)	18. ________
19. Dynamic head, meters 4/ ....(12)	19. ________
20. Water duty per year, cubic meters/feddan ....(12)	20. ________
21. Maximum time system will run per day, hours ....(12)	21. ________
22. Minimum irrigation interval, days ....(12)	22. ________
23. Maximum water required per irrigation, cu. meters/fed.(12)	23. ________

1/ Maximum characters allowed.

2/ Kilowatt hours = $\dfrac{\text{Discharge in m}^3\text{/hr x Dynamic head in m.}}{\text{362 x Overall Efficiency x Engine Efficiency}}$

3/ Static head is defined as the distance between the water level in the delivery canal or pump station well and the water level required in field distribution ditch.

4/ Dynamic head is defined as the difference between the water level in the delivery canal or pump station well at the point of suction and the discharge point of the pump plus losses.

especially important for policy makers to understand these variables since they are not simply "facts". Considerable latitude exists for assigning values to some of these variables depending on what assumptions one makes and what national policies one wished to advocate. Consequently policy makers should be involved in determining the values assigned to each variable.

Users of the model may make adaptations to other specifications which they consider important. For example the model does not explicitly consider field irrigation efficiency and design of field ditches. It might be argued that larger flow rates, possible with electric and diesel pumps, result in higher field irrigation efficiency and require less land for field ditches and bunds. This could be accounted for by adjusting water application variables, items 20. and 23. below, and also making a rental charge in item 11. for land devoted to ditches and bunds.

Components of the Model

1. Present replacement cost in Egypt. This is a relatively sensitive variable, especially if high interest rates are used. The "cost" of a water lifting system depends on equipment quality, customs taxes, government subsidies and related infrastructure. In the case of an electric powered system should the initial cost include transformers and transmission lines? Such questions should be considered before assigning capital costs to the analytical model.

2. Wearout life is difficult to determine but not highly sensitive in the total analysis. It is related to maintenance or repair costs and initial quality of the equipment used in the system.

3. Expected average repair cost. Reasonable estimates of repair costs should be used. Records of existing systems provide the best basis for making this estimate. Training programs for machine operators can help to minimize maintenance and

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repair costs.

4. Fuel consumption is specified by the manufacturer of internal combustion engines. Records from engine users are helpful in determining fuel consumption under field conditions.

5. Fuel cost is often affected by government subsidies. For example diesel fuel presently costs Egyptian farmers L.E. 0.03 per liter while the international price for diesel fuel is at least L.E. 0.14 per liter.[1/] Policy makers may wish to use projected future energy prices in evaluating alternative systems.

6. Oil cost varies for different types of internal combustion engines. Follow manufacturer's recommendations. Use of adequate, clean lubrication minimizes repair and maintenance costs.

7. Grease cost is usually a minor item but also related to repair and maintenance cost and wearout life.

8. Electric power required to operate a water lifting system is related to the condition of the equipment. It should be consistent with the other parameters of the system. The equation shown as footnote 2 on the data input form, page 5a, is used to determine electrical energy requirements.

1/ For a discussion of the difference between financial and economic costs see Pacific Consultants, "New Lands Productivity in Eygpt - Technical and Economic Feasibility," AID Contract No. AID/NE-C-1645, Project No. 263-0042, January 1980, pp. 17-18.

9. Electricity cost. In Egypt electricity is produced and distributed by the government. The price charged to farmers does not necessarily reflect the cost of producing and distributing electricity. Currently small consumers are charged L.E. 0.015 per kilowatt hour. One report from 1977 indicates the cost of producing and distributing new power in Egypt with petroleum fuel is L.E. 0.0932 per kilowatt hour.[1/] Increases in the international price for petroleum since 1977 have undoubtedly made thermal generation of electricity more expensive.

The appropriate price to charge for electricity to lift water is debatable. Some argue that daytime use of electricity will help to "... obtain the optimum use of Rural Electrification ..." in Egypt.[2/] As in the case of diesel fuel policy makers will perhaps wish to make long run price projections.

1/ Technical and Economic Feasibility of Electrifying Tertiary Pumping Means in Middle and Upper Egypt, Ministry of Irrigation, Mechanical and Electrical Department, Louis Berger International, Inc., 1977, see pages 135-136. Also see Pacific Consultants, op.cit., p. 18.

2/ Nasser, Abdel Hady Bary, "Feasibility Study of Electrification of Irrigation Means: Animal Driven Water Wheels and Diesel Pumps, In Menoufia Governorate," Engineering Research Bulletin, Vol. 1, Part 1, Menoufia University, Faculty of Engineering and Technology, Shebin El-Kom, 1978, page 72.

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10. Salvage value is included as a variable in the model to handle the wearout life difference in system components. For example a motor may wearout in 10,000 hours while the pump may have a life of 20,000 hours. In this case the value of the pump at the end of 10,000 hours can be considered as salvage value for the total system. Unit costs for long-life water lifting systems are not likely to be highly sensitive to alternative salvage values.

11. Annual taxes, license, permits, land rent, etc. includes all the possible fixed charges that may be imposed or otherwise required for owning a system. In the case of sakias a convenient method of charging for the land occupied by the sakia is to use the annual market rate of land rent for the specified area.

12. Interest rate. Capital usually has alternative uses. The opportunity interest cost of investing in a water lifting system is the rate of return capital would earn in its next best alternative. Although somewhat subjective, this principle can serve policy makers as a guide in assigning a capital charge to investment alternatives. If the capital is available as a loan and other alternatives are not to be considered, then use the interest rate according to the terms of the loan. If, on the other hand, financing is to be provided out of limited funds that could also be used for other purposes, it is important to use an interest rate

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which reflects the estimated return from the alternative purposes. This is the concept of "opportunity cost".

13. Operator or labor cost. All water lifting systems require some labor. In the case of a sakia a laborer is required to drive the animal. In the case of diesel or electric pumps, labor is required for pump attendants, to keep pipes clean and attend other details necessary for efficient operation. If a highly trained technician serves only one lifting system the hourly cost will be relatively high. If he can serve more than one system and/or perform other labor while operating the system, the cost will be appropriately reduced. There is a relationship between labor cost and other variables such as repairs and wearout life. Well paid, highly trained labor may tend to offset some other costs.

14. Discharge of the pump. An important assumption regarding the discharge of sakias and pumps is that the delivery canal must maintain a uniform water level at the pumping station. Data showing the discharge of sakias often reflects the effects of a fluctuating head. Conversely the discharge assigned to electric and diesel pumps may reflect the manufacturer's specifications at constant head. The delivery canal must be an integral part of any lifting system. In order for any system to operate efficiently and at capacity it must have an adequate supply of water

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at the point of suction, preferably of a uniform head.

15. Animal power cost is one of the most difficult variables to measure. It is common knowledge that most farmers depend on animals for transportation since field access roads are very limited. They also keep animals for the production of meat, milk, fuel, fertilizers and as a store of wealth or capital. However the measurement of these factors is often quite illusive.

If one assumes animals are kept primarily for power and all animal production costs are assigned to power, then the cost is relatively high. On the other hand if one assumes animals are kept more for the other uses and assigns only the marginal costs to power, then the cost is relatively small. In some cases where the work on a sakia is very light and spread among many animals it may be trivial. Some farmers believe a small amount of work only fulfills normal exercise for the animal and costs nothing.

There is also an assumption made by some that if the work requirement for animals were eliminated they would be replaced by animals specialized in meat and milk production. This could increase meat and milk production from a given feed base but may require a substantial training program to introduce new breeds, new feeding technologies, new marketing systems, etc.

Another possibility is that reducing the work requirement for animals will permit reduction of livestock numbers and production of human food on land formerly used to produce animal feed. Whether this would happen is also, of course, debatable.

Since there are only limited empirical data regarding these issues it is natural that wide variations exist in estimates of animal power costs. EWUP is engaged in further study of this issue. Literature reviews are in progress and research is planned to compare areas of gravity irrigation (where animals are not used for lifting water) with areas that are dependent on animal driven sakias for irrigation.

16. Overall efficiency refers to the pump and the drive (system of coupling between the engine and pump). Pump efficiency is specified by most pump manufacturers but may be adjusted downward to reflect efficiency under average field conditions. Standard engineering references suggest efficiencies for direct drive, right angle drive, vee belts, flat belts, etc. The overall efficiency is the product of the pump efficiency and the drive efficiency.

17. Engine efficiency is usually specified by the manufacturer for electric and diesel engines. It may be adjusted downward to properly reflect average field conditions. In the case of sakias, efficiencies can be calibrated to electric pumps where efficiencies and discharge rates are known. This is shown in Appendix B.

18. Static head is defined, for purposes of this model, as the distance between the water level in the canal or pump station well and the water level in the field distribution ditch.

19. The dynamic head includes the static head plus pumping system losses.

20. The water duty per year is the amount of water that must be lifted from a delivery canal to a field given a particular crop rotation. Of course it can be adjusted for specified locations, cropping sequences, and crop yields during a given year. It should include water needed for evapotranspiration plus leaching requirements under given conditions of field irrigation efficiency.

21. Maximum time the system will run per day should reflect the realities of farm and village cultural patterns. Longer period of operation per day will reduce unit costs of lifting water and will increase maximum area to be served but the system will not operate as planned unless it is compatible with values of farmers. The government, of course, may use various methods of coercion or reward systems to get farmers to comply with alternative working day lengths.

22. Minimum Irrigation Interval. This variable, expressed in days, effects the size of the area to be served by the system.

If during the peak irrigation season, the system operates at the capacity consistent with its discharge rate, water requirement and time parameters, a certain number of days will be required to cover a specified area. The first area irrigated will then have gone without water

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for that number of days. This is the concept of "minimum irrigation interval". If the number of days in the interval is lowered then the area served by the system will be reduced accordingly by the program. Under water rotation turns ("off" and "on" periods) the minimum interval should be the same as the days in the "on" period if it is desired that the system have capacity to irrigate all the land served with a "maximum irrigation" during one "on" period.

The cropping pattern and the consumptive use of specified crops during the peak irrigation period also influences the value which should be placed on this variable. For example shallow rooted crops require frequent but light irrigations,especially during July and August.

23. Maximum water required per irrigation. This variable also is part of the equation for setting the limit on the area to be served by the system. It is related to "minimum time between irrigations" in that shallow rooted crops may require less water per irrigation but more frequent irrigations. It is also dependent on water application efficiency.

Equations Utilized in the Model

Before turning to an illustration of the analytical model some readers may wish to examine the equations used in the model. They are shown on page 14a.

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EQUATIONS FOR WATER LIFTING COST PROGRAM*

1. $K = \text{Hrs. PER FEDDAN PER YEAR} = \dfrac{\text{Water Duty Per Year}}{\text{Discharge of Pump}}$

2. $\text{Annual Fixed Costs} = \left\{\dfrac{\text{Present Replacement Price in Egypt + Salvage Value}}{2}\right\}\left\{\text{Interest Rate}\right\} + \text{Taxes, etc.}$

3. $\text{Depreciation} = \left\{\dfrac{\text{Present Replacement Price in Egypt - Salvage Value}}{\text{Wearout Life}}\right\}\left\{K\right\}\left\{\text{No. of feddans}\right\}$

4. $\text{Repairs} = \left\{\text{Expected Average Repair Cost}\right\}\left\{K\right\}\left\{\text{No. of Feddans}\right\}$

5. $\text{Energy Cost if Diesel} = \left\{\text{Fuel Consumption}\right\}\left\{\text{Fuel Cost}\right\}\left\{K\right\}\left\{\text{No. of Feddans}\right\}$

6. $\text{Energy Cost if Electric} = \left\{\text{Electric Energy Required}\right\}\left\{\text{Electric Energy Cost}\right\}\left\{K\right\}\left\{\text{No. of Feddans}\right\}$

7. $\text{Energy Cost if Animal} = \left\{\text{Animal Cost}\right\}\left\{K\right\}\left\{\text{No. of Feddans}\right\}$

8. $\text{Grease and Oil} = \left\{\dfrac{\text{Oil Cost per 100 hours + Grease Cost per 100 hours}}{100}\right\}\left\{K\right\}\left\{\text{No. of Feddans}\right\}$

9. $\text{Operator Cost} = \left\{\text{Operator or Labor Cost}\right\}\left\{K\right\}\left\{\text{No. of Feddans}\right\}$

10. Total Annual Cost = Annual Fixed Cost + Depreciation + Repairs + Energy Cost + Grease and Oil + Operator Cost

11. $\text{Annual Cost Per Feddan} = \dfrac{\text{Total Annual Cost}}{\text{No. of Feddans}}$

12. $\text{Output Horsepower Hours (Work Accomplished)} = \left\{\dfrac{\text{Discharge of Pump x Static Head}}{270}\right\}\left\{K\right\}\left\{\text{No. of Feddans}\right\}$

13. $\text{Cost per HP Hour} = \dfrac{\text{Total Annual Cost}}{\text{Output HP Hours}}$

14. $\text{Max. System Capacity} = \dfrac{\text{Minimum Irrigation Interval x Max. Time per Day x Discharge of Pump}}{\text{Max. Water Required per Irrigation}}$

15. $\text{Brake Horsepower Required at Max. System Capacity} = \dfrac{\text{Discharge of Pump x Dynamic Head}}{\text{270 Overall Efficiency}}$

16. $\text{Total Time Required} = \left\{\text{Max. System Capacity}\right\}\left\{K\right\}$

17. Total Energy Required at Max. System Capacity = Brake HP Req. at Max. System Capacity x Total Time Required

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* See DATA INPUT FORM - WATER LIFTING COSTS on page 5b for unit specifications.

AN ILLUSTRATION OF THREE SYSTEMS

We shall now examine three alternative systems of lifting water using the analytical model previously described. In order to illustrate the potential application of the model we have selected two sets of data for analysis.

It should be understood that data for this model are of three kinds: (1) primary data collected by observation and enumeration, (2) expert opinion data based on engineering coefficients and/or informal collection procedures through years of observation and (3) system design parameters based on judgement, e.g. how many hours per day farmers will operate a system and what is the appropriate charge for energy now and in the future?

One set of data is from a report prepared at Menoufia University.[1] The second set of data was prepared by EWUP. Appendix A contains a discussion and justification for each item of EWUP data. Differences exist between the two data sets concerning energy costs, labor costs and requirements, interest rates, operating hours per day, and discharge rates. The effect of altering these variables will be discussed later.

Table 1 includes data from Menoufia University and from EWUP for three alternative water lifting systems, viz. (1) sakia, (2) diesel pump, and (3) electricity. Each unit of data has its own justification. One assumption, however, underlying the

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1/ Nasser, Abdel Hady Abdel Bary, op. cit., pp. 55-112.

TABLE 1: DATA FOR COST ANALYSES OF PUMPING MACHINES

	MENOUFIA UNIVERSITY DATA			EWUP DATA		
1. Name	SAKIA	DIESEL PUMP	ELECTIRC PUMP	SAKIA	DIESEL PUMP	ELECTRIC PUMP
2. Make	—	—	—	—	IND/CHECK	KSB
3. Model	—	—	—	—	—	—
4. Size	3-METERS	12 HP	12 HP	3-METERS	9 HP	7.5 HP
5. Power Source	ANIMAL	DIESEL	ELECTRICITY	ANIMAL	DIESEL	ELECTRICITY
6. Date, day, month, year	000080	000080	000080	051279	170380	170380
1. Present cost, L.E.	450.	1800.	800.	500.	950.	2325.
2. Life, hrs.	18000.	8161.	28333.	15000.	15000.	15000.
3. Repair cost, L.E.	.013	.221	.035	.008	.060	.010
4. Fuel consumption, liters	.000	1.640	.000	.000	1.429	.000
5. Fuel cost, L.E.	.000	.076	.000	.000	.140	.000
6. Oil cost, L.E./100 hrs.	.000	2.779	.000	.000	1.500	.000
7. Grease cost, L.E./100 hrs.	.000	.000	.000	.100	.500	.500
8. Elect. req., kwh	.000	.000	4.806	.000	.000	3.376
9. Elect. cost, L.E.	.000	.000	.015	.000	.000	.050
10. Salvage value, L.E.	.000	300.000	.000	.000	.000	.000
11. Annual taxes, L.E.	.000	.000	.000	2.000	.000	.000
12. Interest rate, percent	6.	6.	6.	15.	15.	15.
13. Labor cost, L.E./Hr.	.056	.794	.318	.050	.300	.300
14. Discharge, m^3/hr.	57.	300.	300.	100.	170.	170.
15. Animal energy cost, L.E.	.314	.000	.000	.300	.000	.000
16. Overall efficiency	.700	.700	.700	.700	.700	.700
17. Engine efficiency	.900	.850	.850	.900	.600	.850
18. Static head, meter	1.	1.	1.	1.	1.	1.
19. Dynamic head, meter	1.	3.500	3.500	1.	3.500	3.500
20. Water duty, m^3/year	6800.	6800.	6800.	6800.	6800.	6800.
21. Max. time/day, hrs.	16.	12.	16.	12.	12.	12.
22. Min. irrig. interval, days	6.	6.	6.	6.	6.	6.
23. Max. water/irrig., m^3	425.	425.	425.	425.	425.	425.

entire analysis, is that the delivery canal must operate such that the lifting devices can operate at designated capacity.

The data from Table 1 were entered into a computer model to produce Tables 2-7. Examination of Table 2, Water Lifting Costs for 3-Meter Sakia, Data from Menoufia University, shows that costs are reported in annual cost per feddan and cost per horsepower hour. Both values represent the cost of performing a unit of work. In the first case it shows the cost per feddan is L.E. 62.174 when the system is used for only one feddan. This means it costs L.E. 62.174 to lift 6800 m^3, the amount required for one feddan, one meter. These values are included in the data set, i.e. water duty equal 6800 m^3 and static head equal to one meter. Since it requires 25.185 HP hours to do this work we can see the cost per HP hour is L.E. 2.4687 . As the use of the system is expanded over more area we notice that both the annual cost per feddan and the cost per HP hour decline. This is due to the fact that fixed costs are spread over more units of work and consequently total cost per unit declines.

Table 2 also indicates that the maximum capacity of this system is 12.88 feddans per year. This is by equation 14 on page 14a and is of course based on specified crop requirements, irrigation frequency, etc. If any of these specifications are relaxed the computed capacity of the system will change. Also we can observe that power required at maximum capacity of the system is 0.30 horsepower as explained by equation 15. The system requires 1536 hours of operation to perform the work required at the maximum system capacity of 12.88 feddans per year. The total energy required to do this work is 463.24 horsepower hours.

Table 2: Water Lifting Costs for 3-Meter Sakia, Data From Menoufia University

PRESENT REPLACEMENT COST IN EGYPT, LE	450.000
WEAR OUT LIFE IN HOURS	18000.000
EXPECTED AVERAGE REPAIR COST LE /HOUR	0.013
OIL COST LE/ 100 HOURS	0.000
GREASE COST LE /100 HOURS	0.000
SALVAGE VALUE AT END OF WEAR OUT LIFE:LE	0.000
ANNUAL TAXES,LICENSE,PERMIT,RENT,etc.:LE	0.000
INTEREST RATE,PERCENT	6.000 %
OPERATOR COST LE/hr	0.056
Hrs PER FEDDAN PER YEAR	117.298
DISCHARGE OF PUMP,cubic mt./hr	57.000
ANIMAL POWER COST LE/hr	0.314
OVERALL EFFICIENCY	0.700
ENGINE EFFICIENCY	0.900

STATIC HEAD (METERS)	1.000
DYNAMIC HEAD (METERS)	1.000
WATER DUTY PER YEAR,cubic mt/fd	6800.000
MAX. TIME SYSTEM WILL RUN PER DAY,hours	16.000
MIN. TIME BETWEEN IRRIGATION,days	6.000
MAX. WATER REQUIRED PER IRRIG.,cubic mt/fd	425.000

MAX. SYSTEM CAPACITY = 12.80 FEDDANS/YEAR
BHP REQUIRED AT MAX = 0.30 BRAKE HORSEPOWER
TOTAL TIME REQUIRED =1536.00 Hrs/YEAR
TOTAL ENERGY REQ. AT MAX = 463.24HP Hrs/YEAR

FEDD.	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	ENERGY COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	ANNUAL COST/fd	OUTPT HP Hrs.	COST HP HOUR
1.00	13.500	2.982	1.551	37.460	0.000	6.681	62.174	62.174	25.185	2.4687
2.00	13.500	5.965	3.102	74.919	0.000	13.361	110.847	55.424	50.370	2.2006
3.00	13.500	8.947	4.653	112.379	0.000	20.042	159.521	53.174	75.556	2.1113
4.00	13.500	11.930	6.204	149.839	0.000	26.723	208.195	52.049	100.741	2.0666
5.00	13.500	14.912	7.754	187.298	0.000	33.404	256.868	51.374	125.926	2.0398
6.00	13.500	17.895	9.305	224.758	0.000	40.084	305.542	50.924	151.111	2.0220
7.00	13.500	20.877	10.856	262.218	0.000	46.765	354.216	50.602	176.296	2.0092
8.00	13.500	23.860	12.407	299.677	0.000	53.446	402.889	50.361	201.481	1.9996
9.00	13.500	26.842	13.958	337.137	0.000	60.126	451.563	50.174	226.667	1.9922
10.00	13.500	29.825	15.509	374.596	0.000	66.807	500.237	50.024	251.852	1.9862
15.00	13.500	44.737	23.263	561.895	0.000	100.211	743.605	49.574	377.778	1.9684
20.00	13.500	59.649	31.018	749.193	0.000	133.614	986.974	49.349	503.704	1.9594
25.00	13.500	74.561	38.772	936.491	0.000	167.018	1230.342	49.214	629.630	1.9541
30.00	13.500	89.474	46.526	1123.789	0.000	200.421	1473.711	49.124	755.556	1.9505
35.00	13.500	104.386	54.281	1311.088	0.000	233.825	1717.079	49.059	881.481	1.9479
40.00	13.500	119.298	62.035	1498.386	0.000	267.228	1960.447	49.011	1007.407	1.9460
45.00	13.500	134.211	69.789	1685.684	0.000	300.632	2203.816	48.974	1133.333	1.9445
50.00	13.500	149.123	77.544	1872.982	0.000	334.035	2447.184	48.944	1259.259	1.9434
55.00	13.500	164.035	85.298	2060.281	0.000	367.439	2690.553	48.919	1385.185	1.9424
60.00	13.500	178.947	93.053	2247.579	0.000	400.842	2933.921	48.899	1511.111	1.9416
65.00	13.500	193.860	100.807	2434.877	0.000	434.246	3177.289	48.881	1637.037	1.9409
70.00	13.500	208.772	108.561	2622.175	0.000	467.649	3420.658	48.867	1762.963	1.9403
75.00	13.500	223.684	116.316	2809.474	0.000	501.053	3664.026	48.854	1888.889	1.9398
80.00	13.500	238.596	124.070	2996.772	0.000	534.456	3907.395	48.842	2014.815	1.9393
85.00	13.500	253.509	131.825	3184.070	0.000	567.860	4150.763	48.833	2140.741	1.9389
90.00	13.500	268.421	139.579	3371.368	0.000	601.263	4394.132	48.824	2266.667	1.9386
95.00	13.500	283.333	147.333	3558.667	0.000	634.667	4637.500	48.816	2392.593	1.9383
$$$$$	13.500	298.246	155.088	3745.965	0.000	668.070	4880.868	48.807	2518.519	1.9380

Table 3: Water Lifting Costs for 12 HP Diesel Pump, Data From Menoufia University

PRESENT REPLACLMENT COST IN EGYPT, LE	1000.000
WEAR OUT LIFE IN HOURS	8161.000
EXPECTED AVERAGL REPAIR COST LE /HOUR	0.221
FUEL CONSUMPTION LITERS PER HOUR	1.640
FUEL COST LE/LITER	0.076
OIL COST LE/ 100 HOURS	2.779
GREASE COST LE /100 HOURS	0.000
SALVAGE VALUE AT END OF WEAR OUT LIFE:LE	300.000
ANNUAL TAXES,LICENSL,PERMIT,RENT,etc.:LE	0.000
INTEREST RATE,PERCENT	6.000 %
OPERATOR COST LE/hr	0.794
Hrs PER FEDDAN PER YEAR	22.667
DISCHARGE OF PUMP,cubic mt./hr	300.000
OVERALL EFFICIENCY	0.700
ENGINE EFFICIONCY	0.850

MAX. SYSTEM CAPACITY = 50.82 FEDDANS/YEAR
BHP REQUIRED AT MAX = 5.56 BRAKE HORSPOWER
TOTAL TIME REQUIRED =1152.00 Hrs/YEAR
TOTAL ENERGY REQ. AT MAX =6400.00HP Hrs/YEAR

STATIC HEAD (METERS)	1.000
DYNAMIC HEAD (METERS)	3.500
WATER DUTY PER YEAR,cubic mt/fd	6800.000
MAX. TIME SYSTEM WILL RUN PER DAY,hours	12.000
MIN. TIME BETWEEN IRRIGATION,days	6.000
MAX. WATER REQUIRED PER IRRIG.,cubic mt/fd	425.000

FEDD.	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	ENERGY COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	ANNUAL COST/fd	OUTPT HP Hrs.	COST HP HOUR
1.00	63.000	4.166	5.009	2.825	0.630	17.997	93.628	93.628	25.185	3.7176
2.00	63.000	8.332	10.017	5.650	1.260	35.995	124.256	62.128	50.370	2.4668
3.00	63.000	12.498	15.028	8.476	1.890	53.992	154.884	51.628	75.556	2.0499
4.00	63.000	16.665	20.037	11.301	2.520	71.989	185.512	46.378	100.741	1.8415
5.00	63.000	20.831	25.047	14.126	3.150	89.987	216.140	43.228	125.926	1.7164
6.00	63.000	24.997	30.056	16.951	3.779	107.984	246.767	41.128	151.111	1.6330
7.00	63.000	29.163	35.065	19.776	4.409	125.981	277.395	39.628	176.296	1.5735
8.00	63.000	33.329	40.075	22.601	5.039	143.979	308.023	38.503	201.481	1.5288
9.00	63.000	37.495	45.084	25.427	5.669	161.976	338.651	37.628	226.667	1.4940
10.00	63.000	41.662	50.093	28.252	6.299	179.973	369.279	36.928	251.852	1.4663
15.00	63.000	62.492	75.140	42.378	9.449	269.960	522.419	34.828	377.778	1.3829
20.00	63.000	83.323	100.187	56.503	12.598	359.947	675.558	33.778	503.704	1.3412
25.00	63.000	104.154	125.233	70.629	15.748	449.933	828.698	33.148	629.630	1.3162
30.00	63.000	124.985	150.280	84.755	18.897	539.920	981.837	32.728	755.556	1.2995
35.00	63.000	145.815	175.327	98.881	22.047	629.907	1134.977	32.428	881.481	1.2876
40.00	63.000	166.646	200.373	113.007	25.196	719.893	1288.116	32.203	1007.407	1.2786
45.00	63.000	187.477	225.420	127.133	28.346	809.880	1441.256	32.028	1133.333	1.2717
50.00	63.000	208.308	250.467	141.259	31.495	899.867	1594.395	31.888	1259.259	1.2661
55.00	63.000	229.139	275.513	155.385	34.645	989.853	1747.535	31.773	1385.185	1.2616
60.00	63.000	249.969	300.560	169.510	37.794	1079.840	1900.674	31.678	1511.111	1.2578
65.00	63.000	270.800	325.607	183.636	40.944	1169.827	2053.814	31.597	1637.037	1.2546
70.00	63.000	291.631	350.653	197.762	44.093	1259.813	2206.953	31.528	1762.963	1.2518
75.00	63.000	312.462	375.700	211.888	47.243	1349.800	2360.093	31.468	1888.889	1.2495
80.00	63.000	333.292	400.747	226.014	50.393	1439.787	2513.232	31.415	2014.815	1.2474
85.00	63.000	354.123	425.793	240.140	53.542	1529.773	2666.372	31.369	2140.741	1.2455
90.00	63.000	374.954	450.840	254.266	56.692	1619.760	2819.511	31.328	2266.667	1.2439
95.00	63.000	395.785	475.887	268.391	59.841	1709.747	2972.651	31.291	2392.593	1.2424
$$$$$	63.000	416.616	500.933	282.517	62.991	1799.733	3125.790	31.258	2518.519	1.2411

Table 4: Water Lifting Costs for 12 HP Electric Pump, Data From Menoufia University

PRESENT REPLACEMENT COST IN EGYPT, LE	800.000
WEAR OUT LIFE IN HOURS	28333.000
EXPECTED AVERAGE REPAIR COST LE /HOUR	0.035
OIL COST LE/ 100 HOURS	0.000
GREASE COST LE /100 HOURS	0.000
ELECTRIC POWER REQUIRED ,Kw hour	4.806
ELECTRICITY COST LE /Kw.hour	0.015
SALVAGE VALUE AT END OF WEAR OUT LIFE:LE	0.000
ANNUAL TAXES,LICENSE,PERMIT,RENT,etc.:LE	0.000
INTEREST RATE,PERCENT	6.000 %
OPERATOR COST LE/hr	0.318
Hrs PER FEDDAN PER YEAR	22.667
DISCHARGE OF PUMP,cubic mt./hr	300.000
OVERALL EFFICIENCY	0.700
ENGINE EFFICIENCY	0.850

STATIC HEAD (METERS)	1.000
DYNAMIC HEAD (METERS)	3.500
WATER DUTY PER YEAR,cubic mt/fd	6800.000
MAX. TIME SYSTEM WILL RUN PER DAY,hours	16.000
MIN. TIME BETWEEN IRRIGATION,days	6.000
MAX. WATER REQUIRED PER IRRIG.,cubic mt/fd	425.000

MAX. SYSTEM CAPACITY = 67.76 FEDDANS/YEAR
BHP REQUIRED AT MAX = 5.56 BRAKE HORSPOWER
TOTAL TIME REQUIRED =1536.00 Hrs/YEAR
TOTAL ENERGY REQ. AT MAX =8533.33HP Hrs/YEAR

FEDD.	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	ENERGY COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	ANNUAL COST/Fd	OUTPUT HP Hrs.	COST HP HOUR
1.00	24.000	0.640	0.793	1.634	0.000	7.208	34.275	34.275	25.185	1.3609
2.00	24.000	1.280	1.587	3.268	0.000	14.416	44.551	22.275	50.370	0.8845
3.00	24.000	1.920	2.380	4.902	0.000	21.624	54.826	18.275	75.556	0.7256
4.00	24.000	2.560	3.173	6.536	0.000	28.832	65.102	16.275	100.741	0.6462
5.00	24.000	3.200	3.967	8.170	0.000	36.040	75.377	15.075	125.926	0.5986
6.00	24.000	3.840	4.760	9.804	0.000	43.248	85.652	14.275	151.111	0.5668
7.00	24.000	4.480	5.553	11.438	0.000	50.456	95.928	13.704	176.296	0.5441
8.00	24.000	5.120	6.347	13.072	0.000	57.664	106.203	13.275	201.481	0.5271
9.00	24.000	5.760	7.140	14.706	0.000	64.872	116.478	12.942	226.667	0.5139
10.00	24.000	6.400	7.933	16.340	0.000	72.080	126.754	12.675	251.852	0.5033
15.00	24.000	9.600	11.900	24.511	0.000	108.120	178.131	11.875	377.778	0.4715
20.00	24.000	12.800	15.867	32.681	0.000	144.160	229.508	11.475	503.704	0.4556
25.00	24.000	16.000	19.833	40.851	0.000	180.200	280.885	11.235	629.630	0.4461
30.00	24.000	19.200	23.800	49.021	0.000	216.240	332.261	11.075	755.556	0.4398
35.00	24.000	22.400	27.767	57.191	0.000	252.280	383.638	10.961	881.481	0.4352
40.00	24.000	25.600	31.733	65.362	0.000	288.320	435.015	10.875	1007.407	0.4318
45.00	24.000	28.800	35.700	73.532	0.000	324.360	486.392	10.809	1133.333	0.4292
50.00	24.000	32.000	39.667	81.702	0.000	360.400	537.769	10.755	1259.259	0.4271
55.00	24.000	35.200	43.633	89.872	0.000	396.440	589.146	10.712	1385.185	0.4253
60.00	24.000	38.400	47.600	98.042	0.000	432.480	640.523	10.675	1511.111	0.4239
65.00	24.000	41.600	51.567	106.213	0.000	468.520	691.900	10.645	1637.037	0.4227
70.00	24.000	44.801	55.533	114.383	0.000	504.560	743.277	10.618	1762.963	0.4216
75.00	24.000	48.001	59.500	122.553	0.000	540.600	794.654	10.595	1888.889	0.4207
80.00	24.000	51.201	63.467	130.723	0.000	576.640	846.030	10.575	2014.815	0.4199
85.00	24.000	54.401	67.433	138.893	0.000	612.680	897.407	10.558	2140.741	0.4192
90.00	24.000	57.601	71.400	147.064	0.000	648.720	948.784	10.542	2266.667	0.4186
95.00	24.000	60.801	75.367	155.234	0.000	684.760	1000.161	10.528	2392.593	0.4180
*****	24.000	64.001	79.333	163.404	0.000	720.800	1051.538	10.515	2518.519	0.4175

Table 5: Water Lifting Costs for 3-Meter Sakia, Data From EWUP

PRESENT REPLACEMENT COST IN EGYPT, LE	500.000
WEAR OUT LIFE IN HOURS	15000.000
EXPECTED AVERAGE REPAIR COST LE /HOUR	0.008
OIL COST LE/ 100 HOURS	0.000
GREASE COST LE /100 HOURS	0.100
SALVAGE VALUE AT END OF WEAR OUT LIFE:LE	0.000
ANNUAL TAXES,LICENSE,PERMIT,RENT,etc.:LE	2.000
INTEREST RATE,PERCENT	15.000 %
OPERATOR COST LE/hr	0.050
[illegible] PER FEDDAN PER YEAR	68.000
DISCHARGE OF PUMP,cubic mt./hr	100.000
ANIMAL POWER COST LE/hr	0.300
OVERALL EFFICIONCY	0.700
ENGINE EFFICIONCY	0.900

STATIC HEAD (METERS)	1.000
DYNAMIC HEAD (METERS)	1.000
WATER DUTY PER YEAR,cubic mt/fd	6800.000
MAX. TIME SYSTEM WILL RUN PER DAY,hours	12.000
MIN. TIME BETWEEN IRRIGATION,days	6.000
MAX. WATER REQUIRED PER IRRIG.,cubic mt/fd	425.000

MAX. SYSTEM CAPACITY = 16.94 FEDDANS/YEAR
BHP REQUIRED AT MAX = 0.5291 BRAKE HORSPOWER
TOTAL TIME REQUIRED =1152.00 Hrs/YEAR
TOTAL ENERGY REQ. AT MAX = 609.52 HP Hrs/YEAR

FEDD	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	ENERGY COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	ANNUAL COST/Fd	OUTPT HP Hrs.	COST HP HOUR
1.00	39.500	2.2667	0.5440	20.4000	0.0680	3.4000	66.1787	66.1787	25.1852	2.6277
2.00	39.500	4.5333	1.0880	40.8000	0.1360	6.8000	92.8573	46.4287	50.3704	1.8435
3.00	39.500	6.8000	1.6320	61.2000	0.2040	10.2000	119.5360	39.8453	75.5556	1.5821
4.00	39.500	9.0667	2.1760	81.6000	0.2720	13.6000	146.2147	36.5537	100.7407	1.4514
5.00	39.500	11.3333	2.7200	102.0000	0.3400	17.0000	172.8933	34.5787	125.9259	1.3730
6.00	39.500	13.6000	3.2640	122.4000	0.4080	20.4000	199.5720	33.2620	151.1111	1.3207
7.00	39.500	15.8667	3.8080	142.8000	0.4760	23.8000	226.2507	32.3215	176.2963	1.2834
8.00	39.500	18.1333	4.3520	163.2000	0.5440	27.2000	252.9293	31.6162	201.4815	1.2553
9.00	39.500	20.4000	4.8960	183.6000	0.6120	30.6000	279.6080	31.0676	226.6667	1.2336
10.00	39.500	22.6667	5.4400	204.0000	0.6800	34.0000	306.2867	30.6287	251.8519	1.2161
15.00	39.500	34.0000	8.1600	306.0000	1.0200	51.0000	439.6800	29.3120	377.7778	1.1639
20.00	39.500	45.3333	10.8800	408.0000	1.3600	68.0000	573.0733	28.6537	503.7037	1.1377
25.00	39.500	56.6667	13.6000	510.0000	1.7000	85.0000	706.4667	28.2587	629.6296	1.1220
30.00	39.500	68.0000	16.3200	612.0000	2.0400	102.0000	839.8600	27.9953	755.5556	1.1116
35.00	39.500	79.3333	19.0400	714.0000	2.3800	119.0000	973.2533	27.8072	881.4815	1.1041
40.00	39.500	90.6667	21.7600	816.0000	2.7200	136.0000	1106.6467	27.6662	1007.4074	1.0985
45.00	39.500	102.0000	24.4800	918.0000	3.0600	153.0000	1240.0400	27.5564	1133.3333	1.0942
50.00	39.500	113.3333	27.2000	1020.0000	3.4000	170.0000	1373.4333	27.4687	1259.2593	1.0907
55.00	39.500	124.6667	29.9200	1122.0000	3.7400	187.0000	1506.8267	27.3968	1385.1852	1.0878
60.00	39.500	136.0000	32.6400	1224.0000	4.0800	204.0000	1640.2200	27.3370	1511.1111	1.0854
65.00	39.500	147.3333	35.3600	1326.0000	4.4200	221.0000	1773.6133	27.2864	1637.0370	1.0834
70.00	39.500	158.6667	38.0800	1428.0000	4.7600	238.0000	1907.0067	27.2430	1762.9630	1.0817
75.00	39.500	170.0000	40.8000	1530.0000	5.1000	255.0000	2040.4000	27.2053	1888.8889	1.0802
80.00	39.500	181.3333	43.5200	1632.0000	5.4400	272.0000	2173.7933	27.1724	2014.8148	1.0789
85.00	39.500	192.6667	46.2400	1734.0000	5.7800	289.0000	2307.1867	27.1434	2140.7407	1.0778
90.00	39.500	204.0000	48.9600	1836.0000	6.1200	306.0000	2440.5800	27.1176	2266.6667	1.0767
95.00	39.500	215.3333	51.6800	1938.0000	6.4600	323.0000	2573.9733	27.0945	2392.5926	1.0758
100.00	39.500	226.6667	54.4000	2040.0000	6.8000	340.0000	2707.3667	27.0737	2518.5185	1.0750

Table 6: Water Lifting Costs for 9 HP Diesel Pump, Data From EWUP

PRESENT REPLACEMENT COST IN EGYPT, LE	950.000
WEAR OUT LIFE IN HOURS	15000.000
EXPECTED AVERAGE REPAIR COST LE /HOUR	0.060
FUEL CONSUMPTION LITERS PER HOUR	1.429
FUEL COST LE/LITER	0.140
OIL COST LE/ 100 HOURS	1.500
GREASE COST LE /100 HOURS	0.500
SALVAGE VALUE AT END OF WEAR OUT LIFE:LE	0.000
ANNUAL TAXES,LICENSE,PERMIT,RENT,etc.:LE	0.000
INTEREST RATE,PERCENT	15.000 %
OPERATOR COST LE/hr	0.300
Hrs PER FEDDAN PER YEAR	40.000
DISCHARGE OF PUMP,cubic mt./hr	170.000
OVERALL EFFICIENCY	0.700
ENGINE EFFICIENCY	0.600

STATIC HEAD (METERS)	1.000
DYNAMIC HEAD (METERS)	3.500
WATER DUTY PER YEAR,cubic mt/fd	6800.000
MAX. TIME SYSTEM WILL RUN PER DAY,hours	12.000
MIN. TIME BETWEEN IRRIGATION,days	6.000
MAX. WATER REQUIRED PER IRRIG.,cubic mt/fd	425.000

MAX. SYSTEM CAPACITY = 28.80 FEDDANS/YEAR
BHP REQUIRED AT MAX = 3.15 BRAKE HORSPOWER
TOTAL TIME REQUIRED =1152.00 Hrs/YEAR
TOTAL ENERGY REQ. AT MAX =3626.67HP Hrs/YEAR

FEDD.	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	ENERGY COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	ANNUAL COST/Fd	OUTPT HP Hrs.	COST HP HOUR
1.00	71.250	2.533	2.400	8.002	0.800	12.000	96.986	96.986	25.185	3.8509
2.00	71.250	5.067	4.800	16.005	1.600	24.000	122.721	61.361	50.370	2.4364
3.00	71.250	7.600	7.200	24.007	2.400	36.000	148.457	49.486	75.556	1.9649
4.00	71.250	10.133	9.600	32.010	3.200	48.000	174.173	43.543	100.741	1.7291
5.00	71.250	12.667	12.000	40.012	4.000	60.000	199.929	39.986	125.926	1.5877
6.00	71.250	15.200	14.400	48.014	4.800	72.000	225.664	37.611	151.111	1.4934
7.00	71.250	17.733	16.800	56.017	5.600	84.000	251.400	35.914	176.296	1.4260
8.00	71.250	20.267	19.200	64.019	6.400	96.000	277.136	34.642	201.481	1.3755
9.00	71.250	22.800	21.600	72.022	7.200	108.000	302.872	33.652	226.667	1.3362
10.00	71.250	25.333	24.000	80.024	8.000	120.000	328.607	32.861	251.852	1.3048
15.00	71.250	38.000	36.000	120.036	12.000	180.000	457.286	30.486	377.778	1.2105
20.00	71.250	50.667	48.000	160.048	16.000	240.000	585.965	29.298	503.704	1.1633
25.00	71.250	63.333	60.000	200.060	20.000	300.000	714.643	28.586	629.630	1.1350
30.00	71.250	76.000	72.000	240.072	24.000	360.000	843.322	28.111	755.556	1.1162
35.00	71.250	88.667	84.000	280.084	28.000	420.000	972.001	27.771	881.481	1.1027
40.00	71.250	101.333	96.000	320.096	32.000	480.000	1100.679	27.517	1007.407	1.0926
45.00	71.250	114.000	108.000	360.108	36.000	540.000	1229.358	27.319	1133.333	1.0847
50.00	71.250	126.667	120.000	400.120	40.000	600.000	1358.037	27.161	1259.259	1.0784
55.00	71.250	139.333	132.000	440.132	44.000	660.000	1486.715	27.031	1385.185	1.0733
60.00	71.250	152.000	144.000	480.144	48.000	720.000	1615.394	26.923	1511.111	1.0690
65.00	71.250	164.667	156.000	520.156	52.000	780.000	1744.073	26.832	1637.037	1.0654
70.00	71.250	177.333	168.000	560.168	56.000	840.000	1872.751	26.754	1762.963	1.0623
75.00	71.250	190.000	180.000	600.180	60.000	900.000	2001.430	26.686	1888.889	1.0596
80.00	71.250	202.667	192.000	640.192	64.000	960.000	2130.109	26.626	2014.815	1.0572
85.00	71.250	215.333	204.000	680.204	68.000	1020.000	2258.787	26.574	2140.741	1.0551
90.00	71.250	228.000	216.000	720.216	72.000	1080.000	2387.466	26.527	2266.667	1.0533
95.00	71.250	240.667	228.000	760.228	76.000	1140.000	2516.145	26.486	2392.593	1.0516
*****	71.250	253.333	240.000	800.240	80.000	1200.000	2644.823	26.448	2518.519	1.0502

Table 7: Water Lifting Costs for 7.5 HP Electric Pump, Data From EWUP

PRESENT REPLACEMENT COST IN EGYPT, LE	2325.000
WEAR OUT LIFE IN HOURS	15000.000
EXPECTED AVERAGE REPAIR COST LE /HOUR	0.010
OIL COST LE/ 100 HOURS	0.000
GREASE COST LE /100 HOURS	0.500
ELECTRIC POWER REQUIRED ,Kw hour	3.376
ELECTRICITY COST LE /Kw.hour	0.050
SALVAGE VALUE AT END OF WEAR OUT LIFE:LE	0.000
ANNUAL TAXES,LICENSE,PERMIT,RENT,etc.:LE	0.000
INTEREST RATE,PERCENT	15.000 %
OPERATOR COST LE/hr	0.300
Hrs PER FEDDAN PER YEAR	40.000
DISCHARGE OF PUMP,cubic Mt./hr	170.000
OVERALL EFFICIENCY	0.700
ENGINE EFFICIENCY	0.850

STATIC HEAD (METERS)	1.000
DYNAMIC HEAD (METERS)	3.500
WATER DUTY PER YEAR,cubic Mt/fd	6800.000
MAX. TIME SYSTEM WILL RUN PER DAY,hours	12.000
MIN. TIME BETWEEN IRRIGATION,days	6.000
MAX. WATER REQUIRED PER IRRIG.,cubic Mt/fd	425.000

MAX. SYSTEM CAPACITY = 28.00 FEDDANS/YEAR
BHP REQUIRED AT MAX = 3.15 BRAKE HORSPOWER
TOTAL TIME REQUIRED =1152.00 Hrs/YEAR
TOTAL ENERGY REQ. AT MAX =3626.67HP Hrs/YEAR

FEDD.	ANNUAL FIXED COST	DEPRECIA.	REPAIRS	ENERGY COST	GREASE &OIL	OPERATOR COST	TOTAL ANNUAL COST	ANNUAL COST/Fd	OUTPUT HP Hrs.	COST HP HOUR
1.00	174.375	6.200	0.400	6.752	0.200	12.000	199.927	199.927	25.185	7.9383
2.00	174.375	12.400	0.800	13.504	0.400	24.000	225.479	112.740	50.370	4.4764
3.00	174.375	18.600	1.200	20.256	0.600	36.000	251.031	83.677	75.556	3.3225
4.00	174.375	24.800	1.600	27.008	0.800	48.000	276.583	69.146	100.741	2.7455
5.00	174.375	31.000	2.000	33.760	1.000	60.000	302.135	60.427	125.926	2.3993
6.00	174.375	37.200	2.400	40.512	1.200	72.000	327.687	54.615	151.111	2.1685
7.00	174.375	43.400	2.800	47.264	1.400	84.000	353.239	50.463	176.296	2.0037
8.00	174.375	49.600	3.200	54.016	1.600	96.000	378.791	47.349	201.481	1.8800
9.00	174.375	55.800	3.600	60.768	1.800	108.000	404.343	44.927	226.667	1.7839
10.00	174.375	62.000	4.000	67.520	2.000	120.000	429.895	42.990	251.852	1.7069
15.00	174.375	93.000	6.000	101.280	3.000	180.000	557.655	37.177	377.778	1.4761
20.00	174.375	124.000	8.000	135.040	4.000	240.000	685.415	34.271	503.704	1.3608
25.00	174.375	155.000	10.000	168.800	5.000	300.000	813.175	32.527	629.630	1.2915
30.00	174.375	186.000	12.000	202.560	6.000	360.000	940.935	31.365	755.556	1.2454
35.00	174.375	217.000	14.000	236.320	7.000	420.000	1068.695	30.534	881.481	1.2124
40.00	174.375	248.000	16.000	270.080	8.000	480.000	1196.455	29.911	1007.407	1.1877
45.00	174.375	279.000	18.000	303.840	9.000	540.000	1324.215	29.427	1133.333	1.1684
50.00	174.375	310.000	20.000	337.600	10.000	600.000	1451.975	29.040	1259.259	1.1530
55.00	174.375	341.000	22.000	371.360	11.000	660.000	1579.735	28.722	1385.185	1.1405
60.00	174.375	372.000	24.000	405.120	12.000	720.000	1707.495	28.458	1511.111	1.1300
65.00	174.375	403.000	26.000	438.880	13.000	780.000	1835.255	28.235	1637.037	1.1211
70.00	174.375	434.000	28.000	472.640	14.000	840.000	1963.015	28.043	1762.963	1.1135
75.00	174.375	465.000	30.000	506.400	15.000	900.000	2090.775	27.877	1888.889	1.1069
80.00	174.375	496.000	32.000	540.160	16.000	960.000	2218.535	27.732	2014.815	1.1011
85.00	174.375	527.000	34.000	573.920	17.000	1020.000	2346.295	27.603	2140.741	1.0960
90.00	174.375	558.000	36.000	607.680	18.000	1080.000	2474.055	27.490	2266.667	1.0915
95.00	174.375	589.000	38.000	641.440	19.000	1140.000	2601.815	27.388	2392.593	1.0874
[illegible]	174.375	620.000	40.000	675.200	20.000	1200.000	2729.575	27.296	2518.519	1.0838

Each data set is similarly calculated and reported in Table 2-7. The reader is reminded that the six data sets are shown in Table 1 on page 15a.

Cost Curves

To simplify comparison of Tables 2-7 cost curves were plotted to show the relationship between cost per horsepower hour (vertical axis) and the number of feddans which the system serves annually (horizontal axis). Examination of Figure 2 shows that the cost curves slope downward to the right reflecting the declining unit costs of work performed as fixed costs are spread over more units.

The curves do not extend to the right beyond the physical limits of each system's capacity to perform work within the prescribed time and water requirement parameters. The data sets can of course be changed to reflect different parameters and this in turn will affect the shape and relative positions of the cost curves.

Examination of Figure 2, which is based on Menoufia data, will indicate that the cost of a sakia, used at maximum system capacity, is approximately L.E. 2.0 per horsepower hour. From Table 2 we can also observe that this corresponds to approximately L.E. 50.0 per feddan per year.

Similar examination of the diesel pump cost curve and Table 3 will reveal costs of L.E. 1.3 per horsepower hour and L.E. 32.0 per feddan per year. The electricity system reveals

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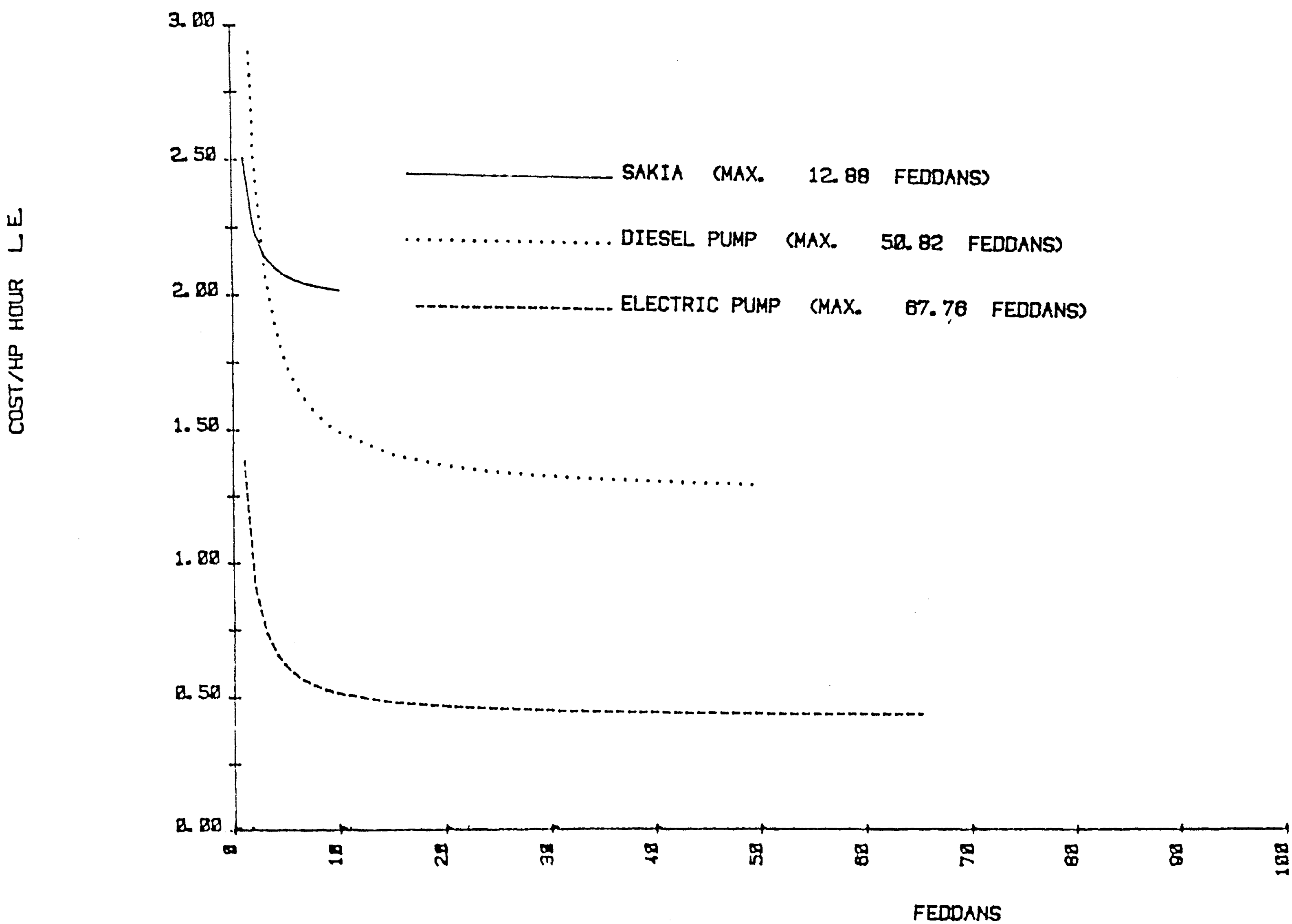

Figure 2: Water Lifting Costs Per Unit of Work Done for Sakia, Diesel Pump and Electric Pump, Menoufia University Data.

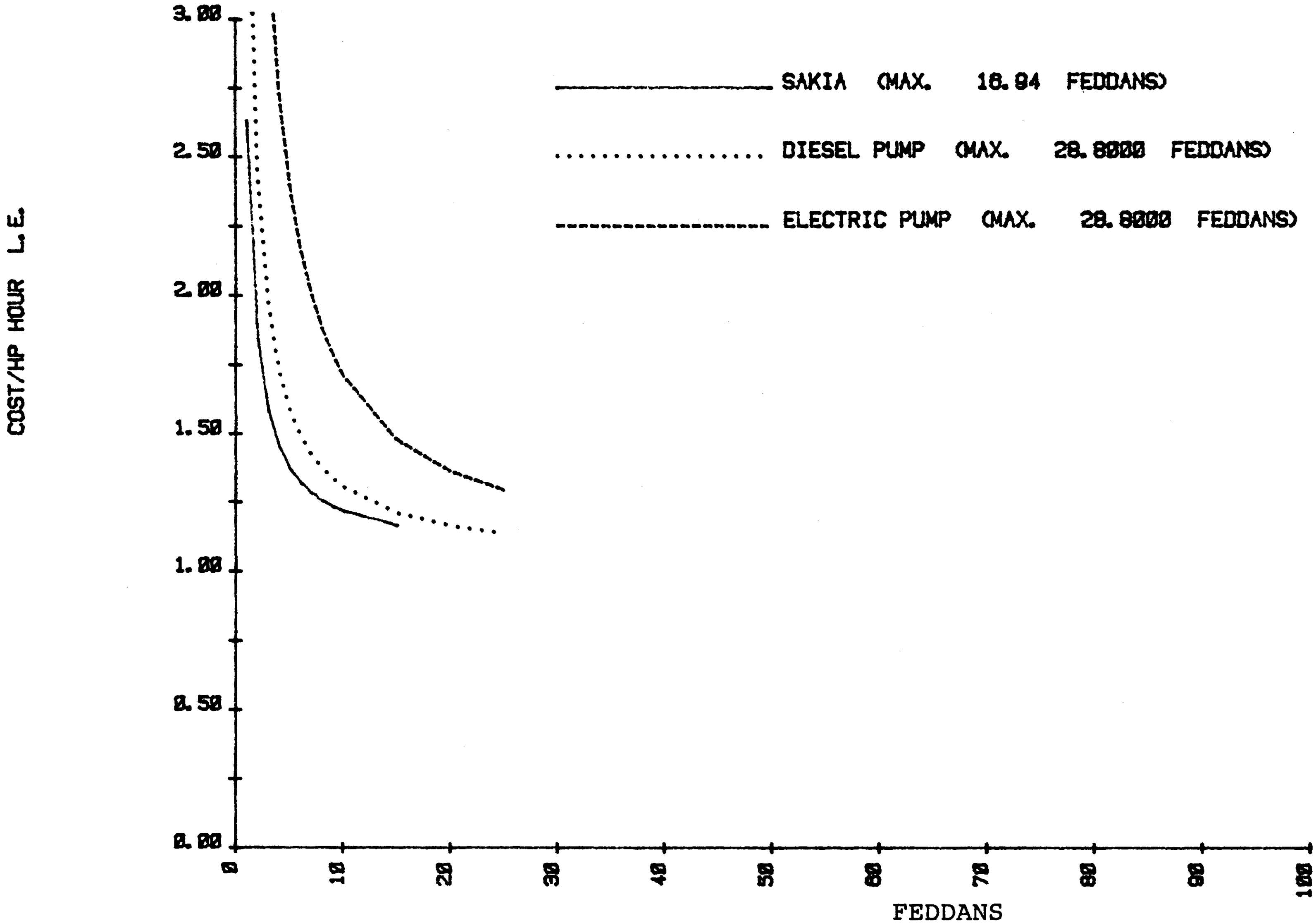

Figure 3: Water Lifting Costs Per Unit of Work Done for Sakia, Diesel Pump and Electric Pump, EWUP Data.

costs of L.E. 0.4 per horsepower hour and from Table 4, L.E. 10.6 per feddan per year.

The cost curves in Figure 3 represent data provided by EWUP scientists.[1/] Examination of these curves and corresponding Tables 5, 6 and 7 reveals substantial differences from Figure 2 and Tables 2, 3 and 4. The difference in unit costs at maximum system capacity for the alternative data sets are shown clearly in Table 8.

Table 8: Comparative Unit Costs of Work Performed for Water Lifting Systems When Operated at Maximum System Capacity.

System	Menoufia		EWUP	
	Cost per Output Horsepower Hour	Cost per Feddan Per Year	Cost per Output Horsepower Hour	Cost per Feddan Per Year
	L.E.	L.E.	L.E.	L.E.
Sakia	2.0	50.0	1.2	29.3
Diesel	1.3	32.0	1.1	28.1
Electricity	.4	10.6	1.2	31.4

SENSITIVITY ANALYSIS

It is not likely that many readers will accept the data presented here without modification. For various reasons there

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1/ See appendix A for discussion and justification for EWUP data.

will be a desire to make some adjustments.

Obviously it is not practical to test all combinations of variables, for each system , and at different levels of magnitude for each variable. This would require many hours of computer time and a very large book to report the results. It is possible and practical, however, to examine a few variables, at different levels of magnitude, in order to assess the impact of each on cost functions. Such analyses will provide the reader with a basis for selecting combinations for further testing.

Present Replacement Price in Egypt

There is room for honest difference of opinion about how much of the nation's electrical infrastructure should be charged to electrification of water lifting. The effect on the cost curve for an electric pump, EWUP data, is shown in Figure 4. The initial cost is reduced from L.E. 2325 to L.E. 800 while holding all other factors constant. The resulting cost curves are shown in Figure 4. The L.E. 800 cost curve would be appropriate if the cost of transformers and transmission lines are omitted from the analysis.

Interest Rate

The cost curves are especially sensitive to interest rates when the system has high capital costs. Figure 5 shows the difference between 6 and 15 percent interest, electric pump, EWUP data with all other factors constant.

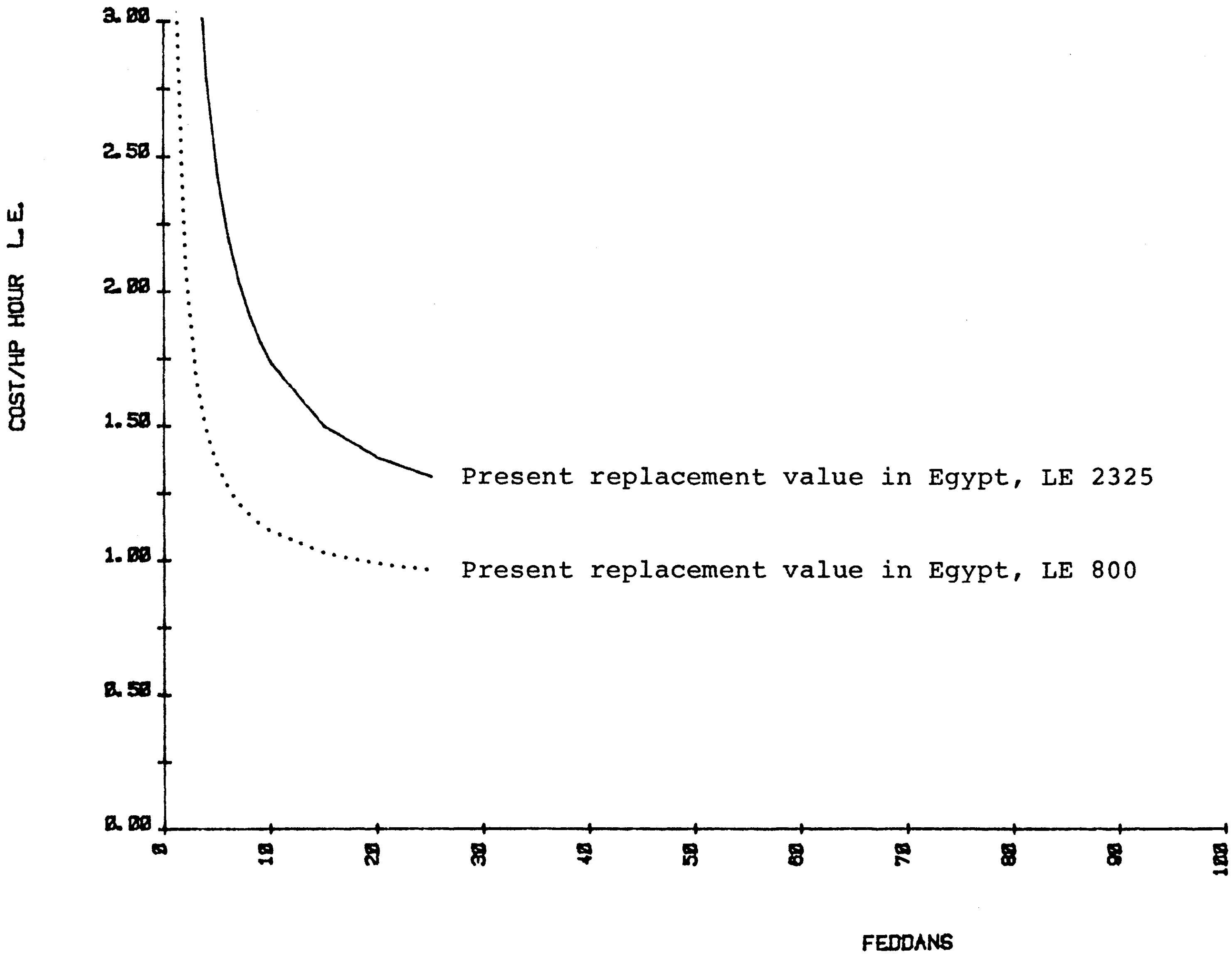

Figure 4: Cost Curve for Electric Pump, EWUP Data, for Replacement Costs of L.E. 2325 and L.E. 800.

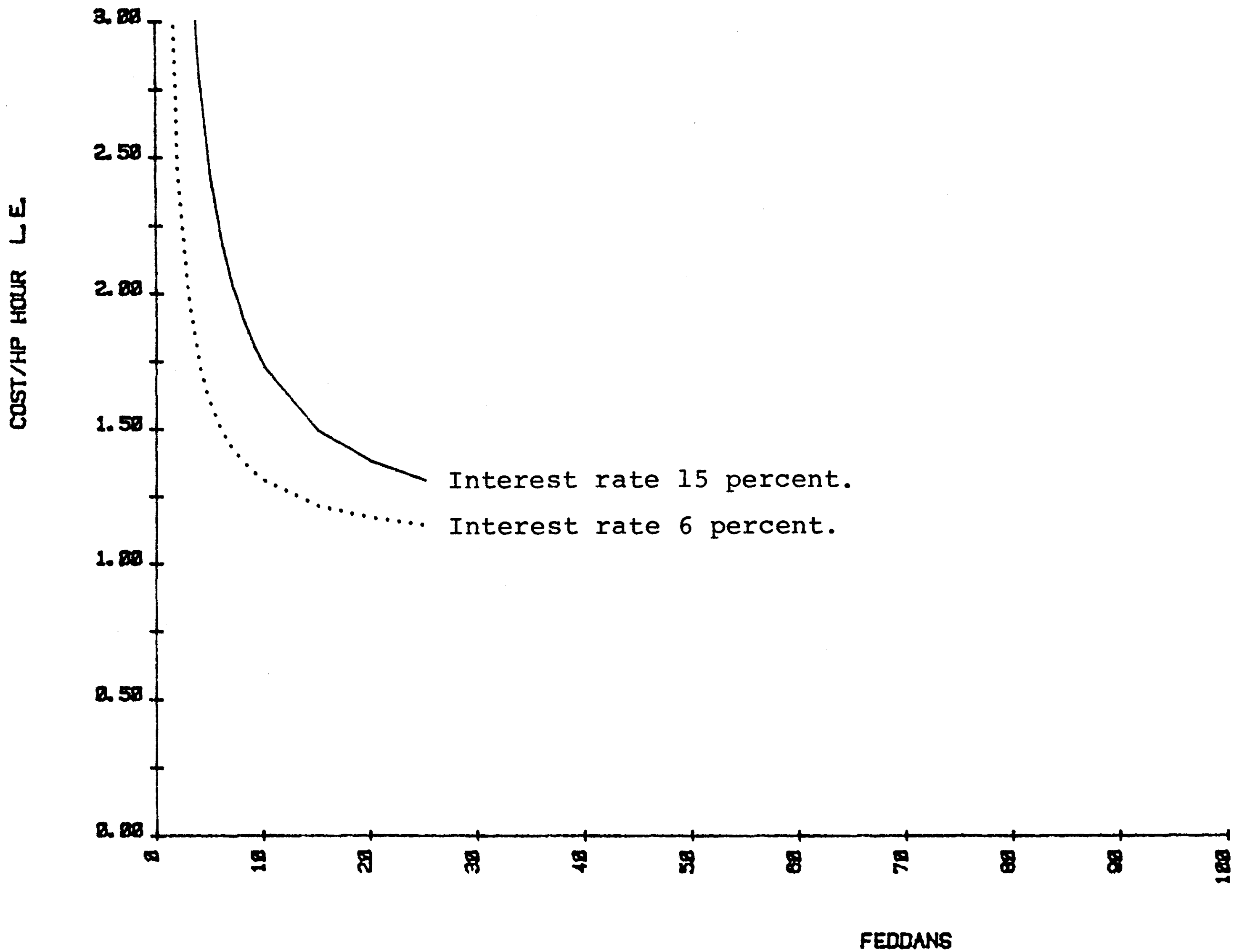

Figure 5: Cost Curves for Electric Pump, EWUP Data, for Interest Rates of 6 Percent and 15 Percent.

Energy Costs

Diesel fuel and electricity prices to Egyptian farmers are subsidized by government. The cost of animal energy is difficult to assess and subject to many different estimates. Figure 6 shows the effect of three different electricity rates on the electric pump costs from Menoufia University. Figure 7 shows the effect on sakia costs of reducing animal power costs from L.E. 0.314 to L.E. 0.15 per hour using the Menoufia University case.

Examination of Figures 6 and 7 suggests that energy prices are of major importance in evaluating water lifting costs and should be given serious attention by policy makers. World energy prices are increasing rapidly. Even if Egypt remains self sufficient in energy she will sacrifice opportunities for obtaining valuable foreign exchange if energy is used domestically rather than exported. The case of animal power is even more

complicated due to the strong dependence by rural people on animals for numerous products including transportation. If agricultural resources are used to feed animals to produce power this obviously affects output of food for human use. The magnitude of this relationship needs to be given careful study in order to have a rational basis for assigning costs to animal power.

Discharge of Pump

Pumps will operate at rated capacity only if delivery canals are adequate to supply the pump intake with sufficient

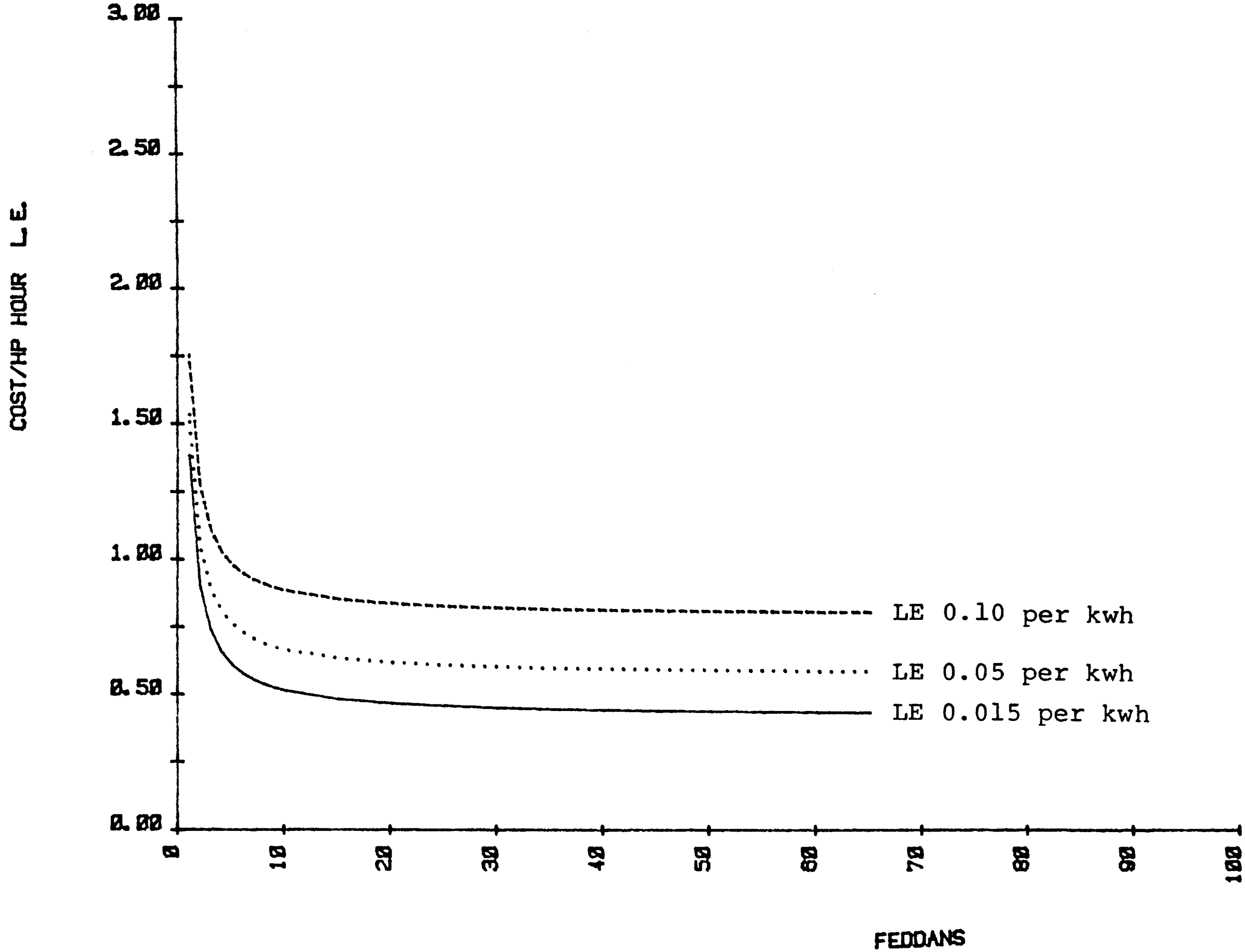

Figure 6 : Cost Curves for Electric Pump, for Electricity Rates of L.E. 0.015, 0.05 and 0.10 per Kilowatt Hour.

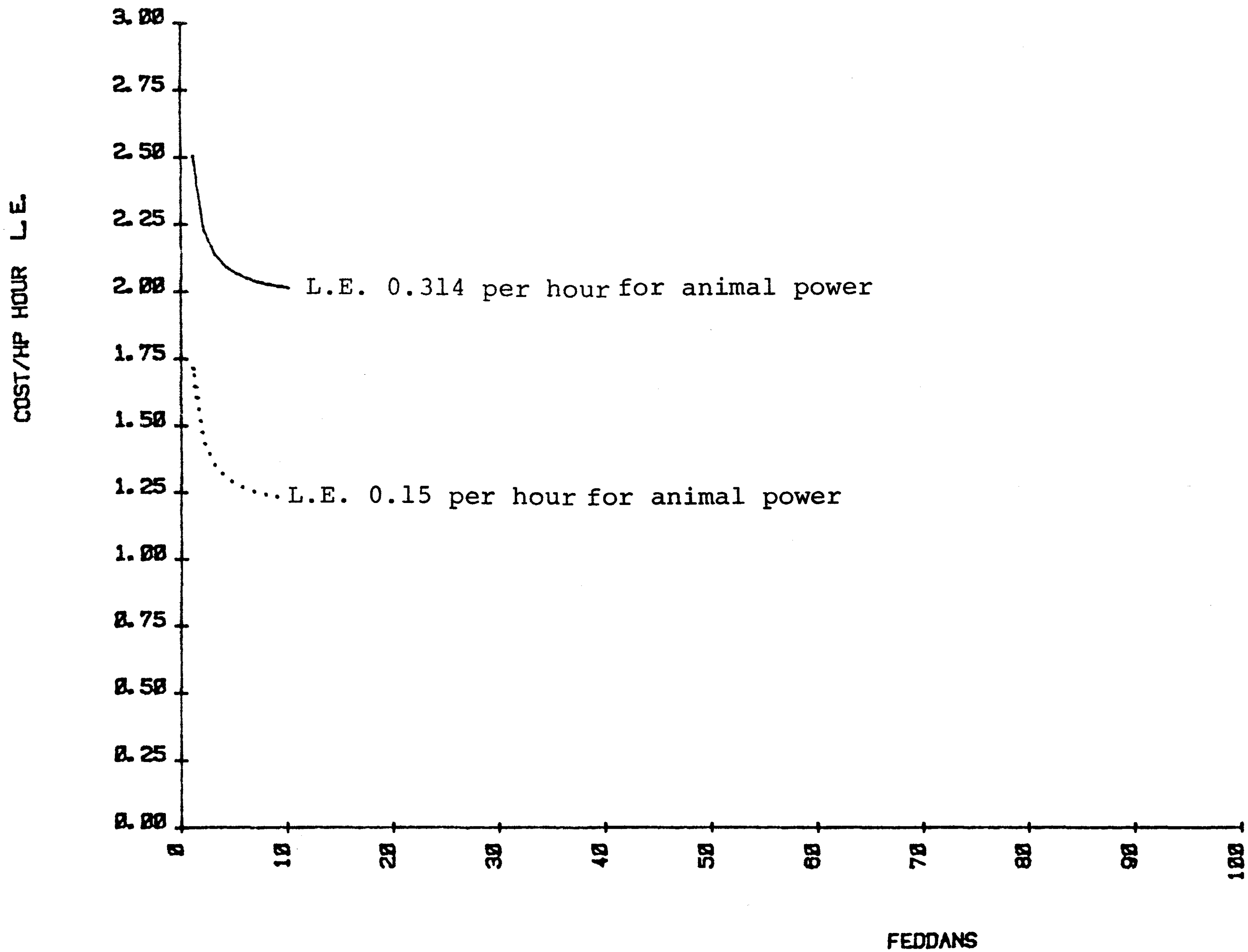

Figure 7: Cost Curves for Sakia, Menoufia Data, for Animal Power Rates of L.E. 0.314 and L.E. 0.15 Per Hour.

water. Empirical data regarding sakia discharge rates shows wide variation but this is largely attributed to the availability of water in canals. Also the design of sakias makes them especially sensitive to the level of water in the sakia well. Their rate of discharge depends on the speed of an animal, which because of habit tends to be more or less constant. It is unlikely that a declining head in the sakia well will be offset by higher revolutions per minute by the animal.

Consequently a fluctuating head is likely to be correlated closely with fluctuating discharge.

The affect on the cost curve for a sakia is shown in Figure 8. Using Menoufia data the discharge rates of 57 m^3/hr. is compared with double that rate, 114 m^3/hr., while holding other factors constant. Notice that unit costs are greatly reduced primarily because less animal power time is required for the same quantity of irrigation water delivered to the fields. Also maximum system capacity is increased in direct proportion to the increase in the discharge rate.

Operator Labor Cost

The amount and price of labor used to operate water lifting systems has an important effect on cost curves. This factor is also difficult to quantify. Empirical studies from Western market oriented economies are probably not valid sources of

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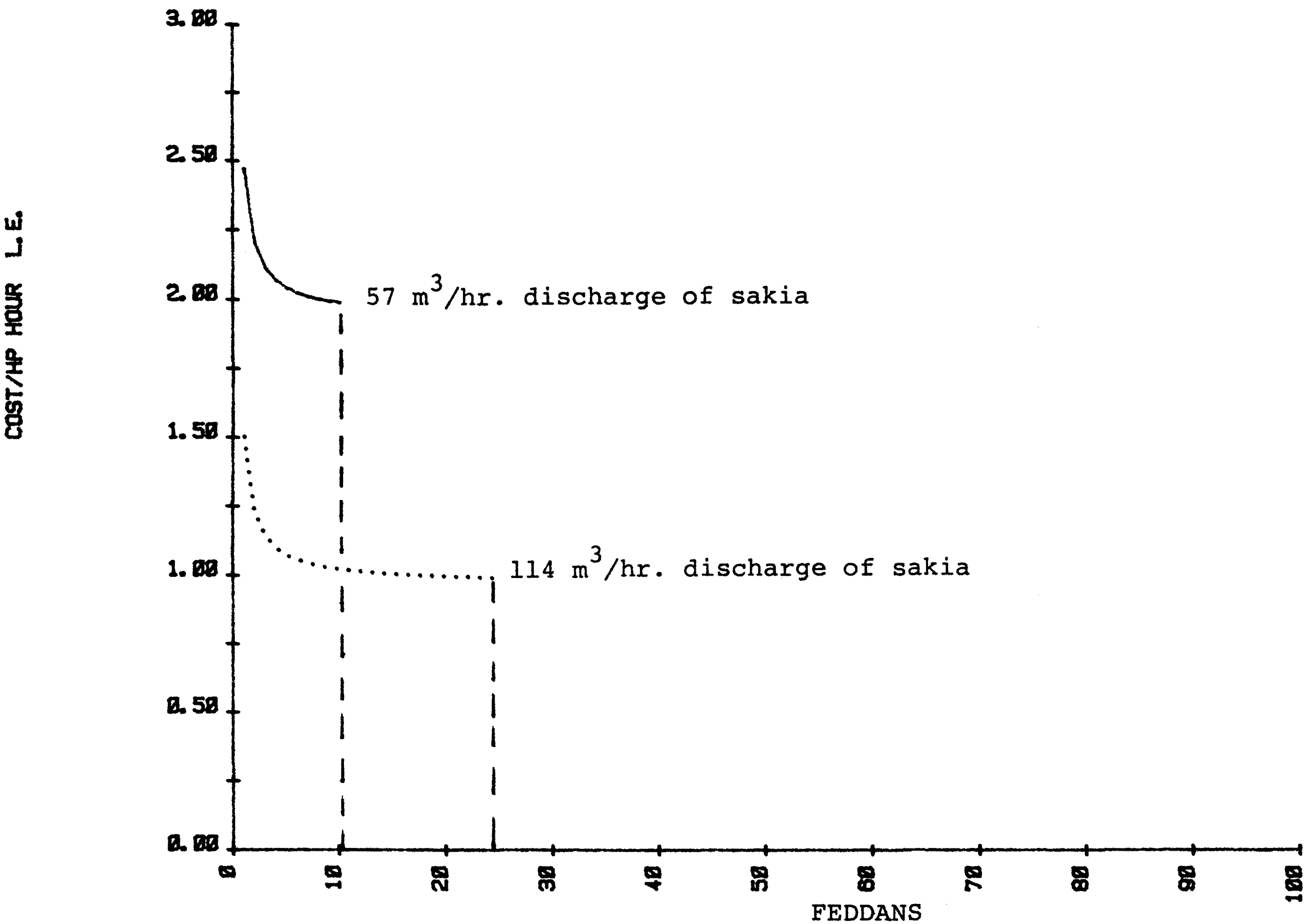

Figure 8: Cost Curves for a Sakia, Menoufia Data, for Discharge Rates of 57 m^3/hr. and 114 m^3/hr.

data. A more useful approach is likely to be a judgement made by an individual farmer regarding the opportunity cost of his own labor or by government policy makers. Questions about wage rates, working conditions, numbers of pumps served by one technician, training provided to pump technicians, are likely to be answered in the public sector. Consequently policy judgements rather than empirical market studies are more likely to be appropriate for assigning operator labor costs.

Figure 9 shows the effect of different operator labor rates on electric pumping costs for EWUP data holding other costs constant. It should be pointed out that changing labor wage rates have more impact on cost curves for low discharge pumps (170 m^3/hr.) than on the higher discharge pumps (300 m^3/hr.) used in the Menoufia study.

Maximum Time System Will Run Per Day

Not only are the cost curves sensitve to the amount of time the system will operate per day but this is a politically sensitive parameter. The area to be served by a system could be maximized and unit costs could be minimized if the system operated 24 hours per day. It may be difficult however, to convince farmers they should adapt to such a system. If not 24 hours then what length of working day is acceptable?

The maximum system capacity increases in direct proportion to hours worked per day while costs per unit of work performed

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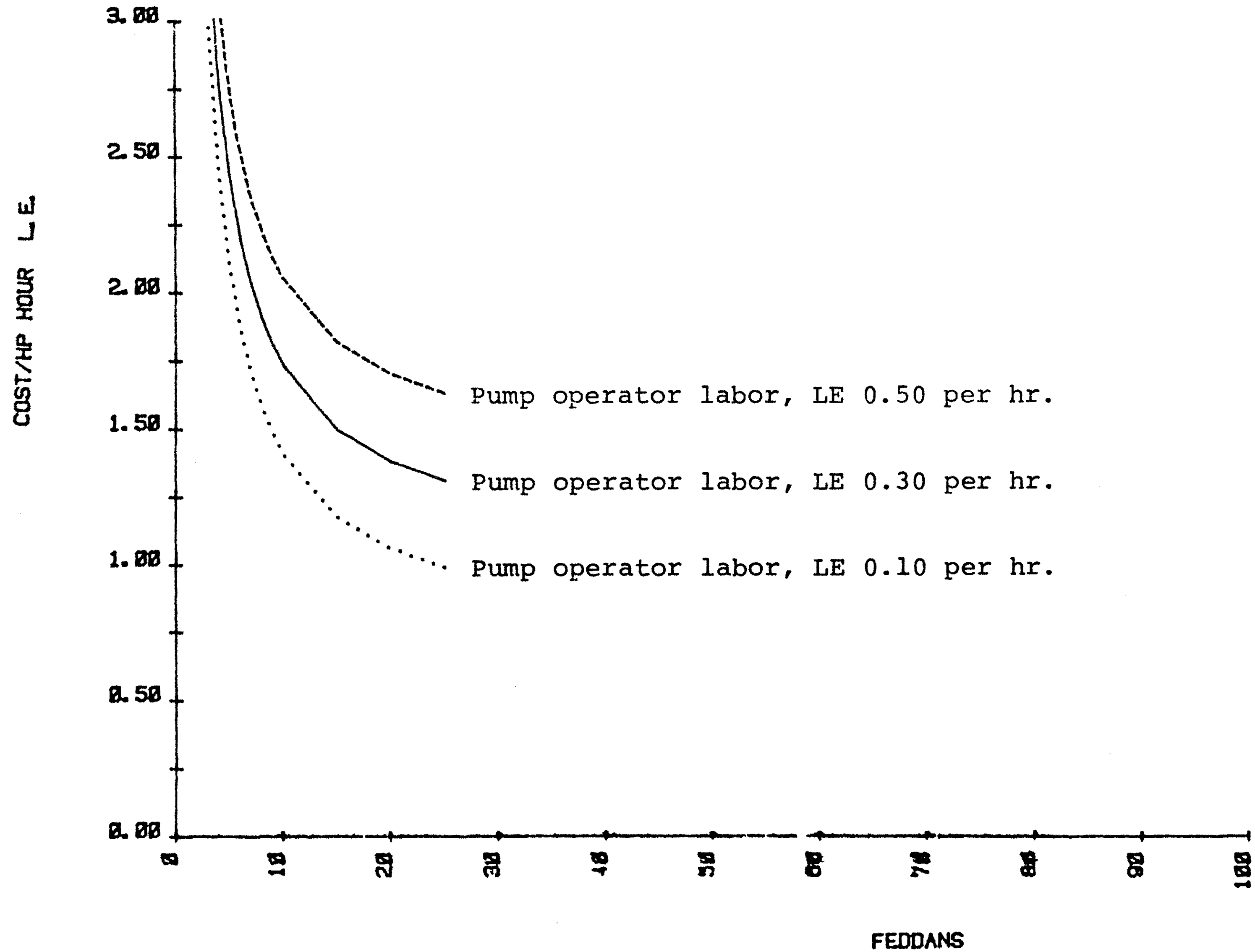

Figure 9: Cost Curves for an Electric Pump, EWUP Data, for Operator Labor Cost of L.E. 0.10, 0.30 and 0.50 Per Hour.

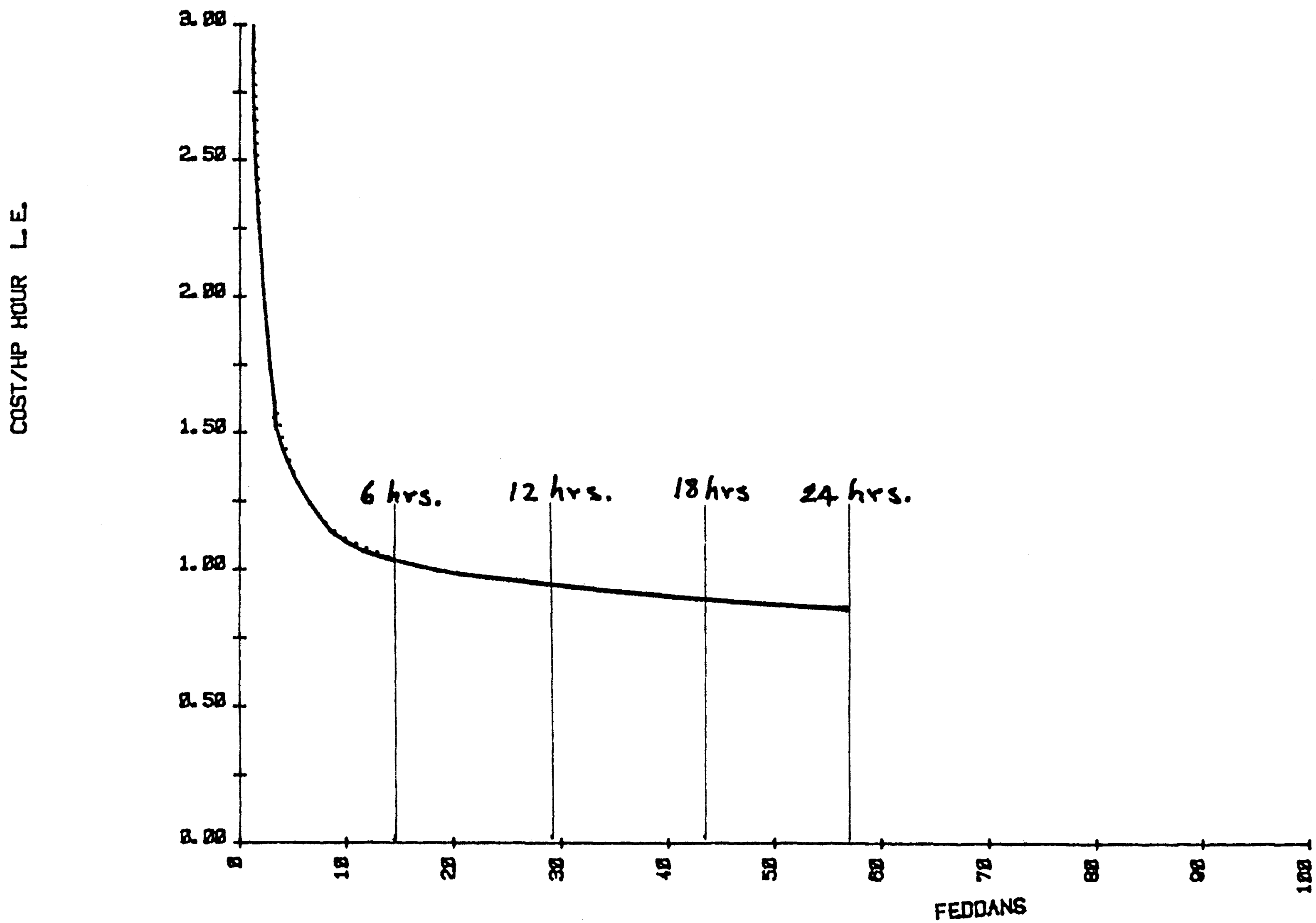

Figure 10: Cost per Unit of Work Done Decreases and System Capacity Increases as Number of Hours per Day the System Operates Increases.

decrease. Figure 10 illustrates this point. Maximum system capacity is, of course, reached when the system operates 24 hours per day.

SUMMARY AND CONCLUSIONS

Cost curves for water lifting systems have been developed using 23 variables. Some of these variables are primarily technical. Their appropriate magnitude depends on physical measurement which can be verified through empirical observation. Other variables depend on subjective judgement about future price relationships, economic conditions and public policy considerations.

Cost curves have been illustrated for sakias, diesel pumps and electric pumps using data sets from two different sources, viz. Menoufia University and EWUP. It has been shown that the cost curves from these two sources suggest contradictory conclusions regarding public policy decisions. If the Menoufia University data and judgements are acceptable to decision makers, then it should be appropriate to encourage electrification of water lifting systems in Egypt. If the EWUP data and judgements are perceived to be practical and consistent with Egyptian national interests, then it would appear more appropriate to leave the existing sakia systems as they are now.

The model lends itself to use by policy and decision makers. Selection of alternative values to be tested in the model could be made by persons responsible for making decisions. If it is agreed to delay decisions pending more evidence for a specified variable, then research efforts could be authorized to improve the basis for assigning values.

Individual entrepreneurs may use the model to test alternative investment opportunities. Minimizing the cost of performing work should lead the entrepreneur to higher profits. He can use values for each specified variable that are appropriate to his circumstances. Comparison of the resulting cost curves should result in better entrepreneurial decision.

The national implications of this report are significant. Decisions to mechanize water lifting may lead to substantial capital investments which reduce flexibility for future policy alternatives. For example it would be difficult to shift to gravity irrigation in the future if heavy investments were already committed to an electrified lifting system. Consequently the policies related to water lifting are of major significance and should be studied carefully. The model illustrated in this report can be extremely useful in studying alternatives and reaching sound decisions.

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APPENDIX A

EXPLANATION OF EWUP DATA

The data to be used in the analytical model should be realistic from a technical point of view and appropriate with respect to current and future needs of the Egyptian nation. EWUP data, which may require special explanation, documentation or clarification are discussed below.

1. Present replacement price in Egypt. Cooperating farmers and equipment companies provided information used in the estimates for sakias, diesel pumps and electric pumps. Cairo dealers reported the present price of 7.5 horsepower electric pump and motor sets to be L.E. 992 for a unit of good quality. According to the Rural Electrification Authority, Ministry of Electricity, the cost of a 25 KVA transformer is L.E. 4,000. Assuming this would be shared by 3 pumps, one-third cost is added to the cost of the pumpset for a total initial cost of L.E. 2325. It should be noted that this amount does not include the cost of transmission and distribution lines. Although the cost of major transmission lines are usually amortized and included in the user price of electricity it is not clear whether the secondary and tertiary distribution lines to field location transformers should be charged to pumping. If they are the initial cost of an electric pump station should be increased accordingly.

.../...

2. Wearout life for each unit is based on the judgement of reliable manufacturers and on the experience of pump users. It assumes good maintenance and ample allowance for spare parts.

3. Expected average repair cost is a judgement reached after interviewing pump users. The reliability of these data could be improved by keeping records on different pump systems through time.

4. Fuel consumption is based on manufacturers specifications. It may be higher under field conditions but again, records or tests under field conditions are needed.

5. Fuel cost is based on Pacific Consultants, *op.cit.* page 18. One may wish to use projected prices for long range planning. The current subsidized price for diesel fuel is L.E. 0.03 per liter.

6. Oil cost is based on manufacturer's recommendation to change oil each 100 hours of use.

7. Grease cost is estimated from interviews with farmers.

8. Electrical energy required is computed by use of the formula on the Data Input Form, page 5a. This formula considers the pump unit's discharge rate, dynamic head and the efficiency of the pump, drive and motor.

9. Electricity cost is based on Pacific Consultants, *op. cit.*, page 17. The present subsidized price for electrical energy is L.E. 0.015 per kilowatt hour. Projected prices for long range planning should also be considered. According to one report Egypt's hydroelectric energy potential is "almost completely exploited".[1/] This leaves one to conclude electric energy for future projects will be based on scarce resources at world prices.

.../...

1/ U.S. Department of Energy "Joint Egypt/United States Report on Egypt/United States Cooperative Energy Assessment", Vol.1, April, 1979, page ES-5.

10. Salvage value at end of wearout life is considered to be zero. One could assign a wearout life to each component of the system and then place a "salvage value" on all longer lifed components based on their estimated values when the shortest lifed component wears out. Such refinements are unlikely to have much effect on the analytical results.

11. Taxes, license, permits, rent, etc. The only annual cost in this category which seemed relevant to water lifting was the cost of land occupied by the sakia. The amount of land required varies from 50 to 175 square meters or more depending on whether the site contains shade trees and feeding space for animals. Since the market value of annual land rent is about L.E. 2.0 per year for 175 square meters, this value was assigned.

12. Interest rate. In view of world interest rates and potential returns from Egyptian investment alternatives 15 percent seems to be a reasonable rate for determining the cost of capital of water lifting systems. Pacific Consultants, op. cit., Table 1 following Annex G, list nine agricultural projects in Egypt which have projected internal rates of return in excess of 15%.

13. Operator or labor cost is difficult to assess. The amount L.E. 0.05 per hour for a sakia seems consistent with other

studies and is perhaps adequate unless one considers the cost of the young boys driving animals turning sakias in terms of their forgone opportunity of going to school. Given the work habits of rural laborers L.E. 0.30 per hour for overseeing mechanical pumps seems realistic and consistent with information obtained by farmer interviews.

14. Discharge of pump. Data from EWUP observations indicate a 3-meter sakia, lifting water one meter from a well with an adequate flow into the well, is capable of discharging 100 m^3 per hour (see Appendix E). The discharge rates for diesel and electric driven pumps are taken from the respective manufacturer's specifications.

15. Animal energy cost is one of the most sensitive variables associated with sakia costs. EWUP data, based on farmer interview, indicate L.E. 0.30 per hour is realistic. This assumes cows are worked, in rotation with other cows, not more than three hours per day. This achieves normal discharge from a sakia assuming adequate head in the sakia well. The rationale for asking farmers about the rental rate of cows for turning a sakia is that they will, on the average, correctly evaluate the cost of extra feed and the reduction in meat and milk associated with working the animals.

This value is verified by Nasser[1/] in a report where he accounts for extra feed, milk losses and cow depreciation. He reports a cost of animal power of L.E. 37.6 per feddan per year. It is deduced from his report that 120

1/ Nasser, Abdel Hady Abdel Bary, op. cit. pp. 63-64.

hours are spent each year to irrigate one feddan which results in L.E. 0.314 per hour as the cost of using a cow on a sakia. Some studies support the point of view that animal production is traditional among villages and the relationship between mechanization and animal production is very loose.[1/] The latter point of view suggests assigning a low cost to animal produced energy.

There are long run and short run considerations regarding the replacement of animal power with machines. With respect to long run considerations a recent study reports improved ruminant livestock would enable the annual meat and milk offtake to increase by nearly 3 fold in areas where ruminant livestock are no longer required for draft power.[2/] The report indicates such an increase would require a comprehensive program of improved animal breeding, forage production and nutrition. Such a program

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1/ See for example Hopkins, Nicholas S., "Imposed Utilization of Feed Resources for the Livestock Sector - Rural Sociology Segment". Unpublished draft of a report to USAID, Jan. 1980.

2/ Winrock International Livestock Research and Training Center, "Improved Utilization of Feed Resources for the Livestock Sector", Preliminary Draft, United States Agency for International Development, Catholic Relief Service, Cairo, A.R.E., January 1980.

.../...

would take time to establish but could generate long run gains which would contribute to justification of mechanization. As stated earlier the short run gains from releasing animals from providing energy to turn sakias appears to be of lower magnitude. Further EWUP research is aimed at providing more information on this subject.

16. Overall efficiency, relating input horsepower to the amount of work performed, is not especially important in the case of diesel pumps or sakias since their energy source is priced in terms of fuel and animal power per hour. It is important in the case of electric pumps when energy is priced in terms of kilowatt hours. Manufacturer's specifications are used.

17. Engine efficiency. The discussion above (16.) also pertains to the engine efficiency.

18. Static head simply reflects the amount of lift from the farms source of water to the field distribution ditches. It is believed that one meter reflects most conditions in Egypt but this value can easily be adjusted to accommodate special situations. It is important in the calculation of output horsepower hours required to irrigate a given area.

19. Dynamic head has been previously defined. It is taken from manufacturers specifications for low pressure pumps.

20. Water duty per year is based on typical conditions at field sites of EWUP. It can also be easily adjusted to fit special conditions.

21. Maximum time system will run per day is an important parameter in establishing the size of area a system can serve. If farmers pay the full cost they will have maximum incentive to use the system for long periods each day. If the government pays the costs it will be more difficult to convience farmers to operate the system beyond their normal working hours. The EWUP data assumes typical daylight working hours.

22. Minimum irrigation interval can be computed if crop patterns, consumptive use for each crop, and soil characteristics are known. The EWUP data assumes a cropping pattern which requires frequent irrigation.

23. Maximum water required per irrigation can be computed with the above information plus information about water application efficiency. The EWUP data assumes typical water application efficiency with a liberal margin of safety.

APPENDIX B

COMPUTATIONS OF POWER REQUIREMENTS AND EFFICIENCIES

Pumps used for lifting water from delivery canals to fields should be of low pressure design. The maximum design head should not exceed 4.0 meters.

The equation for computing water horsepower (WHP) in metric units is:

$$WHP = \frac{W \cdot H}{75} \qquad (1)$$

where: W is discharge flow in liters per second.

H is the total dynamic head in meters.

or

$$WHP = \frac{Q \cdot H}{270} \qquad (2)$$

where: Q is discharge flow in cubic meters per hour.

The equation for computing brake horsepower (BHP) required to operate a pump is:

$$BHP = \frac{WHP}{\text{Overall Efficiency}} \qquad (3)$$

where: overall efficiency is pump efficiency x drive efficiency

Power Requirements for Electric Motors

The BHP of the motor is determined by combining equations (2) and (3), that is:

$$BHP = \frac{Q \cdot H}{270 \text{ Overall Efficiency}} \qquad (4)$$

.../...

To compute the input to the motor the efficiencies of electric motors must be considered. In determining the consumption in kilowatt hours (KWH), the following formula is applied:

$$KWH = \frac{Q \cdot H}{270 \text{ Overall Efficiency}} \times \frac{0.7457}{\text{Motor Efficiency}} \quad (5)$$

For small electric motors running at full speed (1760 rpm), motor efficiency is about 85 percent. Then equation (5) becomes:

$$KWH = \frac{Q \cdot H}{270 \text{ Overall Efficiency}} \times \frac{0.7457}{0.85}$$

or

$$KWH = \frac{Q \cdot H}{307.76 \cdot \text{Overall Efficiency}}$$

Power Requirements for Internal Combustion Engines

Equation (4) can be applied, with necessary corrections for temperature, continuous operation and altitude.

Power Requirements for Sakia

Power requirements for sakias can be calculated by comparing work done by either electric or internal combustion engine driven pumps.

The time ratio between a pump and a sakia to deliver a specific amount of flow can be used to determine the brake horsepower of the sakia as follows:

$$(BHP)_S = (BHP)_P \times \frac{t_P}{t_S} \times \frac{H_S}{H_P}$$

where: $(BHP)_S$ is the break horsepower of a sakia.

$(BHP)_P$ is the break horsepower of a pump.

t_P is the time required for a pump to lift a specified amount of water.

t_S is the time required for a sakia to lift the same specified amount of water.

H_S is the dynamic head of sakia.

H_P is the dynamic head of pump.

APPENDIX C

DATA INPUT FORMS - WATER LIFTING COSTS

DATA INPUT FORM - WATER LIFTING COSTS

Data prepared by ______________________ Date ______________

Tape ; Track ; File

A$ (*)	
1. Name of machine ....(19)	1. ________
2. Make ....(19)	2. ________
3. Model ....(9)	3. ________
4. Size ....(9)	4. ________
5. Power source (DIES. ELEC. ANIM.)	5. ________
6. Date (day, month, year) DDMMYY ....(12)	6. ________
A *	
1. Present replacement price in Egypt, LE ....(12)	1. ________
2. Wearout life, hours ....(12)	2. ________
3. Expected average repair cost, LE/hour ....(12)	3. ________
4. Fuel consumption, liters/hour ....(12)	4. ________
5. Fuel cost, LE/liter ....(12)	5. ________
6. Oil cost, LE/100 hours ....(12)	6. ________
7. Grease cost, LE/100 hours ....(12)	7. ________
8. Electric energy required, kilowatt hours 2/ ....(12)	8. ________
9. Electricity cost, LE/kilowatt hour ....(12)	9. ________
10. Salvage value at end of wearout life, LE ....(12)	10. ________
11. Taxes, license, permits, rent, etc., LE/year ....(12)	11. ________
12. Interest rate, percent ....(12)	12. ________
13. Operator or labor cost, LE/hour ....(12)	13. ________
14. Discharge of pump, cubic meters/hour ....(12)	14. ________
15. Animal energy cost, LE/hour ....(12)	15. ________
16. Overall efficiency, decimal from .01 to 1.0..........(12)	16. ________
17. Engine efficiency, decimal from .01 to 1.0...........(12)	17. ________
18. Static head, meters 3/ ....(12)	18. ________
19. Dynamic head, meters 4/ ....(12)	19. ________
20. Water duty per year, cubic meters/feddan ....(12)	20. ________
21. Maximum time system will run per day, hours ....(12)	21. ________
22. Minimum irrigation interval, days ....(12)	22. ________
23. Maximum water required per irrigation, cu. meters/fed.(12)	23. ________

1/ Maximum characters allowed.

2/ Kilowatt hours = $\frac{\text{Discharge in m}^3\text{/hr x Dynamic head in m.}}{\text{362 x Overall Efficiency x Engine Efficiency}}$

3/ Static head is defined as the distance between the water level in the delivery canal or pump station well and the water level required in field distribution ditch.

4/ Dynamic head is defined as the difference between the water level in the delivery canal or pump station well at the point of suction and the discharge point of the pump plus losses.

APPENDIX D

Development of the Water Wheel Design for Field Irrigation

Introduction

Due to the large increase in the cultivated area in the U.A.R., it was necessary to adopt a new system of field irrigation by lifting the water from distributary canals to the field instead of raising the water levels of the canals and discharging the water by gravity to the land.

The Hydraulic Research and Experiment Station at the Delta Barrage is requested to study and develop the design of the water wheels. The Tanabish water wheels have become the most popular means of lifting water in the last years. This is due to the simplicity of its operation, the low initial and running costs and the durability of the machine. The Tanabish can either be driven by animals or by mechanical power.

The Hydraulic Research and Experiment Station carried out a test program on five different designs of the Tanabish which were 6 cm thick and 75 cm in diameter. The different bucket shapes tested were:

1. The archimedian spiral curve (A).
2. The empirical design according to Professor Ali Fathi's suggestion (F).
3. The logarithmic spiral curve (L).
4. The first design suggested by the HRES "D_1".
5. The second design suggested by the HRES "D_2".

Figure (1) shows the different designs tested.

The Model and the Measuring Devices

Figure (2) shows the experimental setup. It consists of:

1. A glass flume 1.00 x 1.00 x 80 cm. The sides were made of glass. Water is discharged to and from the flume through

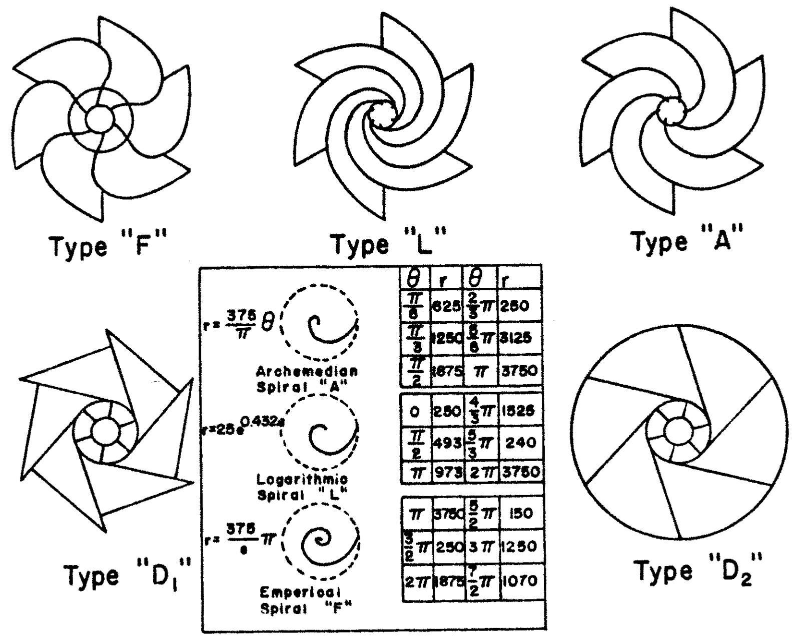


Figure 1

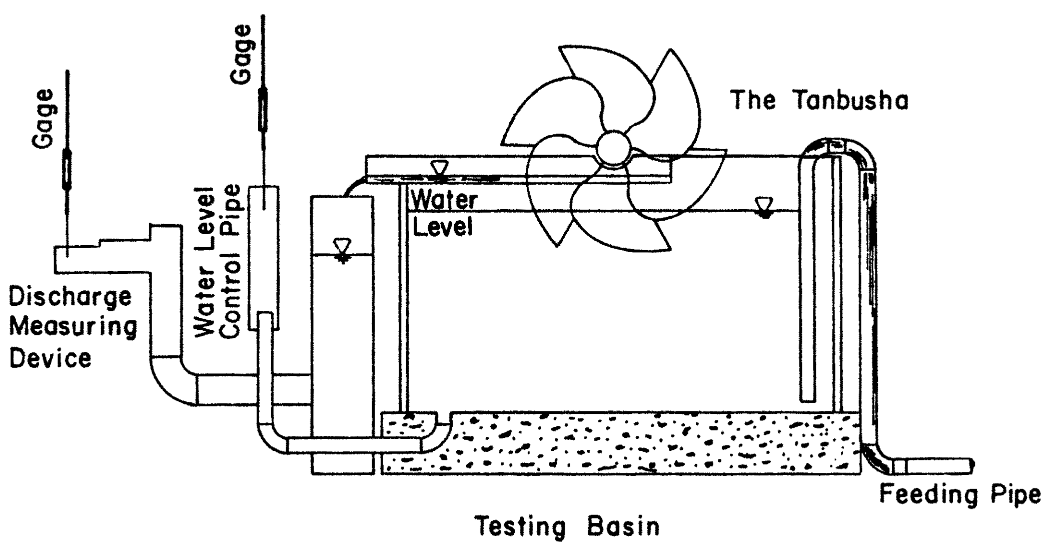


Figure 2

circular pipes in the concrete base. This flume simulates the prototype sump from which the Tanabish lifts the water.

2. The outlet channel: It consists of a wooden channel which collects the water discharging from the water wheel.

3. The discharge measurement: The california pipe method was used for measuring the discharge from the Tanabish. The method is most suitably for small discharges. It consists of a 4 inch pipe equipped with a point guage for measuring the water levels in the pipe. This set was calibrated and the following equation was found to fit the calibration data:

$$Q = 0.165\ (d - a)^{1.974}$$

where (d - a) is the water head at the end of the pipe in cms and Q is the discharge in liters per second.

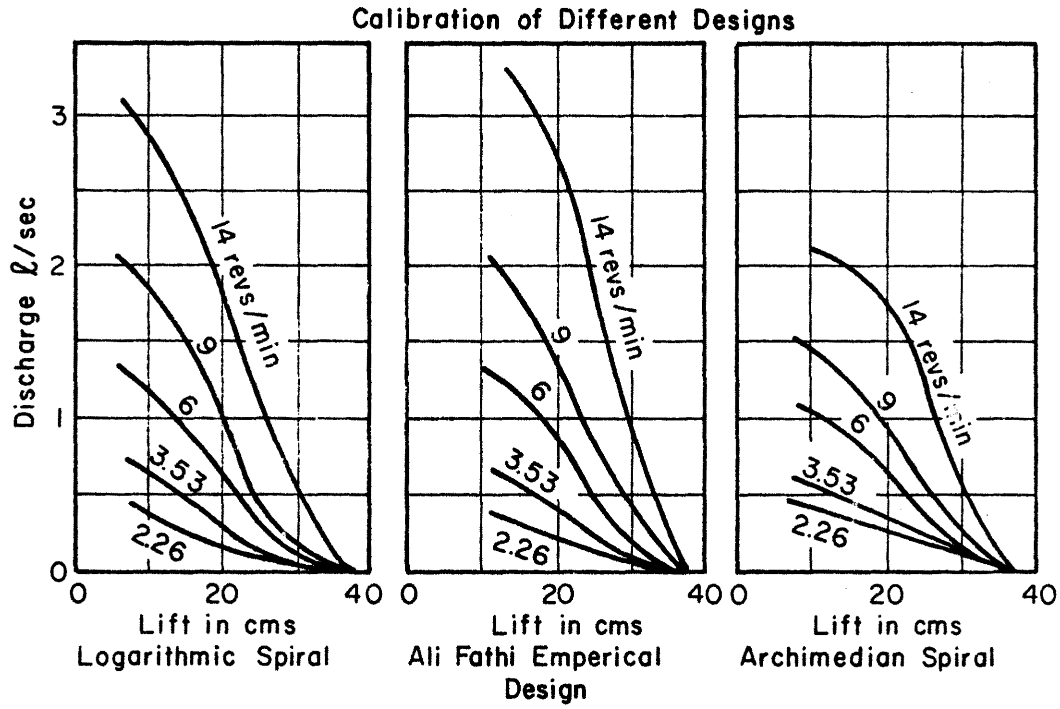
4. The skimming weir: It consists of a 4" pipe connected to the flume on which slides a 6" pipe used as an overflow weir to ensure a constant level in the flume. It is also fitted with a point gage for water level recording.

5. The feeding pipe: The flume is supplied with water through a 2" pipe. The amount of discharge was adjusted by a valve. A screen mesh was also placed at the pipe exit to avoid surface disturbances in the water. The pipe was supplied with water from an overhead constant head bank.

6. The driving equipment: The wheel was driven by an electric motor equipped with a gear box to adjust the rpm which varied between 2 and 14 rpm.

Results of the Calibration of the Three Types of Tanabish Used Currently in the Prototype

Several experiments were carried out on each of these three types. It includes Tanabish having 6, 8, 10 and 12 buckets. The following diagrams show the results of this test.



It was observed in these tests that there is interference between adjacent buckets i.e. some of the water discharging from one bucket did not discharge to the next channel but it fills again the following bucket. This reduced the efficiency of the machine considerably (Figure A).

Other losses are also due to the overflow of water through the entrance of the bucket as it turns out of the water. The amount of this loss was found to be less then 0.5%. This loss also decreased with the decrease of the number of revolutions per minute (Figure B).

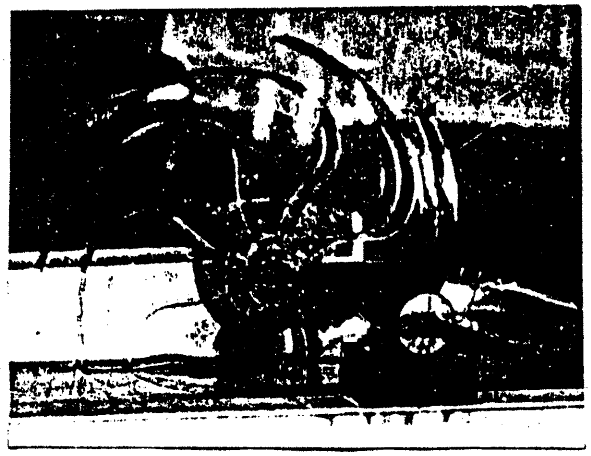


Figure A

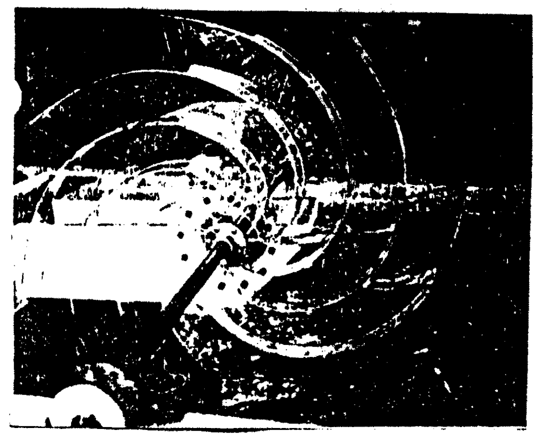


Figure B

<u>The Design of the Bucket Exit and the Relationship Between the Discharge and the Number of Buckets</u>

Guide vanes were used in the bucket exits to separate the water paths through the bucket completely. By this method, the discharge from the wheel will be equal to the product of the discharge through one bucket by the number of the buckets. Figure (3) and (4) show the increase in the total discharge due to the separation of the buckets.

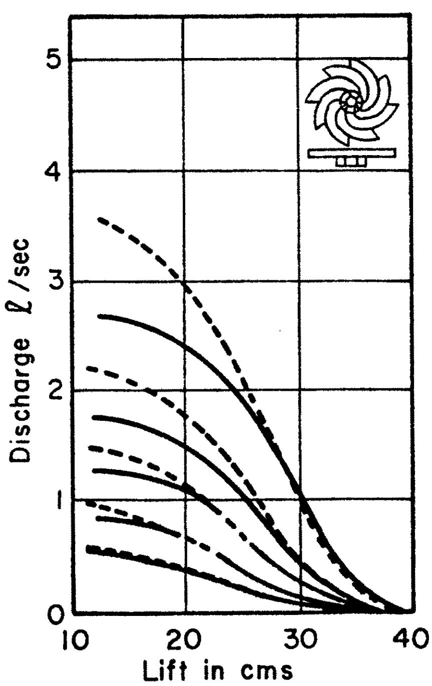


Figure 3

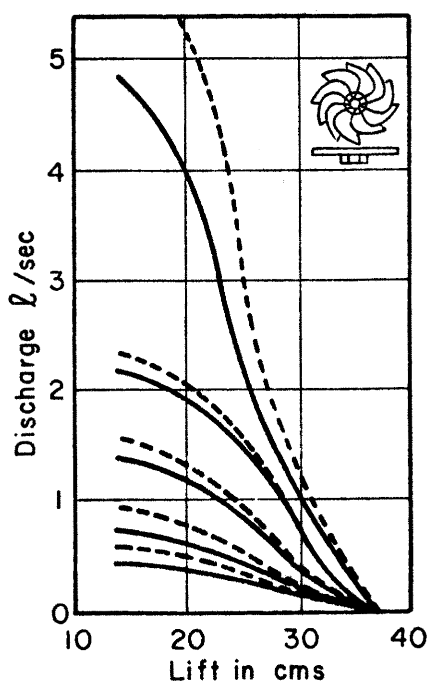


Figure 4

The Empirical Discharge Results

A relationship between the amount of water discharged by the Tanabish and the lift was derived. Figure (5) shows this relationship for the different types of Tanabish at the very low speed of rotation. Assuming that N is the number of buckets, t is the time during which the water of one Tanabish is discharged and L is the lift, the equation is given as:

$$Q = C_d \frac{V\,N}{t}$$

where C_d is the coefficient of discharge and V is the volume of one bucket. It was observed that the values of C_d is not constant for the three types which shows that C_d depends upon the shape of the bucket.

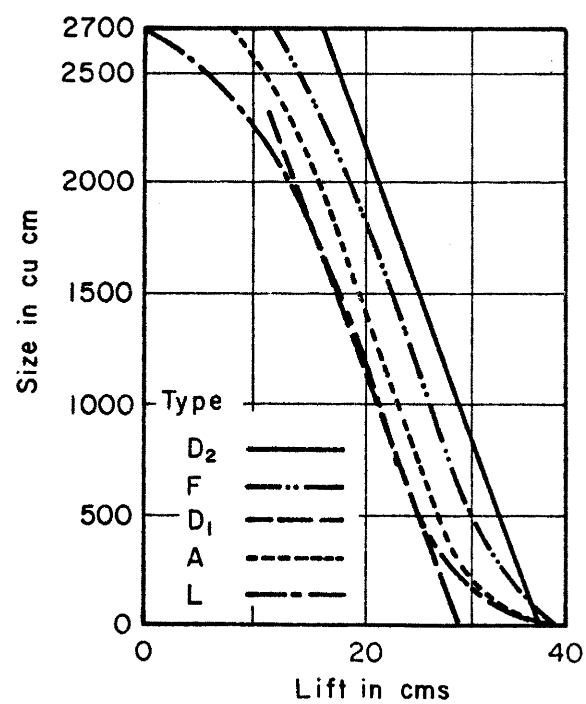


Figure 5

For the D_1-6 design, the relation between V and L is linear although C_d is varied considerably. Modification of this type gave the D_2-5 design in which C_d proved to be constant for each speed of revolution but it does not depend upon L. The following equations show the calibration for this design.

$$Q = \frac{1}{t}\ (16.4 - 0.456\ L) \qquad \text{for 3.53 rpm}$$

$$Q = \frac{1}{t}\ (32.4 - 0.9\ L) \qquad \text{for 6 rpm}$$

$$Q = \frac{1}{t}\ (50.3 - 1.4\ L) \qquad \text{for 9 rpm}$$

The advantages of this design are:

1. The simplicity of the design and the easiness of the manufacture.
2. The increase of discharge varied between 125% and 295% as compared to the best of the previous three designs.
3. The relationship between Q and L is linear.
4. It is easy to find both C_d and t experimentally. They do not depend upon any other factors. Figure (6) shows a comparison between the different design of Tanabish.

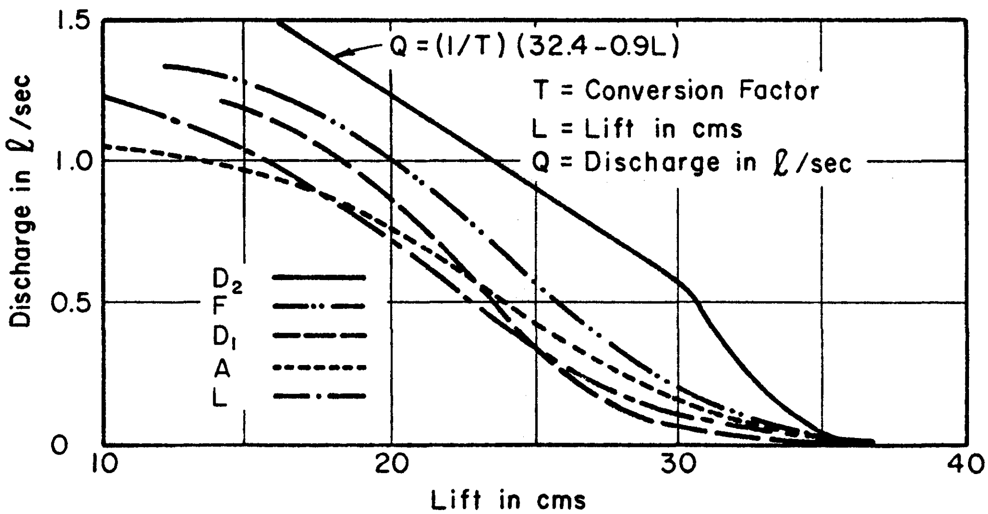


Figure 6

APPENDIX E

EWUP ANALYSIS OF SAKIA DISCHARGE DATA

Data were collected on discharge, lift head, speed in revolutions per minute and total time of irrigation at a dozen sakia locations in 1978 and 1979. The discharge was measured by use of cutthroat flumes.

Several functions were fitted to the data by standard statistical methods. The function giving the best fit is

$$Q = K \quad n\left(\frac{r-h}{r}\right)^{Z}$$

where: Q is discharge in cubic meters per hour
K = 50.7
n is revolution per minute
r is radius of a sakia in meters
h is the lift head in meters
Z = .6252

The data indicated the simple arithmetic average of revolutions per minute is 3.3 r.p.m. This included observations where animals were not driven actively, sometimes stopping completely for various reasons.

The average discharge (Q), under such conditions for a sakia of 1.5 meters radius (3 meter diameter) and lifting water 1 meter is

$$Q = 50.7 \times 3.3\left(\frac{1.5 - 1.0}{1.5}\right)^{.6252}$$

$$= 83.7 \quad mt^3/hr.$$

If we assume animals can be managed in such a way as to achieve 3.9 revolutions per minute the discharge increases to 100 m^3/hour. Based upon field research and experience this appears to be feasible but of course requires good management of the animal as a source of power. It also depends on the desire of the farmer to achieve high rates of irrigation.

See next page for sakia discharge observations and regression function.

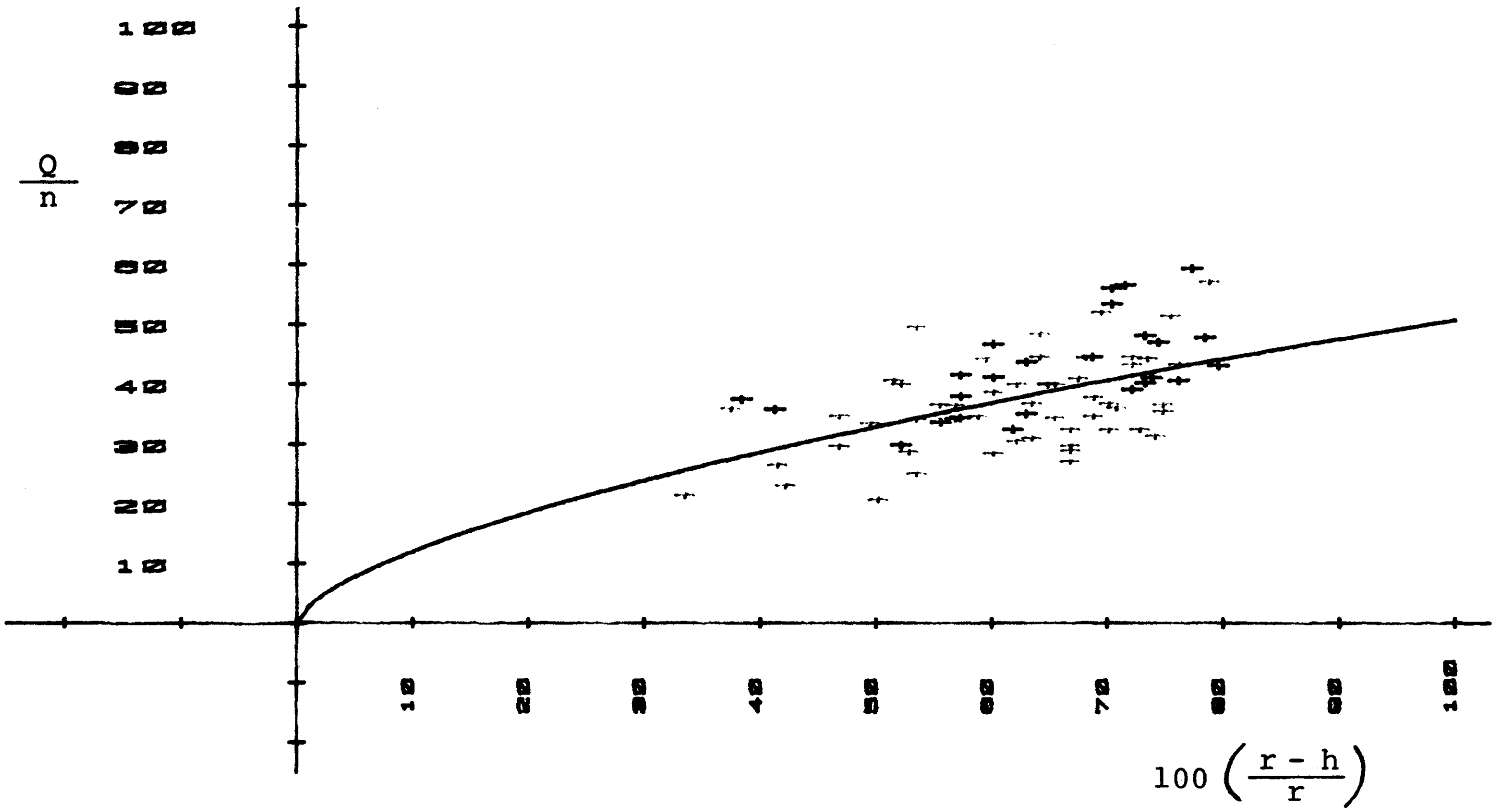


Figure E.1: Sakia Discharge Observations and Regression Function

$$\frac{Q}{n} = 2.8492 \left[\frac{100\ (r-h)}{r}\right]^{.6252}$$

Staff Paper #24

EFFECTIVE EXTENSION FOR EGYPTIAN RURAL DEVELOPMENT; FARMERS' AND OFFICIALS' VIEWS ON ALTERNATIVE STRATEGIES

M. S. Sallam. E. C. Knop and S. A. Knop

The Extension Dimension of Development

For almost a century, persons involved with rural and national development efforts have been exposed to the term "extension" yet, even now, few are fully aware of what is implied by the term. The most common connotation, training in newer procedures (usually occupational ones), is but a part of extension processes, and often a rather minor part. In technically correct usage, extension is a family of processes by which organizations and individuals extend their superior knowledge, skills and insights to other who should benefit from them. Generally, then, extension is an approach to achieving development which focuses on building others' understanding of what changes would be beneficial, why, and how they can be achieved. While it involves "basic education" as a central component (which is more complete and in-depth than simple "training"), extension also involves innovative coordination/organization, some institutional changes, having "approporiate technology" to extend or support the process, and, perhaps most importantly, a suitable "mind set" (intellectual & attitudinal orientation) on the part both of those doing and receiving the extended knowledge, skills and insights.

As with any distinct approach, extension is as much as a "philosophy" as it is a set of techniques for being effective in conveying new meanings to others. It is based in unique assumptions which make it a distinct approach, and which provide the general guidance for its practice. Some of these assumptions include the following:

1. The social ideal of perpetual incremental development, oriented by the aspirations and abilities of the average participant in a society, can be achieved only by simultaneous institutional restructuring and growth in individual's comprehension, caring and initiative;

2. Effective institutional changes comes only when constituents and institutions' officials revise their respective individual behaviors consistent with shared visions of how common benefits can be secured;

3. Lasting behavioral change comes only through people's achieving new meanings (or, new understandings of personal benefits and means for achieving them);

4; New shared meanings come easiest and fastest through active participation in the fullest scope of good-oriented activities people can partially comprehend, making these situations both learning and instrumental events for the participants;

5. Once began on a highly pragmatic basis, development processes feed on themselves, growing as a function of increased self-confidence and experinece, which is transferred to quests of a more idealistic and complicated nature when simple ones are tentatively mastered.[2]

Perhaps what extension is can be best understood by what it is not. It is not "manipulating" others with incentives, directives, or sanctions; rather, it is building a sufficient basis of understanding in people to ensure their continued voluntary practice of innovations which they believe to be to their benefit, and which also have positive longer-range social consequences. Similarily, it is not 'brain-washing" or the "conditioning" of new personal habits, both of which produce counter-productive, and often unstable, development consequences in the longer-run. And extension is not simply supply new techniques or technologies along with instructions for their use. It is, rather, building a basis for recipient's to understand and appreciate what new opportunities innovations represent, encouraging them to be bolder in their self and community-serving experimentation, ensuring that they understand and can manage the maintenance of new procedures and anticipate possible complications arising from them, etc.

The extension process begins with the "extender's" acceptance of these facts:

1. All people have interests and felt-needs;

2. All people voluntarily engage in life-long learning oriented by these interests and felt needs;

3. The extender's challenge is to identify innovations and learning approaches that will appeal to people enough that they will gladly consider the innovation and adopt it once they understand

it and its value for them and others;

4. The introduction of innovations should occur only after carefully preparing the groundwork, which is guided by the extender's understanding the hopes, fears and feelings of propriety found in the target population;

5. Success in the initiation phase of the extension process rests on mutual trust and respect between the extension agent and the constituent population;

6. The initiation phase is but the beginning of the extension process; follow-through efforts, flexibly oriented to emerging opportunities and problems, is the essential counterpart process which ensures success;

7. Ultimately, the sucess of extension must be judged by:

   a. Whether constituents learn enough about innovations and extension processes that they, themselves, become major forces in their dissemination, and

   b. That institution change occurs as a result of this processe, and in support of it.[3]

Basically, extension should work in about the same way as does having a wise, trusted uncle who knows us and our problems well, and cares very much about our welfare. The combination of good, caring advise and active assistance in such a gentle relationship helps us more than anything else to understand our potentials and opportunities better, and to encourage our self-guided experiments to achieve satisfaction of our reasonable aspirations. As we become more personally-effective through the experience, we learn to transfer our new insights to other areas of our life on which our "uncle" may not be so prepared to advise, but toward which he had helped all the same. As well, what we have mastered we can confidently pass on to others, as we serve them like a wise, caring uncle. In fact, many of the techniques for being an effective extension advisor are similar to those used by the best of wise uncles.

The extension research and theory emphasize the following guidelines should be followed to enhance the effectiveness of extension efforts:

1. Capitalize upon existing <u>interests</u> of those who are to be helped, and attempt to develop in them additional interests which correspond to our notions of their greatest needs;

2. Focusing upon present <u>insights</u> that others have, work to expand these gradually and realistically, so that these others come to better comprehend their circumstances with all of its opportunities and constraints;

3. Insure that appropriate incentives are sufficient to justify their experimentation with change, which ordinarily means both material incentives that accrue to them as a direct result of the innovative practice proving successful, as well as indirect benefits of a "social," or non-material, form (i.e., sense of pride at being an innovator, enjoying increased status in the community, becoming more respected and trusted as an important, influential person, etc).

4. Provide opportunities and encouragement for increased personal involvement in the planning and implementation of improved practices (which provides some direct "social" incentives, and gives invaluable "learning by doing" experience that concern why something is being done as it is);

5. Recognize and promote innovativeness in the target population, which involves knowing and respecting social abilities and potentials among those who will benefit, building supporting the leadership of those who show greatest innovativeness, and strengthening the desire and self confidence to innovate among all in the target population.

6. Capitalize upon and facilitate personal initiative, as the basic catalytic ingredient of active extension processes;

7. Institutionalize the accomplishments as well as the process by which they were achieved, so that they will endure in the

minds, activities and social organization of the people;

8. Integrate these innovations with other institutions of the society, so that there will be consistency between all the related patterns (implicitly,changing the greater structure to comfortably accomodate and support that which is new).

Since the choice of extension methods is of great importance to program effectiveness, it is necessary for extension workers to not only know advantages and limitations of available extension methods, but also to know farmer's perceptions of these methods. This allows extension workers to make decisions about which methods to use taking into account both what the literature advocates and what the farmers consider appropriate. In this way we can be more sure of using the most effective and efficient methods for the particular circumstances in which the work is taking place.

A variety extension strategies and tactics, of too many to specify here, can be used to promote diffusion and adoption.[4] Briefly, several broad categories include mass media, public meetings, on-farm visitations and use of experimental or demonstration plots. Decisions about which method(s) to use when and with which people, are guided by insights gained from previous information the extension workers has collected. For example, if the worker knows that many farmers are completely unaware of a new practice, a large number of them can be reached quickly and with little effort through a mass media and public meeting information campaign which focuses on explanation of the practice, its advantages and limitations. Later, when farmers are aware of the new idea, more personal contact and perhaps the opportunity to view results of the practice (on a demonstration plot, for example) may be appropriate. At these later stages in the adoption-diffusion process, background information about the client population and its context is particularly important, as it suggests to the extension worker whether his appeals should be based in psychological, economic, social or other motivational approaches.

To clarify the relationship between extension and the broader set of processes we call "development", we should consider both what development is, and how extension relates to other approaches which contribute to development.

Many people hold the understanding of "development" as the level of material and economic accomplishments of a nation. This leads them to conclude some rich and powerful nations have achieved development, while most others who are poor and less powerful or prestigeous remain clearly "uderdeveloped". On the other hand, when development is viewed as a problem-solving or goal-seeking process (as most development experts view it), the conclusions can be quite different.

Most generally, development is increasing collective and personal capabilities to reasonably establish and effectively pursue commonly-held social ideals. As such, it is both the process and the products of conceptualizing, mobilizing and institutionalizing idealistic goal-seeking and problem-solving efforts. More specifically, however, the term development is used to mean several rather different things.

1. The popular conception of development focusses on a nation's having acquired a relatively advanced technology which enables greater consumptive benefits with less productive labor.[5] Perhaps "industrialization" would be a preferable term for this process. It reflects the bias of the Western world's historic experience (which is probably inappropriate for most of the contemporary world); is keyed to production economics of one or another form (which is an unduly narrow perspective on process means); depends upon the resourcefulness of a relatively small, exclusive category of experts are well as surplus resources (thus depreciating the role of those who become surplus labor, while capitalizing upon the people and resources in scarcest supply in "less developed" settings); etc.

2. A broader and more basic conception of development gives emphasis to "institution building" and intermediate-level institutional accomplishments which become the means for self-directed "modernization".[6] Example include raising literacy rates, increasing per capita GNP, improving medical conditions, slowing population growth, etc. Unquestionably, these are critical ingredients of societal development, and they do give reasonable attention to

approaches beyond national production economics. But they still tend to direct developmental processes toward modernization in a Western sense, and rely upon methods, expertise and innovations that require mainly patience (vs. participation) from the masses. Yet experience has thought us that capitalizing upon personal interest and initiative yields the major development resource in any setting, and minimizes the problems of alienation which often accompanies disrupted cultural continuity.

3. Increasingly, a third conception, "basic development", is being emphasized within the circle of development-process professionals.[7] This conception is rooted in the belief that a people's acquiring insight and experience with self-guided development processes keyed to their existing resources and values is the basic means and end of their development. Various terms summarize aspects of this approach: "grass-roots initiative;" "appropriate technology;" "meaningful participation;" learning by doing;" etc. Major outcomes include some quick, tangible accomplishments that lie within easier reach, direct satisfaction with popular participation in the development process, and strengthening the personal and institutional bases for further incremental development. This conception of development is believed to best insure efficient use of limited development resources, favor a broad distribution of development benefits within the population, minimize cultural disruptions which often accompany change process, and avoid the "strings" of international dependency with which most

nations in time will have trouble living.

Concerning the proper relationships between separate approaches which contribute to development, they should ideally be complementary. In rural development, for instance, legal enactments, the establishment of agriculture support industry, marketing and banking policies, and so forth should both depend upon and support basic development programs, of which the extension approach is a central feature.

Several factors often make achieving complementarity of approaches difficult, however. Sometimes, other approaches are based in assumptions inconsistent with those of the extension approach (eg., people in the target population are basically lazy or have insufficient abilities to understand what is most needed, or are only interested in their own personal welfare at the expense of other's welfare, etc.) Sometimes, perceived time constraints or greater faith in government's abilities to institute change forcefully discourages high-priority attention to such basic development emphases as extension processes. Too often, extension is not envisioned as a means of laying the foundation for other approaches, but, rather, as a way of manipulating the "human factor" when other approaches run into trouble, at which time its effectiveness is severely limited.

In short, official priority in development is commonly given to "short cut" technical acquision in order that immediate benefits of development, and the coveted appearance of being developed, is had. This costs the more broad and gradual "basic" development processes the attention and resources they deserve. It would seem logical that development efforts begin with, or at least include, a "basic" development emphasis. On the other hand, it is not surprising that the complex dynamics of development commonly begin "backward ," whereby initial attemps at development find governments and other institutions borrowing technology in a quest for pay-offs of modernization, in time being forced to realize that ever more-basic development approaches are required to support initial development aspirations that have proved overly-simplisitic.

There seem to be no short-cuts to effecitve, balanced development, but probably only the more experienced, most-developed people can appreciate this. when the deeper level of "basic" development begins to be realized, these more broad and subtle developmental processes feed back upon the institutional infrastructures which precipitated the initial development effort pushing, these institutions toward reform. Where there is institutional responsiveness, the process goes full cycle, and complete, perpetual development processes can be made a permanent feature of a society's structure.

The Egyptian Setting and the EWUP

Problems in the development of poor nations largely concern conditions of the rural population, which typically forms the society's massive base. In these cases, improving agricultural plays an important part in the society's development processes both because so much of the society is directly involved in it, and also because it is often the primary basis of the society's welfare and stability.

In Egypt, agriculture depends upon the productive activities of more than one-half of Egyptian society, and provides satisfaction of the basic needs of every one of its 40 million people. Also, agricultural produce and processed goods make up the largest portion of Egyptian exports. These are a major source of hard currency which supports many basic development porcesses in the country.

Egypt has limited agricultural lands, industrial capacities and natural resources, and a high rate of population growth.[8] These factors make it essential that human efforts be stimulated and effectively used as a basic means to achieve goals of a high level of social welfare, security and standard of living for all.

The approach Egypt has taken for realizing development depends largely on applied research. As national development activity has increased, so have its applied research institutions. Particular attention has been paid developing new means for increasing agricultural production (most Egyptian agriculture is irrigated) and improving the welfare of the rural population.

It is clear that having found answers to rural problems is not enough to solve them, however. The results of the advantage can be realized. Much of the research, in fact, must be on the processes by which the rural population can receive and understand information on improved irrigated agricultural practices. In many cases this includes the processes by which farmers themselves must cooperatively implement improved practices.

As a part of its rural and national development efforts, Egypt has developed an ambitious and soundly-conceived extension plan, operating through the Ministry of Agriculture. As well as, Egypt has a universal public education program, operating through the Education Ministry, and other significant parallel efforts in the Ministry of Social Affairs, the Ministry of Local Affairs and the Ministry of Health. Features of the Agricultural extension plan call for a trained resident extension officer in each village of the country, an Extension Training Institute (now operating in Assute in Upper Egypt), and an Extension and Rural Development Research Institute (operational in Cairo). As well, university Extension Departments operate at Alexandria University, El Azhar University, and Cairo University. A Number of practical problem like inadequate fiscal resources and transportation, a disinclination of educated persons to give up urban amenities for residence in the villages, etc., severely inhibit the implication of the paper plan for an effective nation extension program, however.

Other factors also limit the effectiveness of the Egyptian extension effort. The common desire among both officials and lay populations for fast development gains runs counter to the slower, more gradual pace of the extension approach. Understandably, there is a tendency in Egypt toward technical solutions of problems that reqiure broader address, and an impatience with "people problems" which confound the effectiveness of these technical approaches. In an attempt to minimize complications associated with the human factor of most development efforts. Strategies often rely upon coericion, forcing a mild adversal relationship between development officers and their constituents. The need for a solid extension component of the work becomes realized at the very time it can do the least good, for the mutual trust and respect which is basic to the extension approach is weak. At such times, "extension" often becomes a code-word for "bringing the rural constituents back into line" with development program plans. This is clearly not what extension is (in fact, it is inconsistent with the philosophy of the extension approach), and it cannot be very effective at such tasks.

Many issues of practical and philosophic nature relevant to extension effectiveness deserve empirical study in Egypt before they are made basic components of major new applied research and development efforts there. One such case is that of the Egypt Water Use Project (EWUP), which is the focus of this paper.

To assist with meeting applied research needs in Egypt, the EWUP was begun two and one-half years ago to provide unique guidance and support to the development of irrigated agriculture in selected target areas of Egypt representing different types of old lands strategically located as diffusion points of the country. The project approach to irrigation development has three emphases:

1. Development of new appropriate technologies for field diffusion, including both material and social procedural) techniques and tools;

2. Extension work, bridging the often large and critical gap between scientists and farmers (the emphasis of this paper); and,

3. Training/institutionalization among professional workers so that more effective means for accomplishing sustained agricultural development processes may be realized.

The project is jointly funded by the Government of Egypt and the U.S. Agency for International Development. It brings together a team of Egyptian and American professionals from several disciplines (agricultural and civil engineering, agronomy, economics, sociology and extension) to provide a boradly balanced team in true interdisicplinary fashion.[9] Part of the uniqueness of the EWUP approach is that it honors the themes and cautions of the more recent rural development literature 1) that natural diffusion processes be the ultimate/basic means of extending the program ;2) that it focus on economically feasible appropriate technology for farmer adoption; 3) that the intermediate objectives be broad and balanced to keep the development process unitary and appealing to general felt needs of constituent farmer population;4) that the ultimate objectives be the most basic ones-improving social living conditions for the farmers (e.g., not "development for appearance's sake", having "signs of development", but actually realizing general processes for achieving improvement of farmer's living and labor conditions, of community and society).

The conceptualization of the project identifies the general objective to be improved socio-economic conditions for the small farmer in Egypt. This is to be accomplished through improved management practices of water, land and other agricultural resources.[10] As background, it should be understood that a factor generally believed to be effecting present agricultural production and, more importantly, threatening sustained future agricultural production of Egypt on limited old lands, is high water table, soil salinization and by-products of sub-optimal on-farm water management-leaching nitrates, etc. Expressed as a casual sequence, it is assumed that improved management of irrigation and related agricultural practices will result in improved crop yields and conservation of scarce land and other agricultural input factors. This provides the basic means for general rural and societal development so that farmers and all Egyptian citizens can experience more satisfying and effective lives.

The operational approach of the project conforms to what is often called "action research" - or, the applications of the procedures of relevant scientific areas to the identification and solution of present and anticipated problems of irrigated agriculture, with constant feedback and involvement of the constituent population. For instance, the "on-farm" emphasis of work means that all development experiments are conducted on the field being worked by participant farmers (vs. separate "demonstration plots") who have been invited to join the project in a full working partnership, and who are thoroughly integral in the process at all stages and in all ways. This means, as well, that the research include both determining1) technical improvements in irrigated agriculture practices and 2) procedures for being more effective in facilitating farmer's and official's understanding and cooperation in this irrigated agriculture development effort. The latter concern is emphasized in this paper.

STUDY PROCEDURES

We began this research aware that local and societal circumstances vary and can have an effect on the applicabelity/perceived appropriateness of tactics. As well, the situation in recent Egypt is one where farmers are not accustomed to much opennesss, informality and collaboration between technical agriculture personnel and themselves. Therefore, the question arose early, "is the general extension literature, resulting largely from other situations quite different than the Middle East and Egypt, good guidance in this case?" Expressed another way, we wondered: "are the advocated approaches too different from the expectations and recent experiences of Egyptain farmers, government personnel and institutional structure, and technical/ scientific personnel to be easily accepted by them?" Thus a first extension research priority fell on studying the constituent population's perception of what were appropriate, acceptable and effective ways of working with them in irrigated agricultural development. When time later premitted, we obtained responses to the same basic set of questions from Egyptian officials with responsibility for rural development so that their views could also be compared with those of farmers and contributors to the international extensions literature.

Farmer data were collected by structured interview with a sample of 75 farmers who had agreed to work closely with the project on all or a portion of their farms. The selection of these farmers was based on engineering, agronomic and socio-economic criteria. Main criteria were:

1. Farm /field location relative to source of irrigation water (eg. whether nearer head or tail of conveyance channels;

2. Water application methods used;

3. Soil types and problems;

4. Shape and levelness of fields;

5. Kind of crops grown;

6. Size of forming operation;

7. Owner/renter status;

8. Full-time/part-time farmer status;

9. Operator's age, education, and informal leadership status.

Farmers were chosen to provide as great a representative range of these characteristics as possible. The basic study units are case study farm operations, from which a basic range of detailed information is being collected by all scientific disciplines represented in the project.

Three geographical areas representative of Egypt's differing agricultural and sociocultural conditions were chosen for intensive study, and later shall serve as locations for integrated development pilot demonstration projects. These include: 1) several water course areas in the Giza Governorate adjacent to Cairo, which provides an area of small farms growing broadly-mixed corps including vegetables; 2) a water course area in Kafr el Sheikh Governorate of the north central Nile Delta region, where land has been settled in this century; and 3) A water course area in the Minya Governorate of Upper Egypt, where farming has been practices for many millenia, but, until recent land re-distribution programs, primarily as large tracts with hired labor.

In each of these areas, three separate rounds of structured interviews were conducted in colloquial arabic by the project field sociologists, who received supervision and training from the project's two senior sociologists. The interviews were conducted in 1978 and 1979. The first interview largely concerned agronomic and irrigation practices of the case study farmers and used many open-ended questions. The second round represented more conventional rural sociology measurement of social participation, leadership, communication, organizational matters, and some follow-up focused on attitude questions, agricultural and irrigation practices and policies. The interview schedule used contained mostly structured items with relatively few open-ended questions. The third round of interviews focused on perceptions of appropriate development strategies and tactics and other general attittude matters like community satisfaction, general receptivity to innovation and change processes, self-confidence in decision-making, etc. The third round, emphasized in this paper, was entirely forced-choice items, frequently using Likert-type "agree-disagree" response categories.[12]

The schedule was developed by a normal social science procedure. A literature review and long discussions of conceptual issues were involved. Extended discussions were held with social science colleagues on other projects in Egypt and elsewhere known to be experienced in handling such topics as ours. Sample items were compiled and discussed. The translation process was a critical, difficult and extermely important part. It involved extensive discussion of the comparability of local Egyptian conceptions and western-oriented social science conceptions of the ideas involved. This was a particular valuable learning experience for all participants. Attention had to be given finding empirical referents that could be offered farmers as clarification of the general item without "leading" them. The discussions led to much clarification of concepts and measurement procedures. Before use, the interview schedule was pre-tested and revised.

As we were nearing completion of the farmer interviews, the decision was made to attemp obtaining comparable information from officials holding various technical and administrative rural development responsibilities in or over the three selected field areas. A self-administered questionnaire form composed of selected items from the farmer interviews and a few additional items was constructed and pretested. During the late fall of 1979, these were hand-delivered and retrieved from a potential sample of 100 officials of several mimistries who were either in service to the three field sites from offices at the local, district, governorate or national mininstry level, or in Universities and research institutes which served these ministries efforts through research, policy inputs and training. Eighty-eight completed questionnaires were returned by late December, when data were coded and analysis begun. The excellent cooperation of these officials, and of the case study farmers is greatly appreciated.

It should be noted that data other than these interview responses became relevant in the interpretation of findings. We have drawn personal recollections and impressions from field-work contacts, data and impressions of other social science researchers working in similar Egyptian circumstances, and secondary data availalble on related rural development matters in Egypt.

OVERVIEW AND DISCUSSION OF DESCRIPTIVE FINDINGS

This data section presents responses of farmers and officials to a range of items related to rural development approaches, strategies and tactics. Some of these are conventionals in extension work, while others are more often associated with approaches alternative to the extension one. These data (1) enable comparisons of the relative value respondents give a single item as compared with other items, (2) show differences of viewpoint that exist between regional areas in Egypt on given items, and (3) compare farmer's and official's perspectives in these regards.

Data are summarized here in percentage distributions accompanying the interview questions used in their collection. Following data presentation, comments call attention to major features of the separate results, and note implications of them. In the interpretation process, insights from various other data sources are introduced when they contribute background or clarification.

The data on farmers' perceptions of extension strategies and tactics are presented in response to three basic questions: 1) What kinds of people make the biggest contribution to local rural development sucess? 2) What, generally, should be done to promote and facilitate rural development processes (i.e., what are good strategies)? and, 3) How, more specifically, should these strategies be implemented (i.e., what are effective tactics)? For each of these questions, respondents were asked to choose from a range of often-advocated or used options, in this way indicating the importance or value of that particular item.

Table 1. Perceptions of who Contributes How Much Help to Rural Development Processes by Subsample in Percents[1]

Categories of People / Area Subsamples	Farmers					Officials				
	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)
A. Ministry Officials and Parliament Members										
Mansouria	22	22	57	0	100(23)	58	37	5	0	100(19)
Kafr el Sheikh	35	15	50	0	100(20)	73	18	0	9	100(22)
Minya	22	72	6	0	100(32)	65	29	6	0	100(17)
National & Univ.	--	--	--	--	--	41	46	14	0	100(22)
Totals (N)	25(19)	41(31)	33(25)	0(0)	100(75)	59(47)	33(26)	6(5)	3(2)	100(80)
B. Governorate & District Government Officials										
Mansouria	43	39	17	0	(23)	67	24	10	0	100(21)
Kafr el Sheikh	30	50	20	0	(20)	71	29	0	0	100(21)
Minya	37	59	3	0	(32)	72	22	0	6	100(18)
National & Univ.	--	--	--	--	--	44	52	4	0	100(23)
Total (N)	37(28)	51(38)	12(9)	0(0)	100(75)	63(52)	33(27)	4(3)	1(1)	100(83)

Table 1 Cont.

Categories of People Area Subsamples	Farmers					Officials				
	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)
C. Village-level Government Officials										
Mansouria	74	22	4	0	100(23)	75	15	10	0	100(20)
Kafr el Sheikh	95	5	0	0	100(20)	55	46	0	0	100(22)
Minya	34	53	12	0	100(32)	61	33	6	0	100(18)
National & Univ.	--	--	--	--	--	83	17	0	0	100(23)
Total (N)	63(47)	31(23)	7(5)	0(0)	100(75)	69(57)	28(23)	4(3)	0(0)	100(83)
D. Governorate Council Member (elected)										
Mansouria	57	22	22	0	(23)	25	60	5	10	100(20)
Kafr el Sheikh	25	15	60	0	(20)	50	32	14	5	100(22)
Minya	6	62	28	3	(32)	25	63	13	0	100(16)
National & Univ.	--	--	--	--	--	52	26	22	0	100(23)
Total (N)	27(20)	37(28)	35(26)	1(1)	100(75)	40(32)	43(35)	14(11)	4(3)	100(81)

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Categories of People Area Subsamples	Farmers					Officials				
	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)
E. Village Council Member (elected)										
Mansouria	35	39	26	0	100(23)	29	57	10	5	100(21)
Kafr el Sheikh	20	40	40	0	100(20)	23	55	23	0	100(22)
Minya	3	53	43	0	100(30)	35	41	18	6	100(17)
National & Univ.	--	--	--	--	--	52	44	4	0	100(23)
Total (N)	18(13)	45(33)	37(27)	0(0)	100(73)	35(29)	49(41)	13(11)	2(2)	100(83)
F. Experts in Applied Research										
Mansouria	61	35	4	0	100(23)	68	27	5	0	100(22)
Kafr el Sheikh	95	5	0	0	100(20)	73	23	5	0	100(22)
Minya	81	16	3	0	100(32)	53	37	11	0	100(19)
National & Univ.	--	--	--	--	--	57	39	4	0	100(23)
Total (N)	79(59)	19(14)	3(2)	0(0)	100(75)	63(54)	31(27)	6(5)	0	100(86)

Table 1 Cont.

Categories of People Area Subsamples	Farmers					Officials				
	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)
G. Village Informal Leaders/Influential										
Mansouria	65	30	4	0	100(23	36	23	27	14	100(22)
Kafr el Sheikh	80	10	10	0	100(20)	14	59	14	14	100(22)
Minya	9	28	53	9	100(32)	29	53	12	6	100(17)
National & Univ.	--	--	--	--	--	48	30	22	0	100(23)
Totals (N)	45(34)	24(18)	27(20)	4(3)	100(75)	32(27)	41(34)	19(16)	8(7)	100(84)
H. Local Citizen's Organizations										
Mansouria	91	9	0	0	100(23)	67	24	10	0	100(21)
Kafr el Sheikh	85	10	5	0	100(20)	64	27	0	9	100(22)
Minya	31	56	9	3	100(32)	39	33	11	17	100(18)
National & Univ.	--	--	--	--	--	65	26	9	0	100(23)
Totals (N)	64(48)	29(22)	5(4)	1(1)	100(75)	60(50)	27(23)	7(6)	6(5)	100(84)

Table

Categories of People Area Subsamples	Farmers					Officials				
	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)
I. Villagers' Doing Self-help Activities										
Mansouria	87	13	0	0	100(23)	48	24	19	10	100(21)
Kafr el Sheikh	75	15	10	0	100(20)	59	27	9	5	100(22)
Minya	19	50	28	3	100(32)	55	35	5	5	100(20)
National & Univ	--	--	--	--	--	73	18	9	0	100(22)
Totals (N)	55(41)	29(22)	15(11)	1(1)	100(75)	59(50)	26(22)	11(9)	5(4)	100(85)

Contributors to Rural Development

Responses to the first issue, "who makes the biggest difference:, "are summarized in Table 1. These data permit the following general observations:

1. Comparing the summary totals between items for the farmer subsample, we see:

   A. They view national-level government officials as less helpful than those at the intermediate govenorate and district levels, and officials at the local lèvel as the most helpful in rural development processes;

   B. They consider the intermediate-level elected representatives to be somewhat more helpful than those elected to local council service, but that neither group of elected representatives are thought as helpful in rural development as most other categories of people considered;

   C. Experts in applied research are thought to be the single most helpful category of people in rural development effort;

   D. People from the community engaged in local-initiative ("grass-roots self-help") development activities are thought to be more helpful than administrative or elected government officials in general, with organized local groups, ranking highest, followed by informal cooperative arrangements among villagers and then local informal leaders and influentials.

2. Response patterns shown in the summary totals of data from officials indicate:

   A. They rank the rural development contributions of national, intermediate, and local-level government personnel, including applied research experts, highly and about equally;

B. They consider elected intermediate and local-level officials less helpful than other kinds of officials.

C. They view formal and informal citizens' cooperative efforts very important - as helpful as those of the non-elected officals - but think the contributions of informal local leaders is consideralbe less in general.

3. When comparing the summary responses of farmers and officials, we see:

A. Officials judge the contributions of national and intermediate levels of government to be significantly more helpful in rural development than the farmers do;

B. Officials view the contributions of elected officials somewhat more positively than the farmers do;

C. Both farmers and officials place high value on local citizens pursuing their development in their own cooperative ways, which provides the major basis of agreement between officials and farmers.

4. When considering differences in response patterns between regional areas of Egypt we may conclude:

A. Upper Egyptian (Minya) farmers put less faith in their local appointed or elected officials, informal leaders and organizations than farmers in other areas do; and give about equal, but rather low, value to higher-ranking officials' contributions, expecting those who are applied research experts;

B. National-level officials and university professors generally value the contributions of national and intermediate government to rural development less than other officials do, (and more similarily to how the farmers do), and rate the helpfulness of formal and informal local leadership and cooperation more highly than other officials do;

C. Among both officials and farmers in the Delta area (Kafr el Sheikh), there is somewhat higher value given to national-level government's contributions, including that of applied researchers, but there is considerabledifference of opinion between farmers and officials there concerning the helpfulness of informal local leaders)who the farmers see as much more important) and intermediate level officials (who officials see as more imortant).

The data show the farmer hold views highly consistent with those of experts and researchers found in the rural development and extension literature. That is, people at the local ("grassroots") level, are thought to be the main ones who provide the iniative and practical insights upon which effective rural development depends. As a person moves upward in levels of administrative power and responsibility, the presumed contribution made diminshes.

Several factors help account for limited local feelings of dependence upon direct assistance from high levels of central government for their development. It must be noted that this is a healthy national situation and realistic as well as insightful on the part of the local population. This attitude of local self-reliance is doubtless partly a reaction to extensive national-level regulation production and marketing, which often seems more oriented to satisfying national needs than local farmer interests directly. Thus many farmers often see government activities in the agriculture sector as an unwelcomed imposition (as seems to be a common characteristic of farmers around the world).

As well, most farmers probably assume intervening factors make national-level actions less effective or efficient than local ones.

Specifically, a) the farmers assume their local situations and problems have limited visibility to high officials; b) the layers of bureaucracy between them and the ministries/assemblymen are often though to filter information flow up and impelmentation of policy down; c) most understand that national leaders are faced with a range of highly pressing problems (national security , urban growth, development resource limitations, etc.) that occupy attentions of the top; d) importantly, too, the rural populations know that the national design and implementation intentions for rural development in Egypt are good. They recognize that only problems of limited resources and the sometimes ineffective functioning of intermediate-level bureaucracy interfere with the realization of local development according to plans. They are also aware that national-level policy must be uniform in order for justice to be served, but that a uniform national policy often interferes with the government's ability to deal with differing local circumstances in different ways.

In realization of these facts, the Egyptian President, as of January, 1979, set an official course of decentralization of authority,vesting governors with presidential powers, and some governorate Officials with a Vice-Minister status so that autonomy and localized initiative in problem solving might become reality. The point is, the farmers realize what the Preseident does: that people nearer the local level who know the problems the best and feel them the strongest are the same people who are most critical in their solution. Intermediate levels of government are viewed as being the most appropriate for coordination and institutional factilitation.

It is important to note that one category of participants in the rural development process-scientistis and technical experts are outside of the administrative heirarchy. They are valued by farmers as contributors who can give practical advice directly at the local level where they are working. They can also give general counsel to the top levels, where they have an input into policy deliberations.

Concerning official's views, we may generally conclude that they do acknowledge the emphases of the extension and basic development literature, but, not surprisingly supplement these with equal attention on technocratic policy approach to development. It is noteworthy and paradoxical that in important regards nation-level officials responsible for Egypt's development policies take a position closer to that of farmers than do intermediate-level and local officials, yet farmers value the contributions of the highest government level the least. Part of the explanation here doubtless involves farmer's feeling more confortable with the Known entity" of officials in their area, who presumably know local circumstances and needs best, and who can be approached personally in times of special problems. It is also probable Egyptian farmers are not aware of the similarily of perspective between themselves and national-level officials

A final observation about this set of data is important. Since rural development is largely a process depending upon realistic perceptions of possibilities and prerogatives at the local level, these farmers and officials give evidence of being well along the path of development. It is imoprtant to emphasize that the farmers are already quite developed in important ways. They display attitudes and understanding in support of basic development processes. They assume that local initiative and responsibility are a major factor in achieving a better life in the villages. Accordingly they do not deserve to be considered "ignorant undeveloped peasants" (although they sometimes have fun playing this role for non-local audiences). In fact, they are best thought of as clever, hard-working people who are "developing" in the truest meaning of the term and standing in support of them is a quite unlightened officialdome. Subsequent data reinforces these themes.

RURAL DEVELOPMENT STRATEGIES

We turn now to the second basic question raised: "What are farmers' perceptions of effective strategies for local rural development?"

Table 2. Perceptions of Importance of Alternative Rural Development Strategies By Area Subsamples in Percents*

Categories of People / Area Subsamples	Farmers					Officials				
	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)
A. Government Rules Requiring People to Change										
Mansouria	35	17	48		100(23)	19	38	43		100(21)
Kafr el Sheikh	45	35	20		100(20)	38	29	33		100(21)
Minya	6	44	50		100(32)	25	30	45		100(20)
National & Univ.	--	--	--		--	17	26	57		100(23)
Totals (N)	25(19)	33(25)	41(31)		100(75)	25	31	45		100(85)
B. More Government Public Works										
Mansouria	100	0	0		100(23)	91	9	0		100(23)
Kafr el Sheikh	100	0	0		100(20)	100	0	0		100(22)
Minya	100	0	0		100(32)	80	20	0		100(20)
National & Univ.	--	--	--		--	87	13	0		100(23)
Totals (N)	100(75)	0(0)	0(0)		100(75)	90(79)	10(9)	0(0)		100(85)

Table 2 . Cont.

Categories of People Area Subsamples	Farmers					Officials				
	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)
C. More Machines/Tools Available in Village										
Mansouria	100	0	0		100(23)	96	4	0		100(23)
Kafr el Sheikh	100	0	0		100(20)	96	5	0		100(22)
Minya	100	0	0		100(32)	90	10	0		100(20)
National & Univ.	--	--	--		--	65	30	4		100(23)
Total (N)	100(75)	0(0)	0(0)		100(75)	86(76)	13(11)	1(1)		100(88)
D. Local Industry										
Mansouria	91	9	0		100(23)	59	41	0		100(22)
Kafr el Sheikh	95	5	0		100(20)	64	18	18		100(22)
Minya	66	28	6		100(32)	58	32	11		100(19)
National & Univ.	--	--	--		--	41	36	23		100(22)
Total (N)	81(61)	16(12)	3(2)		100(75)	55(47)	32(27)	13(11)		100(85)

Table 2. Cont.

Categories of People Area Subsamples	Farmers					Officials				
	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)
E. More Money/Credit for Village										
Mansouria	65	22	13		100(23)	65	30	4		100(23)
Kafr el Sheikh	45	5	50		100(20)	64	32	5		100(22)
Minya	25	62	12		100(32)	55	40	5		100(20)
National & Univ.	--	--	--		--	44	52	4		100(23)
Total (N)	43(32)	35(26)	23(17)		100(75)	57(50)	39(34)	5(4)		100(88)
F. Controlling Population Growth										
Mansouria	43	13	43		100(23)	87	13	0		100(23)
Kafr el Sheikh	50	5	45		100(20)	76	19	5		100(23)
Minya	84	16	0		100(32)	70	20	10		100(20)
National & Univ.	--	--	--		--	70	22	9		100(23)
Total (N)	63(47)	12(9)	25(19)		100(75)	76(66)	18(16)	5(5)		100(87)

Table 2. Cont.

Categories of People Area Subsamples	Farmers					Officials				
	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)
G. More/Better Education										
Mansouria	100	0	0		100(23)	96	5	0		100(22)
Kafr el Sheikh	95	5	0		100(20)	100	0	0		100(18)
Minya	53	47	0		100(32)	94	6	0		100(18)
National & Univ.	--	--	--		--	81	19	0		100(21)
Total (N)	79(59)	21(16)	0(0)		100(75)	92(73)	8(6)	0(0)		100(79)
H. Better Information										
Mansouria	96	4	0		100(23)	52	44	4		100(23)
Kafr el Sheikh	95	5	0		100(20)	68	27	5		100(22)
Minya	31	69	0		100(32)	50	50	0		100(20)
National & Univ.	--	--	--		--	61	35	4		100(23)
Total (N)	68(51)	32(24)	0(0)		100(75)	58(51)	39(34)	3(3)		100(88)

Table 2. Cont.

Categories of People Area Subsamples	Farmers					Officials				
	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)
I. Better coop./Org. Among Local People										
Mansouria	96	4	0		100(23)	78	13	9		100(23)
Kafr el Sheikh	85	10	5		100(20)	96	5	0		100(22)
Minya	84	16	0		100(31)	70	30	0		100(20)
National & Univ.	--	--	--		--	78	17	4		100(23)
Total (N)	87(65)	11(8)	1(1)		100(74)	81(71)	16(14)	3(3)		100(88)
J. More Effective Local Leadership										
Mansouria	87	13	0		100(23)	74	26	0		100(23)
Kafr el Sheikh	100	0	0		100(20)	86	14	0		100(22)
Minya	81	19	0		100(32)	80	20	0		100(24)
National & Univ.	--	--	--		--	78	22	0		100(23)
Total (N)	88(66)	12(9)	0(0)		100(75)	80(70)	21(18)	0( )		100(88)

Table 2. Cont.

Categories of People Area Subsamples	Farmers					Officials				
	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)	Most Help	Some Help	No Help	Mostly Hurt	Totals (N)
K. More Respect/ Privilage for those who work hard										
Mansouria	96	4	0		100(23)	100	0	0		100(23)
Kafr el Sheikh	100	0	0		100(20)	100	0	0		100(22)
Minya	62	37	0		100(32)	90	5	5		100(20)
National & Univ.	--	--	--		--	65	26	9		100(23)
Total (N)	83(62)	17(13)	0(0)		100(75)	89(78)	8(7)	3(3)		100(88)
L. People Caring About One another's needs										
Mansouria	91	9	0		100(23)	91	4	4		100(23)
Kafr el Sheikh	60	20	20		100(20)	82	18	0		100(22)
Minya	81	19	0		100(32)	84	16	0		100(19)
National & Univ.	--	--	--		--	73	23	5		100(22)
Total (N)	79(59)	16(12)	5(4)		100(75)	83(71)	15(13)	2(2)		100(86)

Themes in the professional literature on this matter have been summarized above. Table 2, presents respondents' views on the relative effectiveness of various development strategies.

1. In overview, Table 2 shows the highest prioriety strategy concerns expresses by farmers and officials include:

   A. Improving the public works service structure (i.e., roads, drinking water, electricity, etc.);

   B. Increasing the avilability of occupationally-relevant tools and machines in villages;

   C. Having more and better adult and youth educational opportunities for the villages;

   D. Improving cooperation and organization among villagers and with officials;

   E. Having more respect and privileges for local people who work hardest for local development;

   F. Having more effective local leadership in the villages;

   G. Incerasing the caring of local people toward one another and their common needs;

   H. Having greater evidence of morality in the villages (i.e., good and proper hevavior in service of community ideas)

2. There are virtually no discrepancies between farmers' and officials' views. Both agree:

   A. Government rules forcing behavioral change is the single least desirable approach in support of local development;

   B. Making more money or credit avaialble in the village is relatively less important than most other strategies.

   C. Better information on conditions that may affect villagers and be of relevance in local decision-making is important to strive for;

(D) Controlling population growth in an important dimension of village development progress;

(E) More local industry would be valuable (although officials think it somewhat less important than Farmers.

3. Among the farmers, a few differences do appear between area sub-samples.

(A) Minya farmers feel particularly strongly that government-mondated behavioral changes have little value as a development strategy, whereas those in Kafr el Sheikh are somewhat more positive about this approach (but still less positive than about all other approaches).

(B) Minya farmers, similarily, put less value on increasing the availability of money/credit than other farmers;

(C) Minya farmers put somewhat less value on improved education and locally-relevant information than other farmers;

(D) Minya farmers consider improving local cooperation and organization less important than others do, and do not feel as strongly that more respect is due those who work for community goals, yet share others' hope for strengthened local leadership.

(E) Minya farmers think controlling population growth is a higher-priority matter than most other farmers do - in fact, one of the highest on the Minya strategy inventory.

In considering these data on alternative rural development strategies in general, several conclusions seem justified. (1) Most everything possible overwhich local citizens and lower-level citizens feel they can maintain an element of control is considered important to include in an integrated, wholistic aproach to rural development. (2) Of those strategies given highest priority by both officials and farmers, many are matters central to the basic development approach, of which extension is a major component, but which ordinarily are not made an important part of development programs around the world (eq., increasing morality, caring about one another's needs, increasing the respect due those taking initiative for the common benefit, building local leadership and voluntary cooperation, etc.) (3) There is unusually high agreement between these Egyptian officials and farmers about what should be done, and, ironically, these things de-emphasize what Egypt and other countries have, in the past, made the basis of their rural development efforts.

In contemporary Egypt, these findings are not surprising. In light of President Sadat's "corrective revolution," the official emphasis is shifting from centralized bureaucratic control to basic development strategies rooted in grass-roots initiative, cooperation and love. The role reserved for the Egyptian national-level government primarily involves coordination of national resources and planning, research and development, and extension.[IN]

It is not surprising that farmers see the lowest-priority strategy option as government coercion to effect changes, even if the changes are thought important ones. It is more noteworthy that officials do also. This approach appears a most commonly practiced one in recent Egypt. There is a negative reaction to the approach by some; among others it is a familiar approach thought to be an effective, though not always pleasant, means of getting change. Farmers and many officials, however, seem to realize the coercion strategy yields "development" only in the sense of material accomplishments, but not as a path to greater individual initiative, cooperation or satisfaction.

In additional comment on the alternative strategies data presented in Table 2, we see an extension or reinforcement of some of the trends introduced following Table 1. Again, Egyptian farmers show evidence of sharing perspectives highly consistent with the emphases of the professional extension literature. There is agreement ---- attention should be given providing learning experiences for the constituents, so their personal effectiveness can be increased as a basic part of the process. This includes acquiring improved abilities to successfully attend to both routine farming, home and community tasks, and to the special challenges of changing local life through locally-based developmental processes.

This second matter involves procedures for improving the effectiveness of local leadership and local communication and coordination patterns as key private-sector parts of the facilitating structure of development. Related, public-sector supports that help satisfy basic needs of the population--roads, food and water supply--must be developed as facilitating condition. As well, technical supports for development processes like tools used in improved processes need to be obtained. In places where population pressures are having effect, acquiring additional employment opportunities may be important support for more basic development processes.

There is also a qualitatively different dimension, but one as important as all the others. It provides the sense of values that are central in the process, and also functions to prevent unreasonable local disruptions as a by-product of development. Specifically, farmers and officials realize that common conceptions of moral standards generally, and respect for and recognition of human contributions, specifically, must be strengthened as a part of the development processes.

The number and range of items given highest priority demonstrate a mature perspective on rural development processes among these farmers and officials. They do not naively look for simple or single approaches to their development. This is particularly evident when items judged relatively less critical are considered. For instance, a factor sometimes thought to be the basis of development is feeding money or credit into the social system. Given the farmers' understanding of basic development processes, they are realistic enough to know that new capital can only support other development efforts, and that it often carries with it distribution injustices (i.e., the question of who really benefits, or has access to new fiscal resources). Further, they assume it would probably involve sufficient application and regulation difficulties to discourage its effective utilization by them. Islamic cultures promote concepts of fiscal self-sufficiency within families or among friends, and do not accept the concept of "interest." Recent changes in the local bank system have made some new sources and conditions of credit available, without much immediate effect on local development processes. In balance, most farmers probably feel they have sufficient access to investment capital to satisfy their immediate private-sector development expectations, and ar suspicious of the "strings" often attached to new capital.

Population control is commonly considered by development experts to be an important part of integrated rural development strategies. Presently Egypt is experiencing one of the highest birth rates in the world (38 per thousand population per year). The Islamic tradition is thought by some to oppose contraceptive birth control. Further, Egyptian farmers feel basic needs for nutrition and shelter are being satisfactorily met in Egyptian villages, which seems to support both Islamic and Christian conceptions that God will provide for those He has created. Given this, it is perhaps most noteworthy that more than half of the farmer sample and even more of the official sample thought growth control a very important strategy matter.

Rural Development Tactics

These matters of general strategy set the stage for a consideration of farmers' perceptions of operational tactics. We consider here their perceptions of how appropriate strategies can be effectively implemented by development field programs. As before, sample farmers were presented a series of frequently used tactics which they were asked to rate in terms of probable value of each in realizing their aspirations. These data are summarized in Table 3.

1. Specific items which are judged higher-priority tactics by farmers include (beginning with the highest-priority):

   (A) Use of permanent demonstration farms and shops and occasional special demonstrations and speaches concerning new techniques and technology that may be useful for farmer adoption;

   (B) Having expert advise readily available so farmers could get help solving their particular problems as they occur;

Table 3. Perceptions of the Value of Various Rural Development Tactics by Area Subsample in Percents*

Categories of People	Farmers				Officials			
Area Subsamples	Most Value	Some Value	No Value	Total (N)	Most Value	Some Value	No Value	Total (N)
A. Gov. Planners Direct Change								
Mansouria	57	30	13	100(75)	83	13	4	100(23)
Kafr El Sheikh	75	15	10	100(20)	64	27	9	100(22)
Minya	31	66	3	100(32)	65	25	10	100(20)
National & Univ.	-	-	-	—	52	35	13	100(23)
Total (N)	51(38)	41(31)	8(6)	100(75)	66(58)	25(22)	9(8)	100(88)
B. Expert Consultants Recommended Changes								
Mansouria	43	57	0	100(23)	44	44	13	100(23)
Kafr El Sheikh	85	15	0	100(20)	59	36	5	100(22)
Minya	72	28	0	100(32)	65	30	5	100(20)
National & Univ.	-	-	-	—	26	65	9	100(23)
Total (N)	67(50)	33(25)	0(0)	100(75)	48(42)	44(39)	8(7)	100(88)

Table 3 (Continued)

Categories of People Area Subsamples	Farmers				Officials			
	Most Value	Some Value	No Value	Total (N)	Most Value	Some Value	No Value	Total (N)
C. Posters and Slogans								
Mansouria	48	26	26	100(23)	52	39	9	100(23)
Kafr El Sheikh	5	65	30	100(20)	41	46	14	100(22)
Minya	9	62	28	100(32)	20	65	15	100(20)
National & Univ.	-	-	-	-	22	65	13	100(23)
Total (N)	20(15)	52(39)	28(21)	100(75)	34(30)	53(47)	13(11)	100(88)
D. Pamphlets								
Mansouria	35	39	26	100(23)	20	75	5	100(20)
Kafr El Sheikh	15	55	30	100(20)	30	45	25	100(20)
Minya	16	44	41	100(32)	13	73	13	100(15)
National & Univ.	-	-	-	-	0	65	35	100(23)
Total (N)	21(16)	45(34)	33(25)	100(75)	15(12)	64(50)	21(16)	100(78)

Table 3 (Continued)

Categories of People Area Subsamples	Farmers				Officials			
	Most Value	Some Value	No Value	Total (N)	Most Value	Some Value	No Value	Total (N)
E. Films and Rural Threater Presentations								
Mansouria	87	9	4	100(23)	78	17	4	100(23)
Kafr El Sheikh	80	15	5	100(20)	82	18	0	100(22)
Minya	16	59	25	100(32)	68	32	0	100(19)
National & Univ.	-	-	-	—	65	26	9	100(23)
Total (N)	55(41)	32(24)	13(10)	100(75)	74(64)	23(20)	3(3)	100(87)
F. Expert Speakers								
Mansouria	74	22	4	100(23)	52	44	4	100(23)
Kafr El Sheikh	95	5	0	100(20)	50	46	5	100(22)
Minya	78	22	0	100(32)	37	53	11	100(19)
National & Univ.	-	-	-	—	30	57	13	100(23)
Total (N)	81(61)	17(13)	1(1)	100(75)	43(37)	49(43)	8(7)	100(87)

Table 3 (Continued)

Categories of People Area Subsamples	Farmers				Officials			
	Most Value	Some Value	No Value	Total (N)	Most Value	Some Value	No Value	Total (N)
G. Occasional Demonstrations								
Mansouria	87	9	4	100(23)	73	23	5	100(22)
Kafr El Sheikh	100	0	0	100(20)	77	18	5	100(22)
Minya	87	12	0	100(32)	60	32	11	100(19)
National & Univ.	-	-	-	—	52	48	0	100(23)
Total (N)	91(68)	8(6)	1(1)	100(75)	65(56)	30(26)	5(4)	100(86)
H. Permanent Demonstration Farms/Shops								
Mansouria	100	0	0	100(23)	83	17	0	100(23)
Kafr El Sheikh	90	5	5	100(20)	91	5	5	100(22)
Minya	91	9	0	100(32)	70	20	10	100(20)
National & Univ.	-	-	-	—	87	14	3	100(23)
Total (N)	93(70)	5(4)	1(1)	100(75)	83(73)	14(12)	3(3)	100(88)

Table 3 (Continued)

Categories of People / Area Subsamples	Farmers				Officials			
	Most Value	Some Value	No Value	Total (N)	Most Value	Some Value	No Value	Total (N)
I. Experts Available to Answer Questions								
Mansouria	87	9	4	100(23)	65	26	9	100(23)
Kafr El Sheikh	100	0	0	100(20)	55	27	18	100(22)
Minya	78	22	0	100(32)	60	25	15	100(20)
National & Univ.	-	-	-	—	48	30	22	100(23)
Total (N)	87(65)	12(9)	1(1)	100(75)	57(50)	27(24)	16(14)	100(88)
J. Researchers Collecting Opins.								
Mansouria	48	48	4	100(23)	57	35	9	199(23)
Kafr El Sheikh	70	30	0	100(20)	55	46	0	100(22)
Minya	75	25	0	100(32)	60	35	5	100(20)
National & Univ.	-	-	-	—	35	61	4	100(23)
Total (N)	65(49)	33(25)	1(1)	100(75)	51(45)	44(39)	5(4)	100(88)

Table 3 (Continued)

Categories of People Area Subsamples	Farmers Most Value	Some Value	No Value	Total (N)	Officials Most Value	Some Value	No Value	Total (N)
K. Local Public Meetings								
Mansouria	100	0	0	100(23)	65	26	9	100(23)
Kafr El Sheikh	90	5	5	100(20)	64	32	5	100(22)
Minya	12	75	12	100(32)	75	15	10	100(20)
National & Univ.	-	-	-	—	30	61	9	100(23)
Total (N)	60(45)	33(25)	7(5)	100(75)	58(51)	34(30)	8(7)	100(88)
L. Effective, Village Council								
Mansouria	91	4	4	100(33)	78	13	9	100(23)
Kafr El Sheikh	100	0	0	100(20)	82	18	0	100(22)
Minya	31	66	3	100(32)	70	30	0	100(20)
National & Univ.	-	-	-	—	65	30	4	100(23)
Total (N)	68(51)	29(22)	3(2)	100(75)	74(65)	23(20)	3(3)	100(88)

Table 3 (Continued)

Categories of People Area Subsamples	Farmers				Officials			
	Most Value	Some Value	No Value	Total (N)	Most Value	Some Value	No Value	Total (N)
M. Citizens Discussing What they need								
Mansouria	61	13	26	100(23)	48	39	13	100(23)
Kafr El Sheikh	40	20	40	100(20)	55	32	14	100(22)
Minya	12	78	9	100(32)	50	30	20	100(20)
National & Univ.	-	-	-	-	61	35	4	100(23)
Total (N)	35(26)	43(32)	23(17)	100(75)	53(47)	34(30)	13(11)	100(88)
N. Village Committee to Guide Local Devel.								
Mansouria	57	35	9	100(23)	41	50	9	100(22)
Kafr El Sheikh	50	25	25	100(20)	64	23	14	100(22)
Minya	9	69	22	100(32)	58	37	5	100(19)
National & Univ.	-	-	-	-	44	52	4	100(23)
Total (N)	35(26)	47(35)	19(14)	100(75)	51(44)	41(35)	8(7)	100(86)

(C) Using expert consultants to study local conditions and make recommendations for change both to farmers and government agencies;

(D) Having researchers systematically collect local opinions regarding problems, policies and proposals, so that these can be taken into account in government and local decision-making processes;

(E) Having local public meetings in which villagers can discuss with, and speak their mind to, officials, thus influencing decisions which will affect them;

(F) Strengthening the effectiveness and representativeness of local village councils.

(G) Having expert government planners direct and coordinate development at the village level.

(H) Using films and rural theatre presentations to help villagers understand better ways to do things.

2. Officials are generally in agreement with the farmers on tactics. Some differences include:

(A) Officials place somewhat higher priority on getting local citizens together to discuss what they want and what they can do to get this by their own efforts, and on having village committees to guide and coordinate local development efforts (note that the Minya farmer's feelings, discussed below, are primarily responsible for this average farmer-official difference);

(B) Officials put somewhat less emphasis on the role of experts in collecting opinions, being available to answer questions, conducting occasional demonstrations and giving talks than the farmers do;

(C) In general, the officials give highest priority to more-institutionalized (vs. occasional, special-purpose) tactics such as permanent demonstration farms, effective village councils, using standardized films and rural theatre shows, having government planners assist in development processes, etc.

3. Farmers and officials agree that the use of pamphlets, posters and slogans should be considered lowest-priority tactics, although both see some potential value in them;

4. Differences within subpopulations are primarily of two kinds, both introduced previously.

(A) Minya farmers are less-disposed to value tactics which involve local peoples' coming together in the change context, such as having a village committee to guide local development, having citizens meet to discuss what they need and how to pursue it, having local public meetings to influence decision-makers, having a stronger village council, even having public presentations of films or theatre which convey a development message (usually followed by general discussion);

(B) National-level officials, including professors and researchers who make policy-inputs, put somewhat less faith in experts' recommendations, local opinion research and local public meetings to influence policy than do other officials.

In general, several themes characterize these data on development tactics. (1) Farmers and officials put high value on tactics intended to facilitate their learning how to be more effective farmers and village citizens, which they assume to be tactics emphasizing highly visible demonstration teaching keyed to their personal interests. (2) All respondents put high value on tactics that match farmer interests with the special abilities of development experts in a "partnership" arrangement. (3) Most (excepting Minya farmers) consider it essential to have and use good local leadership and organization in support and coordination of development processes.

Written materials were understandably judged less valuable by these officials and farmers, the majority of who do not read. Since they were asked to view the development process from their personal perspectives, many specifically commented that written materials would be useful for Agricultural Cooperative personnel and others who advised them on improved practices. Side comments reported by interviewers indicated posters and slogans were judged relatively less valuable for several reasons. First, they are recognized as superficial actions that don't contain enough substance to provide meaningful guidance. Second, they are often thought to symbolize an approach to local development--decisions imposed from the top down--which the farmers have limited confidence and trust in.

The particularly high value most officials and farmers (again, Minya villagers excepted) put on bringing together citizens, public decision-makers and experts for dialogue, mutual influence, and coordinated action deserves additional comment. Consistent with the basic development literature, there appears a committment to combining citizens, officials and experts as a interactive force for local development, each having something important to contribute in complementary fashion. In such unity of purpose and effort, the best outcome is expected. Particularly in the farmer subsample, there is considerably less optimism with the possibility of having the development process be entirely their own, without expert or official support. There is a realization that autonomous citizen discussions or a grass-roots organization guiding development activities do not hold as much promise as combined government-local efforts, largely because the farmers know they lack the competence to make it work well. In contrast, they do not think it reasonable to turn development processes over to the experts or officials alone. Their confidence in the performance of expert consultants operating independently of normal community processes, or of government planners implementing changes on their behalf, is less than with the combined expert-local effort.

Let us turn attention now to the situation of Upper Egyptian (Minya) farmers. It is generally thought in Egypt that the Upper Egyptians are in many ways different than other Egyptians. In fact, they do derive from the separate

Nubian culture. The data being considered here seem to verify that our Upper Egyptian respondents are more independent, self-reliant and suspicious of a collective approach to developmental change than other Egyptians. It should also be noted that other data collected, to be reported separately, show them more receptive to change an innovation, overall, than other Egyptians - except in the category of changes requiring collective action.

There are important implications of these observations for choice of development approaches. Specifically: (1) Standardized national extension strategies and tactics are probably inappropriate for the entire Egyptian nation. (2) Shorter-run approaches which will probably be most effective in Upper Egypt are those which emphasize person-to-person direct extension education contact, and do not involve coercion (recall Table 2 data). (3) Longer-run development efforts in Upper Egypt should put special emphasis upon developing a stronger sense of community and a mutually-agreable local leadership structure (as most developmental changes ultimately depend upon good local cooperation and coordination). (4) In many ways, development work oriented by extension principles should be easier to achieve in Upper Egypt than elsewhere (given the greater independence and innovativeness), making that a logical place to establish extension pilot programs for others to witness the success of.

Other general implications of the data reviewed in this section can best be approached by way of the "consonance analysis" model. In simplest terms, this approach assumes that the logically first targets of development action as well as the first strategies and tactics to be employed are those on which there is general agreement. For instance, when villagers and officials agree that the availability of suitable agricultural machinery to ease seasonal labor shortages is a problem (not necessarily the most important one from either the farmers or officials perspectives) and that this problem is best approached by the government's obtaining the appropriate machinery, training an operator and mechanic, and renting the machine's service to the farmers on an equitable basis, then this aspect of agricultural development is solved simply. Importantly, good cooperative relations among farmers and officials is strengthened in this way, and in time will provide the understanding and trust necessary to reach genuine agreement on more difficult matters.

In contrast, the consonance model assumes that most matters of goals or means on which there is strong disagreement, whether among farmers, among officials, or between farmers and officials, should, be avoided as direct-action items. Rather, such matters should be approached indirectly, using the basic development approach, when they appear to be objectively important. If sufficient attention is given the indirect strategies and tactics, in time the conditions upon which agreement depends can be realized, and a direct approach then becomes justified. It must be stressed: it is seldom appropriate for any side of a disagreement about means or ends to claim that time is insufficient for a consensual approach to be practical, or that urgency dictates that agreement is irrelevant. Until genuine agreement is made the basis of development efforts, desired social benefits will be evasive, and counter-productive stresses will be added to the situation which jeopardize previous development gains and future potentials.

In reviewing the data presented in this section, the following conclusions concerning agreement of approach seem justified:

(1) Farmers and officials agree that the extension approach to rural development, emphasizing education about proven improvements in common techniques and including provisions to build cooperation and coordination among farmers and with officials (to be pursued more indirectly and gradually in Upper Egypt), are the highest-priority matters;

(2) In the broader rural development context, government should do its part (public works, research and development, providing expert guidance, etc.) in a way complementary to, and in interactive support of, the local citizen's reciprocal role (working together with the government on plans which will benefit them and which they had a role in formulating, being anxious to learn innovative techniques, being willing to experiment with cooperative procedures at the village level, etc.).

(3) Lowest-priority approaches are those involving the imposition of new government rules requiring behavioral change or the use of procedures which require skills the villagers do not yet have (reading, for instance) or which no one seems to have much faith in (posters, slogans, etc.).

Irrigated Agriculture Implications

Based on this review of local perspectives on general development strategies and tactics, we should briefly consider their specific implications for the development of irrigated agriculture practices, where they are equally applicable.

First, we should note that the development of Egyptian agriculture is primarily a process of improving farmer's irrigation and agronomic practices. As a process, it must emphasize encouraging and facilitating farmer's understanding the value and techniques of alternative farm management practices so they will voluntarily adopt appropriate practices, later adapting them to fit new situations and problems. Further, they must be so satisfied with the results that they encourage their neighbors to do the same, serving informally as the most effective possible extension agents. Good knowledge of when to apply how much irrigation water or fertilizer or herbicides is basic in the process, of course.

As well, the development process must emphasize coordination among neighboring farmers in the Egyptian irrigated agriculture case, for many aspects of improved farm management require that alternative practices be adopted by groups of adjacent farmers rather than just some individuals. Coordination in the maintenance of private ditches and drains, cooperating to obtain equipment or services, practicing area-wide insect control, etc., are important parts of developing agriculture. They are recognized by both farmers and officials as some of the more difficult aspects of the process, but ones which must be included as the complement of improved individual practices. Improved understanding among farmers for how and when to pursue voluntary coordination of individual efforts is a matter requiring a different sort of expert assistance--the extension of alternative "social technology"--but is as basic to the agricultural development process as anything else, and has extensive "spill-over value" to improvements in other areas of community life as well.

Improving information flow between farmers and experts, and among farmers themselves, is central in the process. Experience has shown that canal closures, new water measuring devices or structures, the presence of agricultural equipment, etc., must be understood by farmers to alleviate suspicions and rumors, as well as work in support of the adoption and diffusion of innovative practices they enable.

Strengthening local leadership, cooperation and organizational effectiveness is likewise an important aspect of the process. If farmers who adopt procedures for more efficient application of water to fields are strengthened in local influence, their role in extending these procedures will be more effective. The process, in fact depends upon them, for there are not enough extension agents available to convincingly reach all Egyptian farmers. In the same vein, the effectiveness of land-leveling efforts as part of improving irrigation efficiency and crop yields depends upon farmers coordination in planning and implementation. Land plots are usually too small to do this on a single-farmer basis and the government does not hold the legal or manpower resources to effectively accomplish this by itself.

Building the public-sector service structure in support of irrigated agricultural development largely means assisting the Cooperatives or Village Centers to be more effective in Egypt. Partly, this can be done by increasing the technical knowledge and sense of responsibility of its officials, but also it may involve augmenting the implements it has available, arranging it to be exempted from some locally imprudent policy passed down from above, or encouraging farmers to learn how to use it and appreciate what it can do for them.

Encouraging and facilitating support industry may be a part of the process. As small-scale land scrapers or new canal lining materials are developed, there comes need for their production. Promoting the government or private sector manufacture--preferably in a "surplus labor" rural area--is something that is part of the technical expert's role that is often easily fulfilled.

It may not seem, on first consideration, that promoting morality or mutual respect among farmers is a part of developing irrigated agriculture. It is a very important part, however. Acknowledging, capitalizing upon and strengthening major value themes of the target community can be critical to the success of development if, for instance, village people think proposed changes will undermine their value positions. In contrast, beliefs about the almost-sacred qualities of water or congenial relations among family and friends can be used effectively in support of irrigation or agronomic objectives. In the final analysis, any social problems which occur among Egyptian farmers that can be traced to any aspect of development processes underway will lead to a general negative reaction that can undermine the permanency of accomplishments and the prospects for more. Experience has shown that using the assembly at the mosques on Friday, working through religious leaders and supporting local conceptions of morality by one's example is something irrigated agriculture experts must pay attention to.

When attention turns to techniques for successful agriculture development, several matters deserve emphasis. A farmer's energetic participation in the development process will come primarily by his seeing personal value in its accomplishments for him. If experts pay first attention to what farmers think their farm management problems are, what methods farmers consider appropriate, and what contributions technical expertise can make to these within the limits of local resources, then there should be little trouble in getting the farmers attention. Once attention is obtained, the farmer's extensive input to the solutions of these problems should be added. The simple rule of thumb is: never do for farmers what they could possibly do for themselves with your help, and never encourage them to undertake efforts that cannot be successfully replicated by farmers once they have learned how they are done. This enables innovations to diffuse through the national agricultural sector at the hands of farmers, and builds in a "safety valve" for screening out innovations which will likely not work out well.

Whenever a new practice can be demonstrated in advance of its trial application, it should be. Similarily, it should be explained as fully as the farmer's level of understanding will allow. The use of a variety of the most visual and enjoyable educational techniques available results in the greatest comprehension. With this understanding comes the ability to explain to others, and to find modified applications of the technique thus adding to its value.

From small successes the farmers experience comes pride and enthusiasm for more of the same. In this way, simple development efforts in time lead to more ambitious ones that may be more basic to the development of irrigated agriculture. Encouraging three neighbors to cooperate in uniform leveling of their adjacent fields, for instance, may be a significant step toward getting all farmers on the watercourse to develop a schedule for their irrigations. Although the process may be a slow and indirect path to achieving those objectives the experts in the process value, it is often the only way to be effective in the longer run.

Since the data considered here show Egyptian farmers and officials in the areas of Egypt Water Use Project activities to have a developed understanding of and preference for the strategies and tactics discussed here, and elaborated in the development process literature, the major implications for development success among the farmers seem to be: respect them, their desires, their ideas and their efforts; work with them primarily as a resource person, and in time the fruits of the partnership for progress should be a wide range of specific benefits for all parties concerned.

END NOTES

1. M.S. Sallam is Sociology Group Leader, Egypt Water Use & Management Project, Cairo; E.C. Knop is Associate Professor of Sociology, Colorado State University, USA; S.A. Knop is Staff Researcher, Colorado Commission on Higher Education, USA and an independent Adult and Extension Education Specialist.

2. Of the numerous sources that elaborate on this interpretation, the following represent ones which develop the idea and its implications in somewhat different ways: Ronald Lippit, Jean Watson and Bruce Westley, The Dynamics of Planned Change, New York: Harcourt Brace, 1958; R.R. Carkhuff, The Development of Human Resources, New York: Holt, Reinhart and Winston, 1969; C.G. Bennelo and D. Roussapoulos, The Case for Participatory Democracy, New York: Grossman (Viking), 1971; Denis Goulet, The Cruel Choice, New York: Atheneum, 1973; Harvey A. Hornstein, et al., Social Intervention, New York: The Free Press, 1971; D.W. Thomas, et al., Institution Building, Cambridge, Mass.: Schenkman, 1972; Szyman Chodak, Societal Development, New York: Oxford University Press, 1973.

3. Good summaries of these ideas from somewhat differen disciplinary perspectives are: H.C. Sanders, The Cooperative Extension Service, Englewood Cliffs, New Jersey: Prentice-Hall, 1966; M.S. Knowles, The Modern Practice of Adult Education, New York: Assoication Press, 1970; Arensberg and Niehoff, Op. Cit.; Ronald G. Havelock and Mary C. Havelock, Training for Change Agents, Ann Arbor, Michigan: Institute for Social Research, University of Michigan, 1973.

4. Note, particularly: Conrad Arensberg and Arthur Niehoff, Introducing Social Change, Chicago: Aldine, 1964. W.G. Bennis, K.D. Benne and R. Chin, eds., The Planning of Change, New York: Holt Rinehart and Winston, 1969; H.C. Sanders, ed., op. cit.

5. This position is outlined in portions of S. Chodak, Societal Development; New York: Oxford University Press, 1973.

6. Note D.W. Thomas, et al., Institution Building, 1972.

7. See E. Wilner, Gathering the Winds; Baltimore: Johns Hopkins University Press, 1975; W. Biddle and L. Biddle. The Community Development Process; N.Y. Holt, Rinehart and Winston, 1965; Arensberg and Niehoff, op cit.

8. For background and proposals, see: Mohamed Kamel Hindy, et al., Egypt: Major Constraints to Increasing Agricultural Productivity, Washington, D.C.: USAID (Foreign Agricultural Economics Report No. 120), 1976; H.A. El-Tobgy, Contemporary Egyptian Agriculture, Cairo: Ford Foundation, 1976; Elias H. Tuma, "Population, Food and Agriculture in the Arab Countries," Middle East Journal, 28 (3), 1974.

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9. The E.W.U.P. approach is consistent with that called for by Gekee Y. Wickham, "The Sociology of Irrigation: Insights from a Philippine Study," Teaching Forum of the Agricultural Development Council, New York (No. 31), 1973, p. 2ff.

10. Note Wayne Clyma, Max Lowdermilk and Gil Corey, "Rapid Technology Transfer for Improvement of On-Farm Water Management by a Research-Development Process," Fort Collins, Colo.: Engineering Research Center, Colorado State University, 1978.

11. When case study of common research units is done by disciplines with quite different data needs and methodological traditions, it is usually necessary for all to compromise some desires for case selection criteria so that comparable observations are available for cross-disciplinary analysis. This situation prevailed here.

12. As a methodological note on the use of structured schedules for such a population, we begin by being skeptical that it would work well, but had reason to try so that comparable cross-cultural data on these matters could be collected and analyzed. Also, we thought it might expedite the collection and processing of such a range of specific items. Generally, we found the procedure worked well, and only had the deficiencies that apply to the use of the procedure in other seetings where forced-choice items are more commonly used (e.g. referents must be clear, as subjects do not ordinarily deal in abstract conceptions in a very meaningful way, and so they must be anchored in real, familiar circumstances that can be more easily visualized). We found the use of this type of item on these and other scales provoked careful thought in these subjects; there was little evidence of any cliche-conditioned response patterns.

Staff Paper #25

POPULATION GROWTH AND DEVELOPMENT IN EGYPT: FARMERS' AND RURAL DEVELOPMENT OFFICIALS PERSPECTIVES

E. C. Knop, M. S. Sallam and S. A. Knop

One gets the impression from causal conversations with sundry Egyptian officials and representatives of the rural and urban lay populations that most Egyptians do not believe the nation faces a "population problem" or, more correctly, that it does not suffer from over-population presently, and will not in the near future. Beyond that, no one hazards a guess.

Frequent comments on the topic indicate a common realization that high rural-to-urban internal migration flows are problematic, but most people seem not to sense the connection between this and the rate of national population growth. Similarily, one is often told that no one in the country is starving (doubtless a correct assertion), and that in many occupational sectors, like the skilled trades and seasonal agricultural labor, there are actually deficits of people. What is needed, one is told, is education and manpower redistribution of occasional pockets of superfluous people, bringing the national population back into good balance. Occasionally, one even hears the stronger Soviet version of this some basic arguement: that what appears to be a problem of over-population is really a problem of economic inequality which can be solved by restructuring the national socio-economic system (a doctrine no longer accepeted by the Chinese communists or several Eastern European Socialist States).[2]

Whatever else they say, most Egyptians give the impression that they simply do not think much about the consequences of national population growth. And when prompted to reflect on the matter, they seem to typically take a rather private and fatalistic position: what I do in my family is my business; what others do in their family is their business; and what happens in our nation of families is God's business.

Given these impressions, one would expect that popular understanding of and concern about one of the very important but most subtle dimensions of population growth – its erosive effects on national development gains and potentials – would be neligable. Upon reviewing data collected in 1978 and 1979 as a part of a major rural development project in Egypt, we were surprised to discover that impressions can be misleading, and that the matter of Egyptian's perspectives on population growth deserves more careful scrutiny. Survey data we collected from a representative sample of farmers in three regions of Egypt (ranging from Upper Egypt to the north-central Delta), and from officials serving the rural development interests of these three areas from the local to national levels shows:

(A) Sixty-three percent of the farmer sample considered controlling population growth a most important and essential strategy dimension for achieving development of villages like theirs (rated a substantially higher-priority concern than having more money or credit available in the villages for instance);

(B) Seventy-six percent of the official sample agreed that controlling population growth was a most important and essential dimension of rural development (rated substantially higher-priority than having more money or new local industry available for the villages, for instance).

It is outside the scope of this paper to answer the question of whether Egypt suffers from two high a birth rate, or to even fully explore the complex relationship between population growth and development progress. Attention here will focus on personal characteristics of those farmers and officials who are most and least convinced that population growth control should be a major feature of Egypt's national development process, so that program insights and implications can be drawn.

The National Situation

Egypt's birth rate is high by world standards (38 per 1000 population per year as compared with 35 for India, 27 for the People's Republic of China, 15 for the US and 10 for the Fed. Rep. of Germany).[3] Also high is Egypt's determination to develop in an expedient, orderly and balanced fashion. In many regards, good progress is being made in these development efforts, due to years of systematic technical achievements. Commensurate achievements in some other aspects of Egyptian life have lagged behind, however. Rational population planning achievements is one such case. Upon reviewing the nations balanced development progress since the 1952 national revolution, many experts and laymen are left wondering why a substantially-improved life for the average Egyptian seems so evasive. Consistent with the spirit of Presedent Sadat's "corrective revolution," many seem to be concluding that national population growth is part of the reason which deserves additional attention.

Some data help to clarify the picture. Egypt's industrial production has increased 635% from 1951 to 1977; 244% of this increase has occured since 1965.[4] Processed food staples, on the other hand, have shown less spectacular increases. Sugar production, for instance, increased 60% between 1951 and 1977, and native whole cheese production rose 26% during the period, to cite but two specific examples of staples on which official figures are published.[5] All agricultural production rose 457% during the 1951-1977 period, according to offfical figures, but agricultural exports have also increased substantially (compared with a 145% total agricultural production increase between 1972 and 1976, there has been a 275% increase in animal products exports, a 127% increase in vegetable products exports, and a 128% increase in exports of prepared foodstuffs during the last five years on which official published data is available; information is not available for the entire 27-year period).[6] During the 1952-1977 period, Egypt's population grew from approximately 21 million people to about 39 million (p4-ARE). Clearly, progress is being made, but equally clearly, the country's developmental gains must be spread among many more people, substantially reducing percapita benefits.

Recent international data show Egypt's percapita Gross National Product at $280 (1974) with the 1965-1974 percapita GNP growth rate at 1%. During

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this same period, according to official Egyptian data, the average annual population growth was about 2.3%.[7] Although birth rates fell slightly between 1951 and 1965 (45.2 to 41.7), so did death rates during the period (17.8 to 14.1). During the last 10 years for which data are available, there has been very little change in the Egyptian birth rate (38.2 to 37.7) while the death rate has dropped to 11.8 (1977). Accordingly, natural increase rates[8] are now at about the same level as they were in 1960 (25.9/26.0), they are not much lower than they were in 1952 (27.4), and they are considerably higher than they were in 1970 (20.0).[9]

Since 1966, Egypt has had at least a nominal national family planning program. It has been approached largely as a medical service for the population. Occasional information campaigns have also been conducted in rather low-key fashion. In the past several years, however, prominent Egyptians (including President Sadat's wife) have begun to forcefully and publicly promote family planning concepts. A current increase in official attention to the matter (encouraged by industrial "donor nations" to Egypt's development) is characterized by caution perhaps because of uneasiness with the possible political consequences of too fast and forceful a campaign. Probably caution is justified in a nation where children and family life are strongly valued, and where a religious revival is in process, with both the majority Islamic and minority Coptic Christian faiths traditionally having evidenced pronatolist tendencies.[10]

In recent months, Egyptian newspaper headlines announcing new aspects of government plans and programs appear several-times weekly, discrete family planning posters are being produced and disseminated about the country, and two new high-level population commissions (one family planning research and one program implementation planning) have been created to parallel an internal migration commission established the previous year.

It is important to note that the policy shift toward trying to influency public awareness is an important advent for a nation that has herefore

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concentrated on building its family planning health service infrastructure. The data to be reported below suggest that the nation is ready for a more vigorous and complete national approach, and that they are already basically aware of and sympathetic with its implications for natural development.

Farmer/Official Survey Rationale and Methods

When planning surveys of Egyptian farmers and officials in several areas of Egypt where an irrigated agriculture development project would work the sociological support group of the Egypt Water Use & Management Project (EWUP)[11] elected to add a few items to interview/questionnaire schedules intended to give information on how important respondents considered various rural development strategies relative to one another. These alternative/supplemented strategies included such as: increased youth and adult education offerings, government rules requiring charged personal behaviors, increasing local leadership effectiveness, improving the morality of community life, and so forth at great length. One such development strategy item included was: controlling population growth. The response to this item has already been introduced above; it is compared fully with other strategy items in another report.[12] For present purposes, it should suffice to indicate that data from this item and from many other attitudinal and demographic items which were collected provided the opportunity to study various charateristics of farmers and officials who expressed greater or-lesser concern about population growth on rural development processes.

Two sets of analyses are reported here. First personal background, status and general attitude characteristics are compared with respondents' answer to the population growth question. This provides a preliminary profile of those who show greatest understanding and concern about the issue. Second, we consider relationships between the expressed concern about population growth and evaluations of the appropriateness of various change strategies. This analysis provides some insights into what respondents with greater and lesser sensitivity to the population issue think effective and prudent as a

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basis for ameliorative action.

All variables which could be justifiably analyzed using bivoriate Peorson product-moment corelations were treated in that way (eg., all that represented ordered metric or interval level measurement). The few nominal-level variables which were included were analyzed by cross-tabulation procedures. All variables for which data were collected and which held any potential for being conceptually related to respondent's perspectives on population growth or its management strategies were entered into the analysis. Several matters need emphasis in this regard. First, a much broader set of data on personal background, status and attitudes characteristics were collected from farmers than from officials, enabling a more complete profile of farmers who are concerned about population growth. Accordingly, the farmer and official profiles are not intended as strictly comparable; we consider the officials profile to be complementary to that of the farmers, and of secondary importance.

Second, emphasis is given here to relationships showing a statistically significant difference within farmer and official categories. Some non-significant relationships of greater interest will be noted in the narrative discussion, but most non-significant relationships will not be noted. The reason for this is that we seek to identify differentiating characteristics found in the farmer and official samples that are associated with greater or lesser concern about population growth. It is important to understand that many conceptually-important relationships examined showed no empirical relationship only because some explanatory "variables" which were examined showed enough consistency in response patterns that they actually functioned more as constants than variables. For instance, if 95% of respondents considered education to be important as a development strategy, we could expect no significant difference to be apparent when relating views on eduction with those on population growth. While the data would demonstrate perceptions on education to be an important development concern, it would not be a "differentiating characteristics" helping to explain why some people are more concerned about population growth and others less so, or how those who are concerned about growth differ from those who do not on the use of education as a development strategy. (Relevant data

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and interpretations of the non-differentiating sort are presented in another report).[13]

Concerning methods of data collection the farmer sample was interviewed in three successive rounds of questions beginning in the Spring of 1978 and concluding in the Fall of 1979. Interviews were conducted in colloquial Arabic by Egypt Water Use & Management Project field team sociologists trained and supervised by the project's senior sociologists (the first two authors here). The first interview largely concerned personal identification information as well as agronomic and irrigation practices followed by case study farmers. It used primarily open-ended questions. The second round represented more conventional measurement of social participation, leadership, communication, organizational matters, and some follow-up focused attitude questions on agricultural and irrigation practices and policies. This interview schedule contained mostly structured items with relatively few open-ended questions. The third round of interviews focused on perceptions of appropriate development strategies and tactics, and other general attitude matters like community satisfaction, general receptiveness to innovation and change processes, self-confidence in decision-making, perceived community factionalism, collective-/self-orientation, etc. The third round consisted entirely of forced-choice items, frequently using likert-type agree-disagree response categories.

Study sites focused on the Giza Governorate villages of Beni Magdoul and Kafret Nassar (N=23) near Cairo; the Kafr El Sheikh Governorate village of Abu Rayah (N=20) in the north-central Delta region; and the Minya Governorate village of Abueha (N=33), near Abu Quorcas in northern Upper Egypt. These sites were selected to represent varing conditions in the more-populated rural areas of the nation.

The questionnaire used for collecting data from officials consisted of some personal background and occupational service data and the majority of items contained on the third round farmer schedule noted above. Officials' instruments were hand-delivered, explained, and later retrieved by senior or

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field team project sociologists. The official sampling frame was structured to provide balanced representation of the following types of persons: (A) those serving the rural development interests of each field site noted from positions in the Ministry of Irrigation, the Ministry of Local Affairs, and various branches of the Ministry of Agriculture, including the cooperative societies and extension service, and the Village Bank system; (B) those representing the most-local through Governorate levels of service for these areas; (C) those representing national-level service to rural development, including national-level ministry officials, national research institute personnel, and university professors who teach, conduct research and advise on policy in areas related to rural development.

During the Fall of 1979, approximately 100 officials were invited to participate in this phase of the study (to keep the number of cases as comparable as possible with the farmer sample), and virtually none declined. Eighty-eight completed forms were returned by the time data had to be coded for analysis in late December. We are most grateful for the excellent cooperation these officials, and the case study farmers, gave us in this research.

Findings

Table 1 summarizes responses of farmers and officials to the population growth item by separate subpopulation. Most apparent here are the following patterns:

(1) Respondent in the Giza and Kafr El Sheikh Governorates are very evenly divided between thinking population growth control is a very important matter and thinking it is not at all important; rather few of them think it a matter of only some importance for rural development advances.

(2) The vast majority of Minya farmers consider growth limitation very important; none consider it of no importance.

(3) Three of four officials consider growth control very important as a part of rural development strategies; very few think it unimportant. There is no significant subsample differences among officials.

A noteworthy implication of this set of data is that farmers in Lower Egypt

Table 1. Farmers' and Officials' Judgement of the Importance of Population Growth Limitation as a Rural Development Strategy By Geographical Area in Percents.

Subsample	Most Important/ Essential	Somewhat Important	Of No Importance	Total (N)
Farmers:				
Giza Gov.	43	13	43	100(23)
Kafr El Sheikh Gov.	50	5	45	100(20)
Minya Gov.	84	16	0	100(32)
Total (N)	63(47)	12(9)	25(19)	100(75)
Officials:				
Giza Gov.	87	13	0	100(23)
Kafr El Sheikh Gov.	76	19	5	100(21)
Minya Gov.	70	20	10	100(20)
National-level	70	22	9	100(23)
Total (N)	76(66)	18(16)	6(5)	100(87)

appear to feel more strongly about the growth control issue in a pro or con fashion (eg., relatively few feel it moderately important), whereas this does not seem to hold in Upper Egypt, or among officials. More insight into this is provided by data to be examined. The present point is that in Lower Egypt, a family planning public awareness campaign may expect to meet with both solid support and considerable indifference-to-opposition from farmers. (Unfortunately, the wording of the "no importance" response category does not permit us to know whether those responding in this way are indifferent or opposed, although probably both positions are represented). In Upper Egypt, and among officials, on the other hand, most can be expected to support a family planning public awareness effort. In light of the Lower Egypt responses, caution and prudence in launching a nation-wide campaign seems justified, whereas all data, taken together, indicates a desire of the majority that population growth control be a matter of high priority.

Concerning farmer characterisitics differentiating those who consider population control important from those who do not, we begin with several personal "demographic" variables like age, education and socio-economic status.

Age is significantly related to concern about growth (Pearson r = .28; probability of chance occurance = .007 by Z test), wherein the older farmers are more inclined to consider it important strategy matter, and younger farmers more inclined to think it unimportant. Perhaps having already completed one's family, or having younger children to attend to at an older age, changes one's perpective. Or, perhaps the greater historic perspective of watching changes and national growth over the years conditions one's views. Whatever the case, those with less personal reason to be concerned about growth are the most concerned, while those who have more of their lives remaining, and who are more likely to father children, appear less convinced growth limitation is important. As long as older villagers continue to have some influence over their less-concerned juniors, they have an important role to play in a public awareness effort. If their social influence decreases, however, their own views become rather irrelevant to actual growth patterns.

No empirical relationship was observed in these data when total number of children in the household, total male children, total female children or total residents in the household were used as independent variables. The farmer's general family residence pattern was significantly related, however (r=.28; p=.007), wherein those living with other extended family members in a common household were least concerned with population growth, and those living separately as a nuclear family were more inclined to think it important.

Years of formal schooling completed yielded the expected relationship (r=.25; p=.017). wherein those with more education were more likely to be concerned with consequences of population growth. Although there is an inverse relationship between age and education in rural Egypt, relatively few farmers have much formal education (in this sample, 63% no schooling; 75% none beyond primary school; 91% less than secondary school completion). Therefore it is not surprising that more-educated farmers, who tend to be younger, share the population concerns of older persons, whose education has more likely been an informal one. No significant relationship was observed between basic literacy and concern about population growth (71% of this sample were illiterate).

No significant relationships were observed when amount of land operated or owned were compared with concern about growth, nor was whether the farmer held another job in addition to farming. In fact, the only socio-economic variable used that showed a significant relationship - number of cattle owned, as one surrogate variable for wealth (r=.26; p=.012) - leaves it unclear whether having more wealth in cattle is a cause or consequence of concern about growth, if causally related at all. Most probably, socio-economic status is causally irrelevant to the population matter in rural Egypt.

Several variables examining one's present or past status as a local elected official or as an informal leader in the village showed no significant relationship with concern for population growth. One's desire for more leadership than presently held, however, was inversely related (r= -.19; p=.050), with those wishing more influence being less likely to think growth control important. Presumably present informal leadership/influence patterns in Egyptian villages is independent of concern about population growth. Implicitly, leaders are no more or less likely to see growth control as important-or unimportant- than other community members on average.

A series of 25 items dealing with personal and family patterns in use of the mass media (radio, TV, newspapers and magazines) yielded only two significant corelations. One of these showed that those who were more avid fans of radio serials and plays were less inclined to think population control strategies were important (r=.25; p=.015). The other showed those who got more information from newspapers (by themselves or through other family members) also had greater concern about population growth (r=.23; p=.026). By implication, subtle growth limitation messages conveyed in media dramatic programs, and more direct newspaper coverage geared to encouraging family discussion, seem the most effective way to initially use the media for increasing public awareness of family planning goals. Since the Egyptian mass media has not been used much in this way to date, it is not surprising that significant corelations are largely absent.

Several community participation items were likewise considered with no significant corelations occuring. There appears no relationship between concern about population growth and attendance at village wedding celebrations of non-relatives, attendance at funerals of non-relative, or the frequency of participation in village religious observances and celebrations. This is consistent with the findings on community leadership and growth sensitivity (above), and suggests civic-mindedness is presently unrelated, pro or con, with a desire for population control strategies. Similarily, no significant association occured between a desire to out-migrate from one's present village and concern about population growth. Such findings are typical of settings as which awareness about the consequences of growth on development progress are at a rudimentary, or "first stage" level. At this pre-action level, awareness is largely undefined and intuitive. Accordingly, efforts to develop awareness in the population by means of providing acceptable rationales justifying personal concerns will contribute to individual's clarifying and concretiving their thinking on the subject. This is a usually precondition for feeling prepared to discuss the topic with other people, and for taking personal family planning action.

Several items on family patterns were considered in the analysis. No

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significant relationships were noted between a growth concern and number of local families related to self or wife, number of related families with which regular visits were exchanged, or number of related families with whom animals, machines or labor were exchanged. The basis on which such exchanges were conducted showed significance in all contexts, however. Those who usually received or gave rent or pay for animal and implement exchanges were less inclined to think growth control important (r=.35; p=.001), and those putting labor exchange on a monitary basis were less concerned about growth (r=.20; p=.044). This interesting finding is easiest to explain in terms of some attitudinal data analyzed.

Some sociocultural value items used as indicators of receptiveness to innovation and change showed the following significant relationships with concern about population growth. Those taking the fatalistic position that life's events are controlled by people with more power than one's self so why try changing more concerned about growth (r=.30; p=.004). However, those who agreed that life around them was changing too fast thought population control was not important (r=.21; p=.035), and those who believe the "old ways" are generally the best ways thought growth limitation was unimportant (r=.24; p=.018). It appears, therefore, that those favoring population growth control are in some ways more desirous of change in general, but that they feel their effort in promoting or supporting it is futile. In short, they are fatalistic but not traditionalistic. Perhaps they favor change but are disclined to do anything about it (as in the case of adopting the newer pattern of paying for animals or labor provided by relatives) because they are not sure enough of the consequences, or of their own reasoning, and so opt for passive inaction.

Several self-versus collective-orientation items are consistent with this reasoning. Those thinking growth limitation is important also believe people get more by looking out for themselves rather than trying to cooperate for gains (r=.20; p=.041) and that more can be accomplished by people working alone rather than together with others (r=.32; p=.003). Since national growth limitation can be achieved only by many people taking appropriate personal action in concerts it is probable those who are more concerned about growth are prepared

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to do their part, but are not optimistic about a shift in national growth trends. In response to an item asking whether the respondents thought theirs and simliar villages could take care of their own problems, those concerned with growth limitation said no (r= -.33; p=.002).

Before turning attention to what respondents who favor population growth limitation consider the most appropriate development change strategies, some comment on the differentiating characteristics of officials concerned about growth is needed so their strategy preferences can be meaning fully noted together with those of the farmers. Most simply: there were no differentiating characteristics noted among officials on the population issue for any of 22 variables considered. Given that the vast majority of them thought growth limitation was very important for development progress, minor differences among them were not patterned enough to yield statistical significance, thus do not justify comment.

Some of the variables analyzed included: ministry and agency of present employment; level of position; highest educational level attained; subject area of educational concentration; major present professional duties; whether regular contact with farmers was involved in carrying out these duties; total years of professional services to rural development efforts; whether they operated a farm; whether their place of origin was a village, town or urban place; and what category of place they lived in now. None of these factors appear related to how important they think population limitation strategies are to rural development progress.

Change Strategies

A series of 36 separate items summarizing frequent alternative/supplemental approaches to pursuing developmental changes were presented to respondents. They were asked to evaluate each in terms of how helpful or important they considered it to be as part of an effort to improve life conditions for people in a village like theirs (for officials, in Egyptian villages in general). Population growth control strategy was one of these items. Generally, this

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series of questions fall under three headings:

(1) What categories of people make the greatest contributions to grass-roots development (ranging from National-level officials and scientific experts to informal local leaders and village citizens coming together to plan self-help activities);

(2) What general strategies are most important (including improved public education programs, more money or credit for the village, more government-initiated public works and facilities, more local caring about one another's needs, government rules requiring behavioral change, etc.);

(3) What specific development change tactics (or operational strategies) are thought most important (including demonstration farms and shops, posters, slogans and pamphlets, having expert consultants recommend changes, etc.).[14]

In the farmer sample, significant relationships between a concern for growth control and the categories of persons who were important showed the following:

(1) Those rating the contributions of government officials operating at the village level lower than others did tended to think growth limitation more important ($r= -.27$; $p=.010$). Conversely, those less concerned with the consequences of growth place higher value on the work of local government officials.

(2) Those evaluating the importance of local village councils lower considered growth limitation more important ($r= -.40$; $p=.001$). In contrast, those less concerned about population growth were more impressed with the effectiveness of their village council.

(3) Those who thought informal village leaders to be less important judged growth control more important ($r= -.37$; $p=.001$). Conversely,

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those who valued them more thought growth a less important issue.

(4) Those who rated the value of local citizens organizations lower considered growth control more important (r= -.30; p=.005), while less growth-conscious citizens gave greater importance to local organized efforts.

(5) Those who are least convinced it is useful for village people to try solving their own problems in their own way thought growth limitation more important (r= -.39; p=.001). Those with greater appreciation for this approach were less concerned with population growth.

The perceived importance of no other categories of people, including government officials at the national ministry, parliament or research institute levels or at the governorate or district level, was significantly associated with a growth control concern. These patterns, again, reflect the fatalism issue introduced above: those who think growth control is important are unimpressed with the developmental contributions of local efforts, and are no more impressed with the effectiveness of higher governmental levels than anyone else is. On the other hand, those with the least social awareness of population growth's consequences are more responsive to the grass-roots forces which can be effectively used in increasing awareness. It seems fairly obvious, however, that those local citizens who have greater concern about growth cannot be counted on to provide leadership in this regard. Such impetus must come from outside the village, at least initially.

Turning attention to the matter of general strategies, only one is significantly related to the growth concern. The main reason for this is that most strategies were thought very important by most farmers, transforming these "variables" into near-constants, making significant differences unlikely. The one which does show a significant difference is getting better information in the village on occurances which will have local consequences. Here, again, those who think this important are less concerned about growth control (r= -.33; p=.002). On the other hand, those who most desire such information

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are least concerned about growth presently.

Finally, we turn to specific tactics for rural development. Those showing a significant relationship with the growth question include:

(1) More concerned farmers see less value in the use of films and rural theater to convey development messages, whereas those who value this media more are now less likely to think growth control important ($r= -.21$; $p=.037$).

(2) Those more concerned about growth consider public meetings in which citizens can speak their minds to influence official decision-makers less important, whereas those who value such meetings more highly are less concerned about the consequences of population growth ($r= -.42$; $p= .001$).

(3) Those who consider growth limitation more important believe it is also more important to have applied researchers collect local opinions and data to be used in informing and influencing official decision-makers in the development process ($r=.24$; $p=.016$). Conversely, those not concerned about growth see less value in this.

(4) Those most concerned about growth are least concerned about development tactics intended to improve the effectiveness of local village councils, whereas less population-conscious citizens want these councils strengthened ($r= -.45$; $p=.001$).

Data from the official sample contrasts interestingly with the farmer's differentiating patterns. The only significant differences observed among officials was in the category of general strategies (recall that variation in the response patterns of officials was quite limited with the population limitation issue). Most generally, the patterns observed here run counter to the fatalistic tendencies of farmers who are concerned about growth. Specifically, officials who are concerned about the developmental consequences of population increases tend to put higher emphasis on: (1) improved adult

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and youth general education programs in the villages ($r=.35$; $p=.001$); (2) building stronger informal leadership in villages ($r=.18$; $p=.045$); (3) getting more local industry in rural areas ($r=.21$; $p=.027$) (4) increasing the moral conscientiousness of the villages ($r=.23$; $p=.013$); (5) creating more respect and privileges for those local citizens who work hard for their village's benefit ($r=.32$; $p=.001$); and (6) getting better information to villagers about occurances that affect their lives ($r=.18$; $p=.045$).

Summary Comments

There is good reason to believe that Egypt's development progress is not realizing its fullest potential because rapid population growth in the nation is diminishing the percapita benefits and contributing to other problems to which national attention and resources must be diverted.

Survey data suggests that somewhat over half of Egyptian farmers are conscious of this, as are the great majority of officials working in service of Egyptian rural development. More thorough analysis of these survey data, however, suggest that farmers who are concerned about population growth have only the most basic understanding of it, are rather by it, and do not have a good sense of what can be done to combat it. In consequence, they seem to be passively relying upon ameliorative action from outside of their villages, while being skeptical that much can be accomplished by familiar rural development approaches they otherwise favor.[15]

Rural development officials, on the other hand, hold a highly similar perspective on national growth regardless of their backgrounds or present positions. The only difference between them seems to be that those who are more concerned about growth put more faith in basic grass-roots development approaches than do the concerned farmers and the less concerned officials. In this sense, the population-conscious officials and farmers seem to be taking a healthy complementary stance on the matter. Initiative and direction must come from officials committed to: (1) increasing understanding among those villagers who are now somewhat concerned, and (2) increasing the awareness of the personal and social consequences of growth among those who remain

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unconcerned. Such efforts should be met with skeptical sympathy by many in the villages who can lend important informal support to the public awareness process in time.

This appears to be precisely the approach the government of Egypt is cautiously, wisely undertaking presently.

END NOTES

1. E. C. Knop is an Associate Professor of Sociology, Colorado State University, U.S.A.; M. S. Sallam is Assoicate Director, Agricultural Extension and Rural Development Research Institute, A.R.E. Egypt; S. A. Knop is a Staff Researcher, Colorado Commission of Higher Education, U.S.A.

2. While there can be an element of truth to this position concerning reallocation of existing material means of sustenance, it avoids the basic issue of total potential precapita national resource wealth relative to consumptive needs. This balance, of course, is highly favorable in the resource-wealth, under-populated USSR, but is already close to the limits in many other resource-poorer, highly populated settings.

3. John W. Sewell, et al. The United States and World Development: Agenda 1977. N. Y.: Prager, 1977, pp. 160-171.

4. Central Agency for Public Mobilization and Statistics. Statistical Year book, Arab Repubilc of Egytp. Cairo. A.R. Egypt, 1978, p.64.

5. Central Agency ... (Ibid.), p. 68, 70.

6. Central Agency ... (Ibid.), P. 224.

7. Sewell, Opcit, p. 160 and Central Agency (Opcit.), p. 4.

8. Births minus deaths, controlling for international migration.

9. Central Agency ... (Opcit.), P. 14.

10. Both stop short of formally prohibiting contraceptive birth control, but local religious leaders often advise against it, and generally the faith discourage voluntary childlessness while assuring that God will provide for the needs of all people born. The strong familistic emphasis of both faiths also functions inderctly but strongly as a pro-notalist force.

11. EWUP is an irrigated agricultural development project jointly funded by the ARE and USAID.

12. M. S. Sallam E. C. Knop and S.A. Knop. Effective Extension for Egyptian Rural Development. Cairo, ARE and Ft. Collins, Colo. USA: Egypt Water Use Project, 1980.

13. Sallam ... (Ibid).

14. All items are listed in Sallam ... (Ibid).

15. This matter is discussed more fully in Sallam ... (Ibid) and in E.C. Knop, M. Naguib and M.S. Sallam. Voluntary Farmer Organization, Cairo, ARE and Ft. Collins, Colo. USA: Egypt Water Use Project, 1980.

Staff Paper #26

FARM RECORD SUMMARY AND ANALYSIS FOR STUDY CASES AT ABU-RAIA AND MANSOURIA SITES

Farouk Abdel Al
Melvin D. Skold

July, 1980

Management's responsibilities include organizational decisions about what to produce, how much to produce, and when to produce it. Effective management calls for business practices on the part of the operator to control and manage the use of resources. This means keeping good records of what has happened and having a system that provides the information needed for future planning. Public agency officials who plan policies and programs that affect farmers can also benefit from records of farm costs and returns.

SCARCITY OF FARM MANAGEMENT DATA IN AFRICAN COUNTRIES

In most African countries there is very little accurate data available for economic analysis; the scarcity of data is still a problem for researchers and policy makers. The data problem is particularly acute in the agricultural sector which employs over three-fourths of the labor force in most African countries.

In order to generate accurate data for planning and other purposes, surveys of farm systems have been conducted all over Africa.

METHODS OF FARM MANAGEMENT AND PRODUCTION ECONOMICS RESEARCH

For collecting micro- level data from farmers we can distinguish four methods:

1. Case farm study.
2. Farm account books.
3. Farm business survey.
4. The cost route method.

These methods have been popular at different times in the history of western countries. They have all been tried in different parts of Africa with varying degrees of success.

Applications of the methods have been practiced in Egypt over the last twenty-five years. The Agricultural Economics Department -- Ministry of Agriculture, Agricultural Economics Department of Egyptian Universities and Agriculture Research Stations have led the way in developing these studies.

THE MODEL FARM STUDY

In the model or case farm study the operations of selected progressive farmers are studied in detail. This method became popular in the United States around the turn of the nineteenth century and continues to be practiced. Farms are visited for data recording purposes as often as necessary. Collection of farm management data from demonstration farms or from progressive farmers is still a common practice today.

The major disadvantage of using such data in economic analysis is that the farms studied are atypical; their success is often due to many factors, including unusual managerial ability. Such data cannot be used, therefore, for determining "what is", but can be of use in planning "what ought to be". The operational norm, however, becomes that of what has worked or is working for the successful farmer; conditions of economic efficiency may or may not hold.

FARM ACCOUNT BOOKS

The use of farmer kept records as a source of data for management analysis is a widespread practice today in western countries and the United States where farmers are literate. Either farmers or their agents may actually maintain the record books.

In Africa farm account books have rarely been used in collecting data from traditional farmers. The illiteracy of the farmers means that they cannot keep records. Literate children have been used in keeping rough notes on their parents activities, but they can hardly be relied on to keep the detailed records needed for farm management and production economic research.

In Egypt the same problem of farmer illiteracy as faced by other African countries is present, so the Egyptian farmers cannot keep records by themselves.

There are some large-size farms as well as the governmental farms which keep records for their farming business, but the main purpose for these account books is to control the work and workers; it is for administrative business, and the data recorded is not intended for management analysis.

There have been some attempts to keep farm records of the Egyptian farmer. This effort by the Egyptian Water Use and Management Project (EWUP) is another attempt to keep farm records for some study cases. Records are kept on farms at each of the three sites in which EWUP is involved. The procedures for our farm records will be discussed in detail in the next pages.

FARM BUSINESS SURVEYS

Economic surveys were first tried in the urban areas of England, continental Europe, in Russia, and in the United States during the first decade of this century.

In a farm business survey the researchers or his enumerators visit the farmers once or twice to complete a questionnaire. Farm business surveys usually cover a large sample of statistically selected farmers.

This technique provides a means of showing the range of conditions found on the farms in a region or country. Information is collected on the usual use of inputs by relying on the farmers experiences rather than on his memory of actual past occurrences. These surveys could also be effectively used in farm management studies where the aim is solely to generate data for planning purposes.

THE COST ROUTE METHOD

By this method the farmers are interviewed for at least one crop season.

The advantage of this method is that events are recorded as they occur and heavy reliance is not placed on the farmer's memory.

The cost route method has been widely used in farm management and production economics studies carried out in Africa as well as in Egypt.

EWUP FARM RECORD SYSTEM

Background

"Improvement of the irrigation and farm management system" is one of the main goals of EWUP. This project includes experts from four disciplines: economics, sociology, agronomy, and engineering, and operates as an interdisciplinary team.

Goals of EWUP are to improve the social and economic position of Egyptian farms through the improved management of irrigation water on farms. To accomplish this goal it is necessary that project personnel become intimately acquainted with the complexities of farm management. A primary tool applied by farm management economists is that of record keeping. Farm records are used to evaluate the relative contributions of alternative enterprises to farm income, cash flow patterns, to determine the factors which limit operating decisions and to provide comparisons with other farmers following similar practices.

Economists have derived a number of efficiency ratios to be used in these comparative analyses. For example, output per man, machinery and equipment per unit of land, or operating expense per unit of land may provide means by which an individual farm can be compared to other farms or a group average. From such analyses experienced farm management economists can derive useful prescriptive recommendations for individual farm operators.

Unfortunately, record systems and evaluative efficiency ratios have been developed and applied to commercial farming systems in developed countries. The concepts of comparative analyses are very relevant to farm management studies in developing economics.[1] But the concepts must be revised and adapted to agriculture in developing countries. The purposes of this report is to (a) present farm record system as being applied by economists associated with the EWUP, (b) provide some comparative analyses of data obtained from these individual farm records, (c) suggest some efficiency ratios which are more appropriate to agriculture in developing economics and as needed by the goals and objectives of EWUP, (d) provide some preliminary analyses of the farm records data using the efficiency ratios suggested and (e) make recommendations to project personnel of required data measurements needed to make farm management record keeping analyses of most benefit to the EWUP.

FARMING IN EGYPT

The economics team works with the following background about agriculture and irrigation in Egypt:

The agriculture area is about 6.128 million feddan (F)*, the average cultivated area per person is 0.16 F, and the average farm size is 2.05 F. The following tables show up these averages.[2]

Since the Egyptian farmers cultivate at least two crops per year, the average rotated area per person in Egypt = 0.37 F and the average rotated area per each holder = 3.82 F

Table 1 shows how the average cultivated area per capita has declined through time. Because of this declining land base per person, methods are sought to

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[1] Upton, <u>Farm Management in Africa</u>

* 1 feddan (F) = 4200.8335 sq. meter = 1.0381 acre = 0.4201 hectar

[2] Irrigation improvement plan in Egypt, August 1979, Ministry of Irrigation

increase the output per feddan of the existing area and to expand cropping on to newly reclaimed lands. To accomplish this the efficiency of irrigation must be increased so that the existing lands remain productive and water is available for irrigation of new lands.

Most Egyptian farms are less than 5 feddans in size. Significant improvements in irrigation efficiencies can be made only by working with a large number of farmers. This complicates the task of EWUP and other projects; technical, economic and social problems must be solved.

. Almost all of the Egyptian farmers are illiterate, so they cannot keep any data or records by themselves. Egyptian farmers have a suspicion of governmental officials; this problem has to be overcome. On the study case farmers, once they knew of the aim and goals of EWUP, cooperated with our professionals by giving them the information needed.

. Almost all the farmers are members in the agricultural cooperatives which are scattered among Egyptian villages. Farmers get their supplies (seeds, fertilizers, insecticides and their herbicides, . . .) from it by credit.

. No taxes are levied on farmers who own less than 3 feddans, and those who own more, the tax is based on the area which they hold and is not adjusted to their net farm income.

. Irrigation in Egypt[3] began about 6,000 years ago. The annual flood, occurring from August to October, led the inhabitants of Egypt to practice both river training and irrigation to improve their existence. Towards this objective a series of control works such as the Delta Barrage (1840) and Aswan Dam (1902) were built. The works were mainly for irrigation purposes but were also for

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[3]Mona El Kady, Wayne Clyma and Mahmoud Abu-Zeid, October, 1979, on Farm Irrigation Practices. Technical Report No. 4.

Table 1. Average Cultivated Area Per Person in Egypt Since 1897

Year	Population per Million	Agricultural Area and Average Per Person	
		Total Area Per Million F	Average Area Per Person F
1897	9.717	4.943	0.53
1907	11.190	5.374	0.48
1917	12.817	5.309	0.41
1927	14.178	5.544	0.39
1937	15.921	5.312	0.33
1947	18.967	5.761	0.31
1960	26.085	5.900	0.23
1966	30.075	6.000	0.20
1970	33.200	6.000	0.18
1976	38.228	6.128	0.16

Table 2. Agricultural Land Holding by Size of Farm

Census of 1965

Farm Size F.	# of Holders	%	Total Area F.	%	Average Farm Size F.
>5	3.033000	94.5	3.690.000	57.1	1.22
5-10	78.000	2.4	613.000	9.5	7.87
10.1-20	61.000	1.9	671.000	8.2	11.00
20.1-50	29.000	0.9	814.000	12.6	28.10
50.1-99.9	6.000	0.2	394.000	6.1	65.30
100	4.000	100.0	6.582.000	100.0	2.05

flood control (see Figure 1).

The oldest known irrigation practiced in Egypt was basin (flooding) corresponding to the annual flooding of the Nile. Basin irrigation consisted of ponding water on areas flooded by the Nile and growing crops on residual soil moisture after the water receded. Since the construction of the Delta Barrage, perennial irrigation has been practiced in lower Egypt. After the completion of the High Aswan Dam in 1970 the entire cultivated area in Egypt was placed under perennial irrigation.

Before the High Aswan Dam, the cultivated area was decided by the annual storage in Aswan Reservoir (5 billion m^3/year) and Bagal Aelia (2 billion m^3/year), the base flow of the Nile and some use from ground water. This area averaged about 4 million feddans under perennial irrigation and 1 million feddans under basin irrigation of which about 0.6 million feddans were served by wells in the summer.

After the completion of the High Aswan Dam, 55.5 billion m^3/year was made available for irrigation. This volume allowed the conversion of all basin into perennial irrigation as well as the irrigation of additional area. Perennial irrigation presently encompasses about 6.1 million feddans, of which about 1 million feddans are new lands. The cropping intensity in Egypt in 1978 is very close to 2.0 or an average of two crops per year are grown on each field.

Present perennial irrigation receives water from storage behind the High Aswan Dam through scheduled releases of flow of the Nile. Barrages divert water to major canals at selected points and deliver water to supply canals administered by Governates and then to Irrigation Districts. The districts range in area from 20 to 100 thousand feddans. The major canal flow is based on the water requirements of the area served as determined by (1) the crops

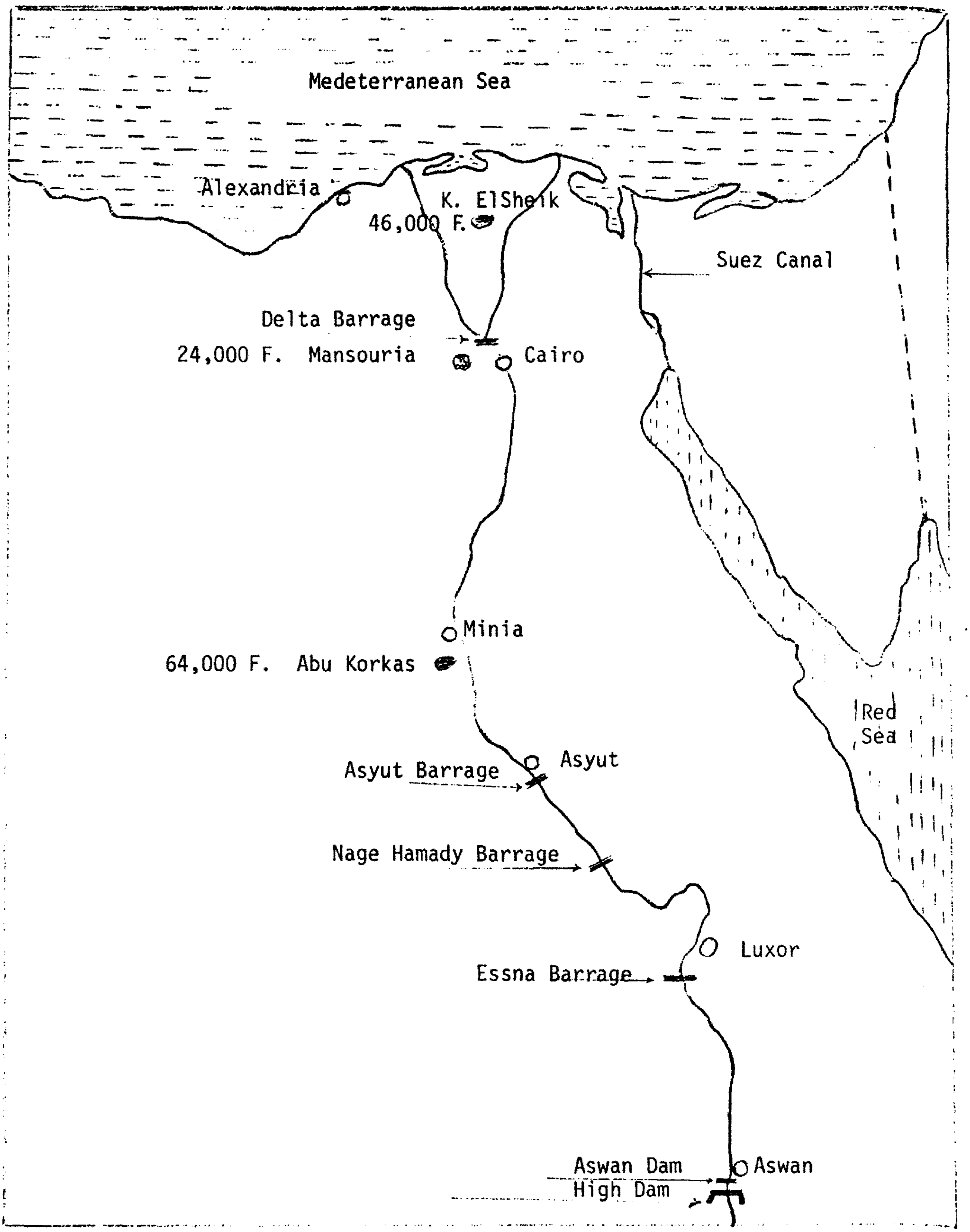

Figure 1. Location Map for Dams, Barrages, and Study Areas

grown, (2) soil type, (3) the area, and (4) the expected distribution and farm area bases. District supply canals serve branch and subbranch canals which provide water to private farm supply channels (Meskas).[4]

Water is supplied to a district on a two or three interval rotation. The length of the interval depends on the crops grown. Intervals are typically four and seven days. On the three-interval rotation, for example, the upper, middle and lower reaches of the canal receive water for an interval in turn. For the four-day and three-interval rotation a branch canal would receive water for four days and then for eight days it receives no water.

Regulation of the flow to a branch canal is related to the available flow in the district supply canal. Water is supplied based primarily on the water surface elevation on the downstream side of the inlet gate. Usually there is no determination or allocation of a specific flow rate at any point within the district. Thus, the more water a group of farmers use on a branch canal the lower the water surface elevation and the more water supplied to that branch canal.

On a branch canal water is conveyed to farmers through an outlet which supplies a private channel (Meska) that serves individual farms. An outlet may serve only one farm supply point or several supply points. One farmer or a small group of farmers may take water at one supply point. Flow through the outlet that serves each Meska is regulated hydraulically by the size of the outlet and by assuming that supply rate to the branch canal results in a specific water surface elevation. The top of the pipe outlet is located 25 cm below the design water surface elevation. This elevation is located up to 50 cm below the surface

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[4]Wolfe, Shahin and Issa, 1979

of the surrounding land. Actually, because of variations in supply rate, use rate, local topography and the installation by farmers of additional unauthorized outlet, flow rates through each Meska outlet vary widely. Each farmer or group of farmers must lift the water from the supply channel to the field.

Costs of lifting water for irrigation in Egypt

As a general rule, irrigation distribution systems in Egypt are designed to supply water to farmers below the surface level of the fields.[5] Consequently, farmers are obliged to lift the water up to 1.5 meters from the delivery canals. There are exceptions; some farmers are able to irrigate by gravity. Studies conducted by the Ministry of Irrigation show that "free flow irrigation has caused an extravagance in the use of irrigation water" and there is a more or less active government policy to place all delivery systems on a lift basis. EWUP is greatly interested in the efficiency of water use and application. El Kady et al found that the present system of requiring farmers to lift their water from canals below field level also contributes to excessive use of water.[6] Wolfe indicated that the problem may be one of the distribution of available water among farmers rather than general over-use of water.[7] They found that farmers located at the lower reaches of canals receive only as little as one-fourth as much water as farmers nearer the water source. El Shinnawi et al studied the

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[5]Technical report by Economic Team. Egypt Water Use and Management, Cairo on June 30, 1979, prepared by G. Quenemoen and Gamal Ayaad.

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

[7]Wolfe, John W., Farouk Shahin, and M. Saif Issa, "Preliminary Evaluation of Mansouria Canal System, Giza Governate, Egypt". EWUP Technical Report No. 3. 1979.

water distribution problem and its effect on farming practices.[8] They found farmers near the lower end of branch canals receive lower yields, exhibit different cropping patterns, and farm less intensively than their counterparts near the upper end of branch canals.

Several methods of lifting water are used in Egypt which involve human, animal, electric and diesel power. Human power is used to operate the shadouf* and the tambour**. Only the tambour is important in commercial agriculture. The shadouf, now virtually obsolete, is used only by a few very small farmers. Animal power is used to operate various types of sakias***. Electric and diesel motors are most frequently attached to various types of centrifugal and axial flow pumps. In the lower delta some large sakias are powered by stationary diesel motors and sometimes tractors.

The cost of lifting water with a tambour, the only human powered system considered here, depends more than anything else on the value of human labor. The initial capital investment is low, about LE 35.0****, as are repairs and maintenance. A sakia which has a maximum lift of 1.2 meters and has an initial investment cost of LE 500 which includes installation. The cost of using a cow for turning a sakia varies. If cows are used sparingly, the work may provide

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[8]El Shinnawi, Shinnawi Abdel Atty, Melvin D. Skold, and M. Loutfy Nasr, "Economic Costs of Water Shortage Along Branch Canals" EWUP Technical Report No. 5. 1980.

*shadouf - bucket and counter balance weight on a pole

**tambour - archimedes screw

***sakia - water wheels usually operated by cows

****LE - Egyptian pound   1 LE = $1.43

only normal exercise and have little effect on milk and meat production. Heavy use will require extra feed in addition to causing a reduction in meat and milk production. Typically farmers pay LE 0.35 per hour to rent a cow for turning the sakia. This includes a boy to handle and drive the cow. The useful life of a sakia is estimated to be 25000 hours with LE 6.0 per year allocated for annual repairs.

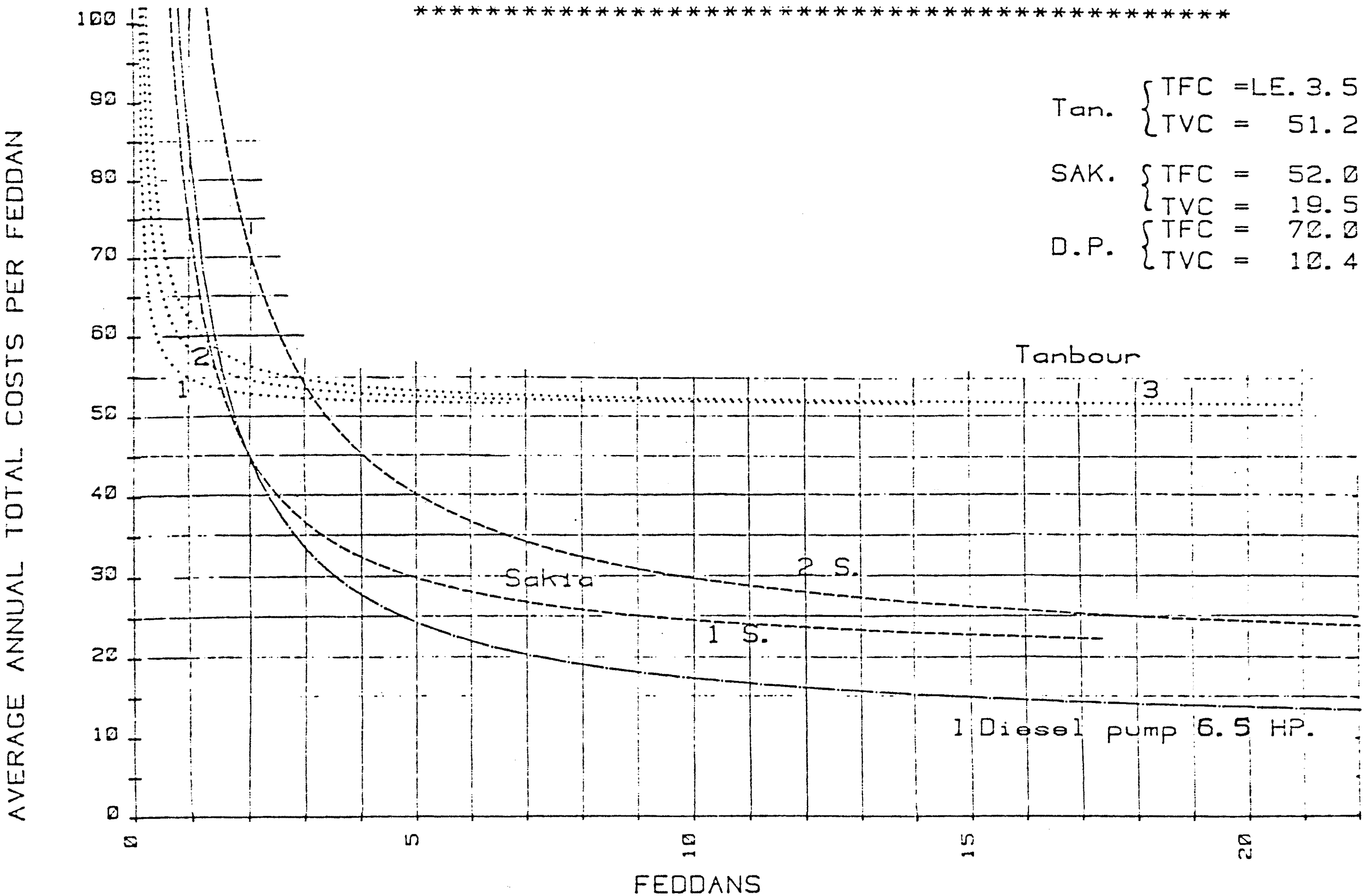
Analyses of three systems of lifting water, assuming each system is used to the limit of its practical capacity, are summarized below (see Figure 2).

Power Supply	Lifting System	Practical Capacity Feddan	Cost when used to practical capacity per hour LE	per feddan LE	per m^3 LE
human	tambour	7.00	0.40	51.71	.0081
animal	sakia	17.50	0.44	22.53	.0035
diesel	pump	20.75	0.32	13.82	.0022

There is interest by the government and among the farmers in lifting water with diesel and electric pumps to replace human and animal power. Increasing costs of labor and rising prices for meat cause farmers to feel economic pressure to consider alternative methods of lifting water to their fields. Some farmers are installing water wheels to replace expensive human labor while others are shifting away from wheels to diesel and electrically driven pumps.

The need to improve water use efficiency in Egypt is great. The declining land base per capita and the large number of small farmers add to the urgency and complexity of diffusing knowledge and technology. The multiple cropping patterns made possible by perennial irrigation lead to a number of interdependencies between enterprises on farms; changes cannot be made in one crop without effecting a number of other farming operations. Egyptian farmers receive their

Figure 2 WATER LIFTING COSTS FOR SELECTED ALTERNATIVES



water at a very high cost. Most farmers must either lift water to their fields by human or animal power. The volume of water that can be lifted by these methods often contributes to inefficient use.[9] Changes in timing and methods of water delivery and methods of application to crops are being studied by EWUP. The feasibility of improved practices can only be known by understanding the decision making environment of farmers. A farm record system adds to the understanding of the constraints and potentials faced by farm operators. The record system presented and analyzed here was developed to enhance the understanding of Egyptian farm management decisions. In that way, EWUP seeks to improve the income and social well-being of farmers through improved management of water and associated inputs on farms.

PROCEDURE

EWUP operates in three areas. The initial area selected was in Mansouria District of the Giza Governate near Cairo. A second site was selected near the Abu Raia village in the Kafr El Sheikh Governate. The third site is up river from Cairo at Abioha village, El Minia Governate (see the location map Figure 1).

At each of the three areas of the project some farms were selected for intensive study by the economics team. The farms were selected based on the following criteria:

1. Location with respect to source of water.
2. Irrigation system and methods.
3. Soil types.
4. Ownership and other social aspects.

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[9] Abu-Zeid, Mahmoud, op. cit.

5. Crops.
6. Shape and leveling of the fields.
7. Continuous flow and rational delivery.

FARM RECORDS DESIGN

A record was to be kept of each farm's operation. First, it was necessary to design a simple farm record book which could provide the information needed for future planning. The main reasons for having our record system are:

1. To measure financial success and progress of the business over time.
2. To aid in planning for the future.
3. To know the more beneficial enterprises.

Farm record keeping was initiated at the Mansouria site and the Abu Raia site during 1978 and 1979.

Since most cooperating farmers are illiterate, study case farmers were visited at least once every two weeks by EWUP junior economists to accurately record the data needed. The accounting period was from November 1, 1978, to October 31, 1979. Appendix at the end of this paper represents the main chapters in our farm record and its summary.

I. FARM RECORDS SUMMARY AND ANALYSIS AT MANSOURIA SITE

Mansouria District is irrigated by Mansouria Canal which has a length of 37 Km. Two distinct research areas are being studied at the Mansouria site; one is irrigated by the Bani-Magdoul branch canal and the other by the El Hammami branch canal (see Figure 3). The total rotated area at Mansouria District is 24745 F, 60 percent is occupied by orchards, and 40 percent is cultivated with vegetables and other crops like barseem, wheat, flax and maize.

Land in this district slopes from south to north and from west to east. In general, 50 percent of the land has a water table of more than 150 cm, 45 percent has a water table from 80 cm to 150 cm, and 5 percent has a water table less than 80 cm. The depth to water in the project area ranges from 60 to 150 cm. The water table fluctuates during the season; it rises immediately after each irrigation and declines between irrigations, but usually a gradual build up occurs during the season. The rate of decline of the water table during the season between irrigations is greatest during the period of higher consumptive use suggesting that declines occur both from literal out flow and from water use by plants from the groundwater.

The soil moisture extractions is from 4 to 8 Mho. and some areas with salinity problems is from 8 to 16 Mho.

Farmers in the Mansouria District appear to assume their fields have zero grade level.[10] Water is introduced into a bonded unit until the area is covered and there is allowed to stand and infiltrate into the soil. This practice is followed in both the sandy soil of El Hammami and the clay loam of Bani-Magdoul.

Representative sites on two branch canals (El Hammami and Bani-Magdoul) were selected for the study (see location map Figure 3). The selection of these sites was based on engineering, agronomic, and socio-economic criteria. All fields on a selected site were monitored at every irrigation. In addition, socio-economic, crop production, and soil data was collected. Since the two sites (El Hammami and Bani-Magdoul) have different soil types, their farm records summary are going to be shown separately.

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[10]El Kady, op. cit.

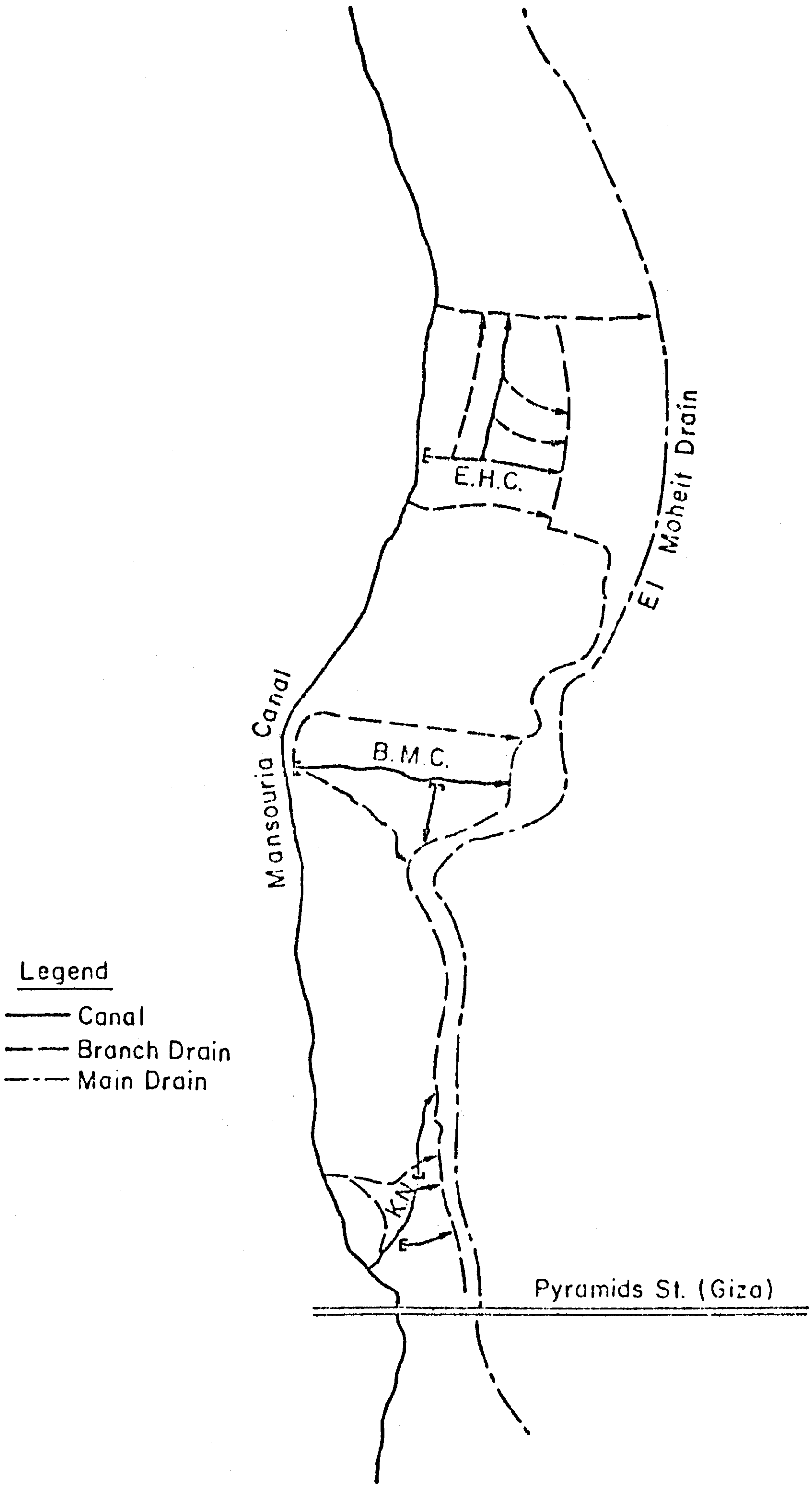

Figure 3. Location map for Beni Magdoul (B.M.C.) and El Hammami (E.H.C.) branch canals in Mansouria District.

I. (A) FARM RECORDS SUMMARY AND ANALYSIS AT BANI-MAGDOUL SITE MANSOURIA DISTRICT

Table 3
Financial Statement for Study Cases Farmers at
Bani-Magdoul Site - Farm Records (1978-1979)

Farm No.	Farmer's Name	Family Members			Area			Livestock								Land and Livestock Total Value L.E.	Area Feddan 00.00
		Male	Female	Total	F*	K*	Total Value L.E.	Cow	Buffalo	Calves	Donkey	Camel	Goats	Poultry	Total Value L.E.		
1	Ahmed El Rachidi	5	2	7	3	6	R.**	1	1	-	2	-	-	-	620	635	3.25
2	Hassan El Shewimy	4	3	7	1	8	16000	1	1	-	1	-	-	44	652	16652	1.33
3	Said El Mezaien	5	3	8	1	12	R.	-	1	-	1	-	-	-	320	320	1.50
4	Abbas Y. El Battawy	4	3	7	2	18	R.	1	1	-	1	-	3	15	717	717	2.75
5	Mohamed A.El Battawy	6	4	10	1	18	12000	-	2	-	1	-	-	33	680	12680	1.75
6	Mohamed N.El Akshar	3	3	6	1	22	25000	-	3	-	1	-	-	2	680	25680	1.92

* 1 Feddan = 24 K. (Kerat)

Table 3 shows the number in the farmers family. Egyptian farm family members all become involved in the farming operation. The father works in the field with the assistance of his sons, even those who are in school. School-age sons assist their father after the school day and during their vacations especially in critical times like planting, insecticide resistance, and harvesting operations. The mother, in addition to her daily home work, takes care of poultry, converts milk into cheese, butter, and non-fat milk, and helps in some light farm work (planting or transplanting and harvesting) and sometimes marketing at the village local market.

The land value at the Bani-Magdoul site is high because of its location near Giza City. Land values at the Mansouria site differ according to the location. The land which is located by the main roads is very high in value; one feddan located along the Mansouria main road is valued at 30.000 L.E. and one feddan located at Bani-Magdoul road is valued at 15.000 L.E. The land values given in Table 3 are estimated by the farmers as are livestock values.

Table 4 illustrates the crop rotation for the study case farms. Barseem represents 74 percent of the winter crops total area because barseem is the main livestock feeding in winter. Almost all summer crops are vegetables which are cash crops. The farmers at Mansouria site prefer to cultivate these cash crops since they supply the central market at Cairo and Giza City with high prices.

In Table 5 it is seen that important amounts of crops are used for home consumption and livestock feed. However, except for one case sales exceed 50 percent of the total value of crops produced. Livestock also contribute to home consumption. In fact, in many instances the value of home consumption exceeds the value of sales. These figures cannot be given direct interpretation in any one year, however. Inventory increases and decreases in a year

Table 4
Crop Rotation for the Study Cases at
Bani-Magdoul Site - Farm Records (1978-1979)

Farm No.	Farmer's Name	Total Area Feddan	Crops Cultivated Area F.															
			Barseem	Wheat	Flax	Tomatoes	Cabbage	Eggplant	Squash	Cucumber	Parsley	Gargir	Sun Flower	Dill	Onion	Sesame	Maize	Maize Forage
1	Ahmed El Rachidi	3.25	1.92	0.94	-	-	0.59	-	0.25	0.58	0.75	-	-	-	-	-	0.50	0.42
2	Hassan El Shewimy	1.33	1.33	-	-	-	-	-	-	-	-	0.67	-	-	-	-	1.33	0.8
3	Said El Mezaien	1.50	0.88	-	-	-	-	-	-	-	0.34	0.29	-	0.50	-	-	0.25	0.17
4	Abbas Y. El Battawy	2.75	2.05	0.3	0.4	-	0.1	0.3	-	-	-	0.3	1.3	-	-	-	0.9	1.30
5	Mohamed A. El Battawy	1.75	1.37	0.38	-	-	0.13	-	-	0.38	-	-	-	-	0.38	-	0.63	0.25
6	Mohamed N. El Akshar	1.92	1.72	0.20	-	-	-	-	-	0.21	-	-	0.29	-	-	0.92	0.29	0.21

Table 5
Summary of Crop and Livestock Production at
Bani-Magdoul Site - Farm Records (1978-1979)

Farm No.	Production and Disposition of Crops				Production and Disposition of Livestock						
	Fed to Livestock L.E.	Home Use L.E.	Sales L.E.	Production Total Value L.E.	Home Use L.E.	Sales L.E.	Total Value L.E.	Non Purchased Feed L.E.	Purchased Feed L.E.	Purchased and Non Purchased Feed L.E.	Gain Over* All Feed Cost L.E.
1	171	-	921	1092	171.5	182.7	354.2	171	113	284	70.20
2	401	136.3	370	907.3	136.6	65.9	202.5	401	144	545	-342.5
3	58.5	-	572	630.5	183.6	87.3	270.9	58.5	86	144.5	126.4
4	285	17	846.1	1148.1	154.3	98.6	253.4	285	188	473	-219.6
5	249	38.5	336.1	623.6	116.7	392.7	509.4	249	141	390	119.4
6	54	36	571.8	661.8	77.3	492.3	569.5	54	239	293	276.5

* Gain over all feed costs is negative in Farm #2 and #4. *We did not compute the animal power value which is used in farm operations in this table.*

Table 6

Farm No.	Crop Production Value L.E.	Livestock Production Value L.E.	Total Production Value L.E.	Crops %	Livestock %
1	1092	354.2	1446.2	76	24
2	907.3	202.5	1109.8	82	18
3	630.5	370.9	901.4	70	30
4	1148.1	253.4	1401.5	82	18
5	623.6	509.4	1133	55	45
6	661.8	569.5	1231.3	54	46
TOTAL	5063.3	2159.9	7223.2	70	30

may cause distortions in the value of home use versus value of livestock product sales accounts.

Table 5 also shows the values of home produced versus purchased feeds for livestock. Most farmers rely heavily on home produced feeds for livestock although all study farms purchase some feed.

Table 6 represents the summary of crop and livestock production. From this table the relative contribution that crops and livestock make to the total value of farm production can be computed. On the average 70 percent of total production value comes from crops and 30 percent from livestock. The production value is the actual price which the farmers receive from selling their production at the market. For the products which are used at home, values are determined according to the market price minus transportation and marketing cost.

Tables 7, 8, and 9 present the ratios of livestock production divided by livestock feed expenses with and without livestock work value. The work values are estimated according to their opportunity cost taken as the rental payment for livestock for the work option in question. The value of livestock production relative to the total value of feed shown in Table 7 shows the differences which may occur due to changes in inventories of livestock and the value of work done by livestock. On two farms the value of livestock sales is about 50 percent or less than the value of livestock feed used. Table 8 places a value on the work done by livestock; including the value of work from livestock still leaves Farm #2 and 4 with livestock total values (sales and work) being less than the value of livestock feed (Table 9). If these differences cannot be accounted for in inventory adjustments, these farms may benefit by some changes in their feed-livestock programs.

Table 10 is the summary of net farm income. All study farms served by the Bani-Magdoul canal show a positive net farm income. Notice that inventory changes are large on Farms #2 and 4 indicating that the low ratios of total livestock value to the value of feed is explained by inventory build-up.

Table 11 represents the average value of production per feddan and the average net farm income per person. The average value of crops produced per feddan varies considerably between farms. There is some tendency towards a greater value of crop output per feddan on small farms than on large farms. There are too few observations in this set of study farms to reach any such conclusion, however. The value of livestock production is more uniform than for crops; the two larger farms do have smaller livestock values per feddan than the smaller farms.

Average net farm income per feddan varies considerably between farms ranging from 146.6 L.E. to 609.9 L.E. The higher ratios of net farm income by feddan are associated with farms which have the higher values of livestock production per feddan.

Table 12 shows the average net farm income per feddan and per person from each of the study cases at Bani-Magdoul site. Net farm income per person also varies over a sizable range. Table 13 provides some insight into the differences; low net farm income per person is directly associated with small amounts of land per person; although, some farms exhibit more success with intensification (producing more per unit of land) than others.

From Table 14 the relationships between working capital assets and the value of farm production are seen. It does appear that the value of farm production is positively associated with the value of working capital assets. But, by examining Tables 14 and 15 together it appears as though additional investments in working capital per feddan do not necessarily bear fruit in a greater value of farm production per amount of working capital. That is, capital intensification does not appear to be the key to increasing the value of agricultural production per feddan on this set of study farms.

Farm analysis is the climax of any record-keeping activity. It is important to use the same measurements from year to year so that the comparison will be meaningful over time. This was the first time for analyzing the farm study case data, plans are to use at least some of the same measurements in future years.

Analyses to measure efficiency involve comparative analysis. The comparisons can be between farms and/or between years. This year between farm comparisons are made for each individual study case net farm income (NEI) with the average N.F.I. for the total study cases. Table 13 illustrates that, but we hope that next year we can compare our study cases with comparable farms in the same area or with the average yields at the site.

Table 12 presents the ratio of farm production divided by the value of working capital assets, we went far from the fixed assets because of not all of our study cases own the land, and to avoid the high appreciation of land value.

Table 13 shows up the ratio of working capital assets divided by number of feddans, and finally Table 14 illustrates the ratio of value of crops divided by crop expenses.

Earlier it was shown that on some farms the value of livestock production is exceeded by the value of livestock feed. Table 16 presents similar data for crops. The value of crop production relative to the value of crop expenses is always greater than one.

Table 7
Number of Livestock by Species, Work Done by Livestock and
Ratio of Livestock Production (Not Including Work Value) ÷ L.S. Feed Expenses
for the Study Cases at Bani-Magdoul Site (1978-1979)

Farm No.	Area Feddan	Farm Livestock				Working Hours Done by L.S.					L.S. Production ÷ L.S. Feed Expenses		
		Cow	Buffalo	Calves	Donkeys	Transportation*	Plowing	Leveling	Puddling	Turning Sakia**	Purchased and Non Purchased Feed L.E.	Total Value of L.S. Production L.E.	L.S. Production ÷ L.S. Feed Expenses
1	3.25	1	1	-	2	700	40	-	-	541	284	354.2	1.25
2	1.33	1	1	-	1	350	20	-	-	194	545	202.5	0.37
3	1.50	-	1	-	1	350	20	-	-	319	144.5	270.9	1.87
4	2.75	1	1	-	1	350	30	-	-	383	473	253.4	0.54
5	1.75	-	2	-	1	350	30	-	-	310	390	509.4	1.31
6	1.92	-	3	-	1	350	15	-	-	144	293	569.5	1.94

* Transportation and loading done by donkey. We assume that the minimum is 350 h. per year for 1 donkey

** Cows, buffalo, and donkeys are used for turning sakia. These actual hours from record books.

Table 8
Value of Work Done by Livestock and Total Value of Livestock Production for Bani-Magdoul Study Cases (1978 - 1979)

Farm No.	Area Feddan	No. of L.S.				Value of Work Done by Livestock							Total Value of Livestock Production, Home Use and Sales L.E.	Gross Total Value of Livestock Production L.E.
		Cow	Buffalo	Calves	Donkeys	Trans-port Hours	Value* per Hour L.E.	Total Value L.E.	Plow-ing Turn Sakia Hours	Value** per Hour L.E.	Total Value L.E.	Gross Total Value L.E.		
1	3.25	1	1	-	2	700	0.15	105	691	0.225	155.5	260.5	354.2	614.70
2	1.33	1	1	-	1	350	0.15	52.5	214	0.225	48	100.5	202.5	303.0
3	1.50	-	1	-	1	350	0.15	52.5	339	0.225	76.3	128.8	270.9	399.7
4	2.75	1	1	-	1	350	0.15	52.5	413	0.225	92.9	145.4	253.4	398.8
5	1.75	-	2	-	1	350	0.15	52.5	340	0.225	76.5	129	509.4	638.4
6	1.92	-	3	-	1	350	0.15	52.5	159	0.225	36	88.5	569.5	658.0

* The opportunity cost for 1 donkey hour is 0.15 L.E.
** The opportunity cost for 1 cow or buffalo hour is 0.30. Since the farmers used both donkey and cow or buffalo in plowing and turning sakia the opportunity cost = (0.30 + 0.15) ÷ 2 = 0.225.

Table 9
Ratio of Livestock Production (Including Work Value) ÷ L.S. Feed Expenses
For the Study Cases at Bani-Magdoul Site (1978-1979)

Farm No.	Area Feddan	Farm Livestock					Livestock Production Value			Purchased and non Purchased Feed L.E.	Gain Over All Feed Costs L.E.	Ratio of L.S. Production ÷ L.S. Feed Expenses
		Cow	Buffalo	Calves	Donkey	Poultry	Value of Work Done by L.S. L.E.	Value of L.S. Production Home Use & Sales L.E.	Total Value L.E.			
1	3.25	1	1	-	2	-	260.5	354.2	614.7	284	330.7	2.16
2	1.33	1	1	-	1	44	100.5	202.5	303.0	545	-242	0.56
3	1.50	-	1	-	1	-	128.8	270.9	399.7	144.5	255.2	2.77
4	2.75	1	1	-	1	15	145.4	253.4	398.8	473	- 74.2	0.84
5	1.75	-	2	-	1	33	129	509.4	638.4	390	248.4	1.64
6	1.92	-	3	-	1	2	88.5	569.5	658.0	293	365	2.25

Table 10
Summary of Net Farm Income at Bani-Magdoul Site
Farm Records 1978 - 1979

Farm No.	Summary of Income						Summary of Expenses						Net Farm Income
	Animal Products L.E.	Crop Products L.E.	Capital Sales L.E.	Inventory Changes if (+) L.E.	Off Farm Income L.E.	Total Gross Income L.E.	Crop Expenses L.E.	Non Crop Expenses L.E.	Capital Purchases L.E.	Inventory Changes if (-) L.E.	Non Purchased Livestock Feed L.E.	Total Gross Expenses L.E.	
1	354.2	1092	00.0	254	00.0	1700	392	313	00.0	00.0	171	876	** 824
2	203	907	00.0	3957	00.0	5067	259	214	00.0	00.0	401	872	*4195 ** 195
3	271	747	00.0	00.0	00.0	1018	276	186	00.0	16	00.0	478	** 540
4	253	1148	00.0	6899	00.0	8300	225	380	00.0	00.0	285	890	** 410
5	509	624	00.0	5120	00.0	6259	135	141	00.0	00.0	249	525	*5734 ** 934
6	570	662	00.0	1392	00.0	2624	222	344	00.0	00.0	54	620	*2004 **1171

* N.F.I. including land appreciation ** N.F.I. without land appreciation

Table 11
Average Value Production per Feddan and Average Net Farm Income per Person at Bani-Magdoul Site Farm Records (1978-1979)

Farm No.	Total Family Members	Area Feddan	Average Crop Prod/F.		Average Livestock Prod/F.		Average N.F.I./F.		Average N.F.I./Person	
			Crop Production Value L.E.	Average Per Feddan L.E.	Livestock* Production Value L.E.	Average Per Feddan L.E.	Net Farm** Income Value L.E.	Average Per Feddan L.E.	N.F.I. L.E.	Average N.F.I. Per Person L.E.
1	7	3.25	1092	336.0	354.2	109.0	824	253.5	824	117.7
2	7	1.33	907	681.9	203	152.6	195	146.6	195	27.9
3	8	1.50	747	498.0	271	180.7	540	360.0	540	67.5
4	7	2.75	1148	417.5	253	92.0	410	149.0	410	58.6
5	10	1.75	624	356.6	509	290.9	934	533.7	934	93.4
6	6	1.92	662	344.8	570	296.9	1171	609.9	1171	195.2

* L.S. production without work done by L.S. value
** N.F.I. without land appreciation

Table 12
Average Net Farm Income Per Feddan and Per Person
From the Total Study Cases at Bani-Magdoul Site
Farm Records (1978-1979)

Farm No.	Family Members	Area Feddan	Gross Income Including Land Appreciation L.E.	Gross Income Without Land Appreciation L.E.	Gross Expenses L.E.	N.F.I. Including Land Appreciation L.E.	N.F.I. Without Land Appreciation L.E.
1	7	3.25		1700	876		824
2	7	1.33		1067	872		195
3	8	1.50		1018	478		540
4	7	2.75		1300	890		410
5	10	1.75		1459	525		934
6	6	1.92		1791	620		1171
Total	45	12.5		8335	4261		4074

Average N.F.I. per feddan
= 4074 ÷ 12.5 = 325.9 L.E.

Average N.F.I. per person
= 4074 ÷ 45 = 90.5 L.E.

Table 13
Ratio of N.F.I. per Feddan and per Person ÷ Average N.F.I.
for the Study Cases at Bani-Magdoul Site (1978-1979)

Farm No.	Family Members	Area Feddan	Ratio of N.F.I. per Feddan ÷ Average N.F.I.			Ratio of N.F.I. per Person ÷ Average N.F.I.		
			N.F.I. Per Feddan L.E.	Average N.F.I. Per Feddan L.E.	Ratio Col. 1 ÷ Col. 2	N.F.I. Per Person L.E.	Average N.F.I. Per Person L.E.	Ratio Col. 4 ÷ Col. 5
1	7	3.25	253.5	325.9	0.78	117.7	90.5	1.30
2	7	1.33	146.6	325.9	0.45	27.9	90.5	0.31
3	8	1.50	360.0	325.9	1.10	67.5	90.5	0.75
4	7	2.75	149.0	325.9	0.46	58.6	90.5	0.65
5	10	1.75	533.7	325.9	1.64	93.4	90.5	1.03
6	6	1.92	609.9	325.9	1.87	195.2	90.5	2.16

Table 14
Ratio of Value of Farm Production ÷ Working Capital Assets
for the Study Cases at Bani-Magdoul Site (1978-1979)

Farm No.	Area Feddan	Total Assets Value at the Beginning of the Year					Total Value at the End of the Year L.E.	Average Value of Assets L.E.	Farm Production Value L.E.	Ratio of Farm Production ÷ Work Capital Assets
		Equip-ment Value L.E.	Live-stock Value L.E.	Poultry Value L.E.	Grain and Forage Value L.E.	Total Value L.E.				
1	3.25	70	620	00.0	6.5	696.5	950	823	1446	1.76
2	1.33	300	550	102	22	974	931	952	1110	1.17
3	1.5	00.0	320	00.0	35.5	355.5	340	348	901	2.59
4	2.75	269.5	695	22.5	92.1	1079.7	979	1029	1401	1.36
5	1.75	80	640	40	54	814	1139	976	1133	1.16
6	1.92	30	655	15	32	732	1291	1011	1231	1.22

Table 15
Ratio of Working Capital Assets Value ÷ No. Feddans
for the Study Cases at Bani-Magdoul Site (1978-1979)

Farm No.	Area Feddan	Working Assets Value at the Beginning of the Year L.E.	Working Assets Value at the End of the Year L.E.	Average Value of Working Assets L.E.	Ratio of Working Assets ÷ Area/Feddan	Remarks
1	3.25	696	950	823	253.23	
2	1.33	974	931	952	715.79	
3	1.5	355	340	348	256.00	
4	2.75	1079	979	1029	374.18	
5	1.75	814	1139	976	557.71	
6	1.92	732	1291	1011	526.56	

Table 16
Ratio of Value of Crop Production ÷ Crop Expenses
for the Study Cases at Bani-Magdoul Site (1978-1979)

Farm No.	Area Feddan	Value of Crop Production				Total Crop Expenses L.E.	Ratio of Value of Crop Production ÷ Crop Expenses	Remarks
		Livestock Feed L.E.	Home Use L.E.	Sales L.E.	Total Value L.E.			
1	3.25	171	00.0	921	1092	391	2.79	
2	1.33	401	136	370	907	257	3.53	
3	1.5	58	00.0	572	360	251	1.43	
4	2.75	285	17	846	1148	225	5.10	
5	1.75	249	38	336	623	135	4.61	
6	1.92	54	36	572	662	222	2.98	

I. (B) FARM RECORDS SUMMARY AND ANALYSIS AT EL HAMMAMI SITE MANSOURIA DISTRICT

Table 17
Financial Statement for Study Cases Farmers at
El Hammami Site - Farm Records (1978-1979)

Farm No.	Farmer's Name	Family Members: Male	Family Members: Female	Family Members: Total	Area: F*	Area: K*	Area: Total Value L.E.**	Livestock: Cow	Livestock: Buffalo	Livestock: Calves	Livestock: Donkey	Livestock: Camel	Livestock: Goats	Livestock: Poultry	Livestock: Total Value L.E.	Land and Livestock Total Value L.E.	Area Feddan 00.00
1	Abdel Sattar Barour	5	5	10	2 -	1 10 R	8166	-	-	-	1	1	-	30	358	8524	2.46
2	Fathy El Kilany	7	5	12	-	11	2000	-	-	-	1	-	2	5	94	2094	0.46
3	Mousa Abdel Maksoud	6	12	18	2	18	13500	1	-	-	1	-	1	15	277	13777	2.75
4	Ragab Hotaita	17	14	31	7 6	6 4 R	53400	5	2	4	2	1	-	-	1890	55290	13.30
5	Saied El Rabiey	2	1	3	- -	12 21 R	2500	-	-	2	1	-	2	25	272	2772	1.38

* 1 F. (feddan) = 24 K. (kerat)   R = rented land
** Land value at El Hammami Site is [illegible] in it's value than [illegible] Site

Table 18
Crop Rotation for the Study Cases at El Hammami Site
Farm Records (1978-1979)

Farm No.	Total Area Feddan	Crop Cultivated Area per Feddan														
		Barseem	Wheat	Squash	Tomatoes	Hot Pepper	Cabbage	Okra	Eggplant	Onion	Sunflower	Peanut	Mellons	Jews Mellon	Maize	Maize Forage
1	2.46	0.90	0.46	0.58	0.54	0.46	0.54	-	-	0.08	-	-	-	-	0.42	0.92
2	0.46	0.46	-	-	-	-	-	0.20	-	-	-	-	-	0.16	-	0.10
3	2.75	0.67	0.50	0.25	0.50	1.58	0.58	-	-	-	0.33	0.67	-	-	0.25	1.00
4	13.30	3.00	1.70	0.50	2.50	2.30	-	-	0.80	-	-	-	1.30	-	1.80	2.50
5	1.38	0.58	-	-	-	1.38	-	-	-	-	-	-	-	0.80	0.58	0.63

Table 19
Summary of Crop and Livestock Production
El Hammami Site - Farm Records (1978-1979)

Farm No.	Production and Disposition of Crops				Production and Disposition of Livestock						
	Fed to Livestock L.E.	Home Use L.E.	Sales L.E.	Production Total Value L.E.	Home Use L.E.	Sales L.E.	Total Value L.E.	Non Purchased Feed L.E.	Purchased Feed L.E.	Purchased and Non Purchased Feed L.E.	Gain Over All Feed Cost L.E.
1	59.5	16.4	739.4	815.3	189.9	230.4	420.3	59.5	63	122.5	297.80
2	39	7.4	25	71.4	00.0	20	20.0	39.0	8	47	-27.00
3	253	1.7	489.5	744.2	90	00	90	523	19	542	-452.00
4	554	6.7	3177.9	3738.6	455.5	305	760.5	554	262	816	-55.50
5	382	79.00	218	679	145.7	114	259.7	382	126	508	-248.30

Table 19/B

Summary of Crops and Livestock Production at El Hammami Site Farm Records 1978-1979

Farm No.	Crop Production Value L.E.	Livestock Production Value L.E.	Total Production Value L.E.	Crops %	Livestock %
1	815.3	420.3	1,235.6	66	34
2	71.4	20.0	91.4	78	22
3	744.2	90.0	834.2	89	11
4	3,738.6	760.0	4,498.6	83	17
5	679.0	259.7	938.7	72	23
Total	6,048.5	1,550.0	7,598.5	80	20

Table 17 shows the numbers in the farmers family. As for Bani-Magdoul, all members become involved in the farming operation. Since El Mansouria site lies near El Giza City and Cairo, many farm laborers move to these two big cities for employment in construction, industrial work, or commercial business. Even school-age sons often seek jobs at these two big cities.

The land value at El Hammami site is lower than Bani-Magdoul site. Likely, this is because El Hammami lies at a slightly greater distance from Cairo. The land values given in Table 17 are estimated by the farmers as are livestock values. Farms are larger, on the average, than at Bani-Magdoul; but, this is primarily because of one relatively large farm which is included in the study.

Table 18 gives the crop mix for the study case farms. Barseem represents 28 percent of the winter crop and maize forage represents 25 percent of the summer crop; both are mainly used for livestock feeding in winter and summer, respectively. Vegetables are the primary cash crop in this area and are capable of producing a high return. By comparing Tables 17 and 18 it can be seen that using the land to produce forage for livestock requires a much higher percentage of available land on the small farms than on larger sized farms.

In Table 19 it is seen that a relatively high proportion of the total value of crops produced are sold off the farm. For the one small farm (No. 2), because such a large amount of available land must be used to produce forage for livestock, sales of crops represent only about 35 percent of the total value of crops. On this farm all of the value of livestock is represented in sales; the donkey is "rented out" to provide income to the small farmer.

On four of the five farms the value of purchased and non-purchased livestock feeds exceeded the value of livestock. Home use of livestock tends to be a relatively important contribution from livestock in most cases. And, farm produced feed makes up most of the value of feed fed to livestock.

Table 19/B presents the summary of crop and livestock production. This table shows the relative contribution that crops and livestock make to the total value of farm production.

On the average, 80 percent of the total production value comes from crops and 20 percent from livestock. The production values are set by the actual prices which the farmers received from selling their production in the market.

Tables 20, 21, and 22 present the ratios of livestock production divided by livestock feed expenses with and without livestock work value. The work values are estimated according to the opportunity cost--that is, the going rate for hiring such livestock work services are applied. On only one farm does the value of livestock production exceed the value of livestock feed expenses. The primary work value of livestock is for transportation and turning sakias. This set of farms reported no livestock use in field operations.

When the work-value of livestock is added to their contribution to home consumed items and sales values, the rationale for livestock's existence on farms becomes more apparent. The total value of livestock exceeds the value of livestock feed expenses in three of the five cases.

Table 23 is the summary of net farm income. Net farm income (ignoring land appreciation) is negative for the smallest farmer. Table 24 represents the average value of production per feddan and the average net farm income per person. The value of crops produced per feddan varies over a sizable range. Farm 5 has over three times as much crop value per feddan as does Farm two. Only two farms produced a modest amount of income per person in 1978-79. For the others, income per person was either negative or extremely low.

Table 25 shows the average net farm income per feddan and per person from each of the study cases at El Hammami site. This average is very low when compared with the average at Bani-Magdoul site (Table 12).

From Table 27 the relationships between working capital assets and the value of farm production are seen. It again appears that the value of farm production is positively associated with the value of working capital assets.

Tables 28, 29 show the ratio of working capital assets per feddan and the ratio of crop production value divided by crop expenses, respectively. The value of crop production exceeds the value of crop expenses in all cases. This ratio also appears to be related to farm size, measured in feddans of land.

Table 20
Number of Livestock by Species, Work Done by Livestock and
Ratios of Livestock Production (Not Including Work Value) ÷ L.S. Feed Expenses
for the Study Cases at El Hammami Site (1978-1979)

Farm No.	Area Feddan	Farm Livestock					Working Hours Done by L.S.					L.S. Production ÷ L.S. Feed Expenses		
		Cow	Buffalo	Calves	Donkey	Camel	Transportation*	Plowing	Leveling	Puddling	Turning Sakia**	Purchased and Non Purchased Feed L.E.	Total Value of L.S. Production L.E.	L.S. Production ÷ L.S. Feed Expenses
1	2.46	-	-	-	1	-	350				238	122.5	420.3	3.43
2	0.46	-	-	-	1	-	350				94	47.0	20.0	0.43
3	2.75	1	-	-	1	-	350				433	542	90.0	0.17
4	13.30	5	2	4	2	-	700				532	816	760.0	0.93
5	1.38	-	-	2	1	-	350				163	508	259.7	0.51

Transportation and loading done by donkey. We assume that the minimum is 350 h. per year for donkey.
* Donkey is used for turning sakia except cases #3 and 4. Cows and buffalo are used.

Table 21
Value of Work Done by Livestock and Total Value of Livestock Production for El Hammami Study Cases
(1978 - 1979)

Farm No.	Area Feddan	No. of L.S.				Value of Work Done by Livestock							Total Value of Livestock Production, Home Use and Sales L.E.	Gross Total Value of Livestock Production L.E.
		Cow	Buffalo	Calves	Donkey	Trans-port Hours	Value per Hour L.E.	Total Value L.E.	Turn Sakia Hours	Value per Hour L.E.	Total Value L.E.	Gross Total Value L.E.		
1	2.46	-	-	-	1	350	0.15	52.5	238	0.15	35.7	88.2	420.3	508.5
2	0.46	-	-	-	1	350	0.15	52.5	94	0.15	14.1	66.6	20.0	86.6
3	2.75	1	-	-	1	350	0.15	52.5	433	0.30	129.9	188.4	90.0	272.4
4	13.30	5	2	4	2	700	0.15	105	532	0.30	159.6	264.6	760.0	1024.6
5	1.38	-	-	2	1	350	0.15	52.5	163	0.15	24.5	77.0	259.7	336.7

Table 22
Ratio of Livestock Production (Including Work Value) ÷ L.S. Feed Expenses
for the Study Cases at El Hammami Site (1978-1979)

Farm No.	Area Feddan	Farm Livestock							Livestock Production Value			Purchased and Non Purchased Feed L.E.	Gain Over All Feed Costs L.E.	Ratio of L.S. Production ÷ L.S. Feed Expenses
		Cow	Buffalo	Calves	Donkey	Camel	Goats	Poultry	Value of Work Done by L.S. L.E.	Value of L.S. Production Home Use & Sales L.E.	Total Value L.E.			
1	2.46	-	-	-	1	1	-	30	88	420.3	508.5	122.5	386	4.15
2	0.46	-	-	-	1	-	2	5	66.6	20.0	86.6	47.0	39.6	1.84
3	2.75	1	-	-	1	-	1	15	182.4	90.0	272.4	542	-269.6	0.50
4	13.30	5	2	4	2	1	-	-	264.6	760.0	1024.6	816	208.6	1.26
5	1.38	-	-	2	1	-	2	25	77.0	259.7	336.7	508	-171.8	0.66

Table 23
Summary of Net Farm Income at El Hammami Site
Farm Records 1978 - 1979

Farm No.	Summary of Income						Summary of Expenses						Net Farm Income
	Animal Products L.E.	Crop Products L.E.	Capital Sales L.E.	Inventory Changes if (+) L.E.	Off Farm Income L.E.	Total Gross Income L.E.	Crop Expenses L.E.	Non Crop Expenses L.E.	Capital Purchases L.E.	Inventory Changes if (-) L.E.	Non Purchase Livestock Feed L.E.	Total Gross Expense L.E.	
1	420	815	830	3551	-	5616	278	93	400	-	60	831	*4785 ** 951
2	20	71	-	343	-	434	63	36	-	-	39	138	* 296 ** -4
3	90	744	182	2160	-	3176	383	19	134	-	253	789	*2387 ** 87
4	761	3739	-	9074	-	13574	1446	482	-	-	554	2482	*11092 ** 2292
5	260	679	-	497	-	1436	324	209	-	-	382	915	* 521 ** 21

* N.F.I. including land appreciation
** N.F.I. without land appreciation

Table 24
Average Value Production per Feddan and Average Net
Farm Income per Person at El Hammami Site
Farm Records (1978-1979)

			Average Crop Prod/F.		Average Livestock Prod/F.		Average N.F.I./F.		Average N.F.I./Person	
Farm No.	Total Family Members	Area Feddan	Crop Production Value L.E.	Average Per Feddan L.E.	Livestock* Production Value L.E.	Average Per Feddan L.E.	Net Farm** Income Value L.E.	Average Per Feddan L.E.	N.F.I. L.E.	Average N.F.I. Per Person L.E.
1	10	2.46	815	331.3	420	170.7	951	386.6	951	95.1
2	12	0.46	71	154.3	20	43.5	-4	-8.7	-4	-0.33
3	18	2.75	744	270.5	90	32.7	87	31.6	87	4.83
4	31	13.30	3937	296	761	57.2	2292	172.3	2292	73.9
5	3	1.38	679	492	260	188.4	21	15.2	21	7

* L.S. production without work done by L.S. value
** N.F.I. without land appreciation

Table 25
Average Net Farm Income Per Feddan and Per Person
From the Total Study Cases at El Hammami Site
Farm Records (1978-1979)

Farm No.	Family Members	Area Feddan	Gross Income Including Land Appreciation L.E.	Gross Income Without Land Appreciation L.E.	Gross Expenses L.E.	N.F.I. Including Land Appreciation L.E.	N.F.I. Without Land Appreciation L.E.	
1	10	2.46		1782	831		951	Average N.F.I. per feddan = 3347 ÷ 20.35 = 164.5 L.E
2	12	0.46		134	138		-4	
3	18	2.75		876	789		87	Average N.F.I. per person = 3347 ÷ 74 = 45.2 L.E.
4	31	13.30		4774	2482		2292	
5	3	1.38		936	915		21	
Total	74	20.35		8502	5155		3347	

Table 26
Ratio of N.F.I. per Feddan and per Person ÷ Average N.F.I.
for the Study Cases at El Hammami Site (1978-1979)

Farm No.	Family Members	Area Feddan	Ratio of N.F.I. per Feddan ÷ Average N.F.I.			Ratio of N.F.I. per Person ÷ Average N.F.I.		
			N.F.I. Per Feddan L.E.	Average N.F.I. Per Feddan L.E.	Ratio Col. 1 ÷ Col. 2	N.F.I. Per Person L.E.	Average N.F.I. Per Person L.E.	Ratio Col. 4 ÷ Col. 5
1	10	2.46	386.6	164.5	2.35	95.1	45.2	2.1
2	12	0.46	-8.7	164.5	-0.05	-0.33	45.2	-0.01
3	18	2.75	31.6	164.5	0.19	4.83	45.2	0.11
4	31	13.30	172.3	164.5	1.05	73.9	45.2	1.63
5	3	1.38	15.2	164.5	0.09	7	45.2	0.15

Table 27
Ratio of Value of Farm Production ÷ Working Capital Assets
for the Study Cases at El Hammami Site (1978-1979)

Farm No.	Area Feddan	Total Assets Value at the Beginning of the Year					Total Value at the End of the Year L.E.	Average Value of Assets L.E.	Farm Production Value L.E.	Ratio of Farm Production ÷ Work Capital Assets
		Equipment Value L.E.	Livestock Value L.E.	Poultry Value L.E.	Grain and Forage Value L.E.	Total Value L.E.				
1	2.46	100	320	38	65	523	240	382	1236	3.24
2	0.46	35	80	14	-	129	172	150	91	0.61
3	2.75	174	247	30	70	521	381	451	834	1.85
4	13.30	1915	1890	-	245	4050	4324	4187	4499	1.07
5	1.38	150	225	47.5	9	431.5	428	430	939	2.18

Table 28
Ratio of Working Capital Assets Value ÷ No. of Feddans
for the Study Cases of El Hammami Site (1978-1979)

Farm No.	Area Feddan	Working Assets Value at the Beginning of the Year L.E.	Working Assets Value at the End of the Year L.E.	Average Value of Working Assets L.E.	Ratio of Working Assets ÷ Area/Feddan	Remarks
1	2.46	523	240	382	155.28	
2	0.46	129	172	150	326.09	
3	2.75	521	381	451	164.00	
4	13.30	4050	4324	4187	314.81	
5	1.38	431	428	430	311.59	

Table 29
Ratio of Value of Crop Production ÷ Crop Expenses
for the Study Cases at El Hammami Site (1978-1979)

Farm No.	Area Feddan	Value of Crop Production				Total Crop Expenses L.E.	Ratio of Value of Crop Production ÷ Crop Expenses	Remarks
		Livestock Feed L.E.	Home Use L.E.	Sales L.E.	Total Value L.E.			
1	2.46	59.5	16.4	739.4	815.3	277.6	2.94	
2	0.46	39	7.4	25.0	71.4	63.1	1.13	
3	2.75	253	1.7	489.5	744.2	382.5	1.95	
4	13.30	554	6.7	3177.9	3738.6	1446.4	2.58	
5	1.38	382	1.0	218.0	679	323.7	2.10	

II. FARM RECORDS SUMMARY AND ANALYSIS
AT ABU-RAIA SITE
KAFR EL SHEIKH GOVERNATE

Background:

The Abu-Raia area is located in the North Delta and it lies to the South of El Broells Lake. This area is newly reclaimed land; it has been reclaimed for about 50 years.

The soil type is clay on the surface; the soil profile includes a heavy clay for from 40-60 cm and after that it is a loam soil. The area suffers from soil salinity and sodicity problems. A highly significant negative relationship exists between soil salinity and yields.

The water in canals is of high quality. The electrical conductivity of irrigation water averages about 0.54 millimhos for the period of measurement, with relatively low sodium. The water in drains has the range from 1.06 to 3.26 millimhos. The Gadalla drain is very highly saline and should not be used for irrigation if there is any other alternative.

The water table varies from 40-160 cm from land surface. The farmers near Abu-Raia as well as all Egyptian farmers have no modern methods available to guide their decisions about when to irrigate and how much to apply; modern techniques could perhaps increase their yield and reduce the water they apply. Improved water management might also effect a lowering of the water table and reduce the danger of excess moisture in the root zone. See Abu-Raia Area map Figure 4.

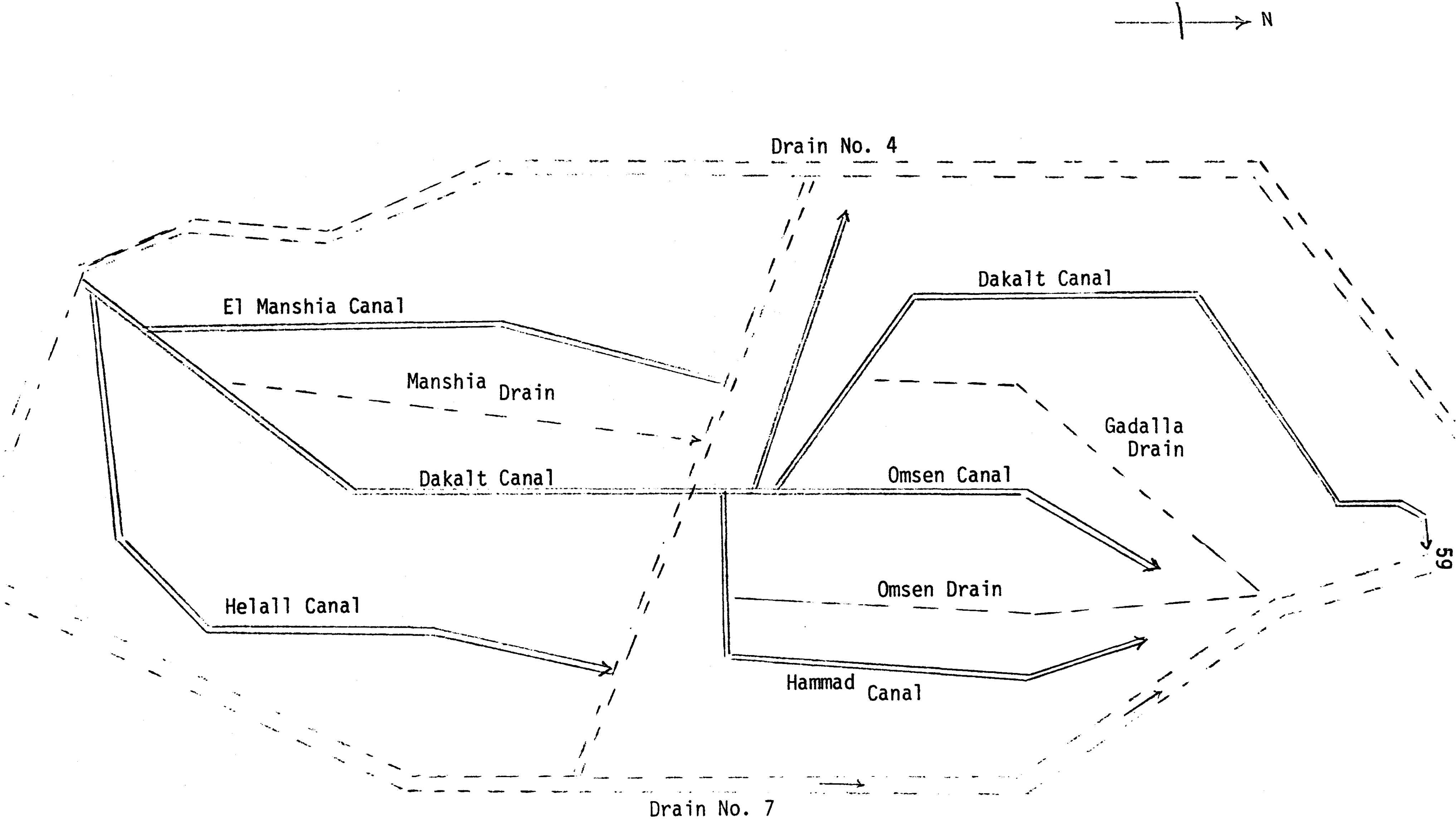

Figure 4 . Map of Abu-Raia Area

Table 30
Financial Statement for Study Cases Farmers at
Abu-Raia Site - Farm Records (1978-1979)

Farm No.	Farmer's Name	Family Members			Area			Livestock								Land and Livestock Total Value L.E.	Area Feddan 00.00
		Male	Female	Total	F.*	K*	Total Value L.E.	Cow	Buffalo	Calves	Donkey	Camel	Goats	Poultry	Total Value L.E.		
1	Ibrahim Shamseldin	6	3	9	6	9	11750	-	2	1	2	-	-	39	595	12345	6.38
2	Marey Marey Yosef	2	4	6	6	19	13563	1	1	4	2	-	-	-	898	14481	6.79
3	Serriah Mustfa Abdu	7	11	18	8	8	14800	2	1	2	2	-	-	8	652	15452	8.33
4	Hamed El Behairy	4	4	8	2 O 1 R	12 12	5000	1	1	-	1	-	-	-	405	5405	4.00
5	Abdel Hamid Shaban	4	6	10	4 O 2 R	16 -	8000	1	1	-	2	-	-	-	410	8410	6.67
6	Ahmed Abdel Baki	6	2	8	10	18	21500	4	2	3	2	-	-	10	1864	23364	10.75
7	Salem Aly Marey	3	2	5	3	-	6600	-	2	2	1	-	-	22	809	7409	3.00

O = owned R = rented land

Table 31
Crop Rotation for the Study Cases at Abu-Raia Site
From Their Farm Records (1978-1979)

Farm No.	Winter Crops						Summer Crops						
	Barseem F.	Wheat F.	Flax F.	Broad Beans F.	Veg. F.	Maize Forage F.	Cotton F.	Rice F.	Maize F.	Maize Forage F.	Mellons Seeds F.	Tomatoes F.	Cucum-ber F.
1	4.10	1.60	0.70	-	-	-	2.90	2.80	0.70	0.3	-	-	-
2	3.10	2.70	1.00	-	-	-	-	4.70	1.00	-	-	0.50	0.60
3	3.40	2.70	1.50	0.80	-	-	2.00	5.20	0.70	0.30	0.20	-	-
4	2.00	1.00	1.00	-	-	-	1.50	2.50	-	-	-	-	-
5	3.30	1.80	1.30	0.30	-	-	2.90	1.80	1.50	0.40	0.10	-	-
6	5.30	1.50	3.00	-	-	1.00	4.30	5.00	0.50	1.00	-	-	-
7	2.00	1.00	-	-	-	-	1.00	1.00	1.00	-	-	-	-

Table 32
Summary of Crop and Livestock Production at
Abu-Raia Site - Farm Records (1978-1979)

Farm No.	Production and Disposition of Crops				Production and Disposition of Livestock						
	Fed to Livestock L.E.	Home Use L.E.	Sales L.E.	Production Total Value L.E.	Home Use L.E.	Sales L.E.	Total Value L.E.	Non Purchased Feed L.E.	Purchased Feed L.E.	Purchased and Non Purchased Feed L.E.	Gain Over* All Feed Cost L.E.
1	376.0	248.0	1072.5	1696.5	231.7	37.4	269.1	376.0	3.0	379.0	-109.9
2	644.5	213.6	1038.9	1897.0	164.3	33.9	198.2	644.0	321.0	965.0	-766.8
3	444.5	356.5	1789.4	2590.4	188.6	50.0	238.6	444.5	65.0	509.5	-270.9
4	131.0	76.5	419.0	626.5	40.9	00.0	40.9	131.0	12.0	143.0	-102.10
5	523.5	173.8	1209.4	1898.7	87.0	36.0	123.0	523.5	00.0	523.5	-400.5
6	610.5	347.2	3171.5	4129.2	321.0	00.0	321.0	610.5	47.0	657.5	-336.5
7	308.0	197.0	584.5	1089.5	111.2	00.0	111.2	308.0	3.8	311.8	-200.6

* *Gain over all feed costs is negative because we did not compute the animal power value which were used in farm*

Table 33

The Summary of Crops and Livestock
Production at Abu-Raia Site
Farm Records 1978-1979

Farm No.	Crop Production Value L.E.	Livestock Production Value L.E.	Total Production Value L.E.	Crops %	Livestock %
1	1,696.5	269	1,965	86	14
2	1,897.0	198	2,095	91	9
3	2,590	239	2,829	92	8
4	626	41	667	94	6
5	1,899	123	2,022	94	6
6	4,129	321	4,450	93	7
7	1,089	111	1,200	91	9
Total	13,926.5	1,302	15,228	91	9

Table 30 shows the numbers of individuals in the farmers family at Abu-Raia site. All the family members cooperate in the farming operation, particularly at critical times like transplanting rice nurseries, applying cotton insecticides, rice harvesting, and cotton picking.

The land value at Abu-Raia site ranges between 1500-2000 L.E. per feddan; the land values given in Table 30 are estimated by the farmers as are livestock values.

Table 31 illustrates the crop mix for the study case farmers. Berseem represents 51 percent of the winter crop because it is the main livestock feed in winter. Cotton represents 32 percent of the summer crops and rice represents about 50 percent. Cotton and rice and maize are the main summer crops at Abu-Raia site.

Table 40 shows the ratio of net farm income per feddan and per person divided by the average net farm income for all the study cases at Abu-Raia. Each individual study case is compared to the average of all study cases since this was the first year for keeping farm records and for analyzing its data.

Table 41 represents the relationships between working capital assets and the value of farm production.

Tables 42, 43 show the ratio of working capital assets per feddan and the ratio of crop production value divided by its expenses.

Table 34
Number of Livestock by Species, Work Done by Livestock and
Ratio of Livestock Production (Not Including Work Value) ÷ L.S. Feed Expenses
for the Study Cases at Abu-Raia Site (1978-1979)

Farm No.	Area Feddan	Farm Livestock				Working Hours Done by L.S.**						L.S. Production ÷ L.S. Feed Expenses		
		Cow	Buffalo	Calves	Donkey	Transportation*	Plowing	Leveling	Puddling	Turning Sakia	Total Hours	Purchased and Non Purchased Feed L.E.	Total Value of L.S. Production L.E.	L.S. Production ÷ L.S. Feed Expenses
1	6.38	-	2	1	2	700	56	19	11	738	824	379.00	269.10	0.71
2	6.79	1	1	4	2	700	235	40	11	726	1012	965.00	198.20	0.21
3	8.33	2	1	2	2	700	92	92	25	1038	1247	509.50	238.60	0.47
4	4.00	1	1	-	1	350	110	52	8	394	519	143.00	40.90	0.29
5	6.67	1	1	-	2	700	157	95	18	411	681	532.50	123.00	0.23
6	10.75	4	2	3	2	700	7	21	19	751	798	657.5	321.00	0.49
7	3.00	-	2	2	1	350	20	6	6	182	236	311.80	111.20	0.36

* Transportation and loading done by donkey. We assume that the minimum is 350 h. per year for one donkey.
** Working hours done by cows and buffalo only. These actual hours from record books.

Table 35
Value of Work Done by Livestock and Total Value of Livestock Production for Abu-Raia Study Cases
(1978 - 1979)

Farm No.	Area Feddan	Farm Livestock				Value of Work Done by Livestock							Total Value of Livestock Production, Home Use and Sales L.E.	Gross Total Value of Livestock Production L.E.
		Cow	Buffalo	Calves	Donkey	Trans-port Hours	Value per Hour L.E.	Total Value L.E.	Plowing Leveling Puddling Turn Sakia Hours	Value per Hour L.E.	Total Value L.E.	Gross Total Value L.E.		
1	6.38	-	2	1	2	700	0.150	105.00	824	0.300	247.20	352.20	269.10	621.30
2	6.79	1	1	4	2	700	0.150	105.00	1012	0.300	303.60	408.60	198.20	606.80
3	8.33	2	1	2	2	700	0.150	105.00	1247	0.300	374.10	479.10	238.60	717.70
4	4.00	1	1	-	1	350	0.150	52.50	519	0.300	155.70	208.20	40.90	249.10
5	6.67	1	1	-	2	700	0.150	105.00	681	0.300	204.30	309.30	123.00	432.30
6	10.75	4	2	3	2	700	0.150	105.00	798	0.300	239.40	344.40	321.00	665.40
7	3.00	-	2	2	1	350	0.150	52.50	236	0.300	70.80	123.30	111.20	234.50

Table 36
Ratio of Livestock Production (Including Work Value) ÷ L.S. Feed Expenses
for the Study Cases at Abu-Raia Site (1978-1979)

Farm No.	Area Feddan	Farm Livestock					Livestock Production Value			Purchased and non Purchased Feed L.E.	Gain Over All Feed Costs L.E.	Ratio of L.S. Production ÷ L.S. Feed Expenses
		Cow	Buffalo	Calves	Donkey	Poultry	Value of Work Done by L.S. L.E.	Value of L.S. Production Home Use & Sales L.E.	Total Value L.E.			
1	6.38	-	2	1	2	39	352.20	269.10	621.30	379.00	242.30	1.64
2	6.79	1	1	4	2	-	408.60	198.20	606.80	965.00	-358.20	0.63
3	8.33	2	1	2	2	8	479.10	238.60	717.70	509.50	208.20	1.41
4	4.00	1	1	-	1	-	208.20	40.90	249.10	143.00	106.10	1.74
5	6.67	1	1	-	2	-	309.30	123.00	432.30	532.50	-100.20	0.81
6	10.75	4	2	3	2	10	344.40	321.00	665.40	657.50	7.90	1.01
7	3.00	-	2	2	1	22	123.30	111.20	234.50	311.80	- 77.30	0.75

Table 37
Summary of Net Farm Income at Abu-Raia Site
Farm Records 1978 - 1979

Farm No.	Summary of Income: Animal Products L.E.	Crop Products L.E.	Capital Sales L.E.	Inventory Changes if (+) L.E.	Off Farm Income L.E.	Total Gross Income L.E.	Summary of Expenses: Crop Expenses L.E.	Non Crop Expenses L.E.	Capital Purchases L.E.	Inventory Changes if (-) L.E.	Non Purchase Livestock Feed L.E.	Total Gross Expense L.E.	Net Farm Income
1	269.0	1697.0	260.0	2421.0	00.0	4647.0	444.8	34.3	170.0	00.0	376.0	1025.1	*3621.9 **1739.9
2	198.2	1897.0	1837.0	226.5	00.0	4158.7	398.8	355.6	1615.0	00.0	644.9	3013.9	1144.8 569.8
3	239.0	2590.0	505.0	5162.0	00.0	8496.0	814.0	190.0	590.0	00.0	445.0	2039.0	6457.0 1857.0
4	40.9	226.5	280.0	595.5	2.0	1544.9	161.6	24.5	253.0	00.0	131.0	570.1	974.8 294.8
5	123.0	1906.5	445.0	1601.0	00.0	4075.5	578.7	26.5	474.6	00.0	136.0	1215.8	2859.7 1599.7
6	322.0	4129.0	368.0	2383.0	175.0	7377.0	863.0	194.0	731.0	00.0	611.0	2399.0	4978.0 2373.0
7	111.0	1090.0	670.0	1654.0	00.0	3525.0	215.0	50.0	240.0	00.0	308.0	819.0	2706.0 1806.0

*N.F.I. including land appreciation

** N.F.I. without land appreciation

Table 38
Average Value Production per Feddan and Average Net
Farm Income per Person at Abu-Raia Site
Farm Records (1978-1979)

Farm No.	Total Family Members	Area Feddan	Average Crop Prod/F.		Average Livestock Prod/F.		Average N.F.I./F.		Average N.F.I./Person	
			Crop Production Value L.E.	Average Per Feddan L.E.	Livestock Production Value L.E.	Average Per Feddan L.E.	Net Farm* Income Value L.E.	Average Per Feddan L.E.	N.F.I.* L.E.	Average N.F.I. Per Person L.E.
1	9	6.38	1696.5	265.9	269.1	42.2	1739.9	254.7	1739.9	193.3
2	6	6.79	1897.0	281.5	198.2	29.2	569.8	83.9	569.8	95.0
3	18	8.33	2590.4	311.0	238.6	28.6	1857.0	222.9	1857.0	103.2
4	8	4.00	626.5	156.6	40.9	10.2	224.8	56.2	224.8	28.1
5	10	6.67	1898.7	284.7	123.0	18.4	1558.7	223.7	1558.7	155.9
6	8	10.75	4129.2	384.0	321.0	29.9	1473.0	137.0	1473.0	184.1
7	5	3.00	1089.5	363.2	111.2	37.9	1806.0	602.0	1806.0	361.2

* N.F.I. without land appreciation

Table 39
Average Net Farm Income Per Feddan and Per Person
From the Total Study Cases at Abu-Raia Site
Farm Records (1978-1979)

Farm No.	Family Members	Area Feddan	Gross Income Including Land Appreciation L.E.	Gross Income Without Land Appreciation L.E.	Gross Expenses L.E.	N.F.I. Including Land Appreciation L.E.	N.F.I. Without Land Appreciation L.E.	
1	9	6.38	4647.00	2765.00	1025.10	3621.90	1739.9	Average N.F.I. Per Feddan = 10240 ÷ 45.92 = 223 L.E.
2	6	6.79	4158.70	3583.70	3013.90	1144.80	569.80	
3	18	8.33	8496.00	3896.00	2039.00	6457.00	1857.00	
4	8	4.00	1544.90	864.90	570.10	974.80	294.80	Average N.F.I. Per Person = 10240 ÷ 64 = 160 L.E.
5	10	6.67	4075.50	2815.50	1215.80	2859.70	1599.70	
6	8	10.75	7377.00	4772.00	2399.00	4978.00	2373.00	
7	5	3.00	3525.00	2625.00	819.00	2706.00	1806.00	
Total	64	45.92	33824.10	21322.10	11081.90	22742.20	10240.00	

Table 40
Ratio of N.F.I. per Feddan and per Person ÷ Average N.F.I.
for the Study Cases at Abu-Raia Site (1978-1979)

Farm No.	Family Members	Area Feddan	Ratio of N.F.I. per Feddan ÷ Average N.F.I.			Ratio of N.F.I. per Person ÷ Average N.F.I.		
			N.F.I. Per Feddan L.E.	Average N.F.I. Per Feddan L.E.	Ratio Col. 1 ÷ Col. 2	N.F.I. Per Person L.E.	Average N.F.I. Per Person L.E.	Ratio Col. 4 ÷ Col. 5
1	9	6.38	254.7	223	1.14	193.3	160	1.21
2	6	6.79	83.9	223	0.38	95.0	160	0.59
3	18	8.33	222.9	223	1.00	103.2	160	0.65
4	8	4.00	56.2	223	0.25	28.1	160	0.18
5	10	6.67	223.7	223	1.00	155.9	160	0.97
6	8	10.75	137.0	223	0.61	184.1	160	1.15
7	5	3.0	602.0	223	2.70	361.2	160	2.26

Table 41
Ratio of Value of Farm Production ÷ Working Capital Assets
for the Study Cases at Abu-Raia Site (1978-1979)

Farm No.	Area Feddan	Total Assets Value at the Beginning of the Year					Total Value at the End of the Year L.E.	Average Value of Assets L.E.	Farm Production Value L.E.	Ratio of Farm Production ÷ Work Capital Assets
		Equipment Value L.E.	Livestock Value L.E.	Poultry Value L.E.	Grain and Forage Value L.E.	Total Value L.E.				
1	6.38	155.5	570	47	401.5	1174.5	1712.5	1443.5	1965.6	1.36
2	6.79	256	798	10	143.5	1198.5	2009	1603.7	2095.2	1.31
3	8.33	410	590	12	384	1396.0	1957.5	1676.7	2829.0	1.69
4	4.00	34	485	-	84.5	603.5	627.0	615.3	667.4	1.08
5	6.67	169.5	410	34.5	282	896.0	1237	1066.5	2029.7	1.90
6	10.75	455	1850	110	366	2781.0	2559	2670.0	4450.8	1.67
7	3.00	116	890	39	244	1289.0	1642.5	1465.8	1200.7	0.82

Table 42
Ratio of Working Capital Assets Value ÷ No. of Feddans
for the Study Cases at Abu-Raia Site (1978-1979)

Farm No.	Area Feddan	Working Assets Value at the Beginning of the Year L.E.	Working Assets Value at the End of the Year L.E.	Average Value of Working Assets L.E.	Ratio of Working Assets ÷ Area/Feddan	Remarks
1	6.38	1174.5	1712.5	1443.5	226.25	
2	6.79	1198.5	2009.0	1603.7	236.19	
3	8.33	1396.0	1957.5	1676.7	201.28	
4	4.00	603.5	627.0	615.3	153.83	
5	6.67	896.0	1237.0	1066.5	159.90	
6	10.75	2781.0	2559.0	2670.0	248.37	
7	3.00	1289.0	1642.5	1465.8	488.60	

Table 43
Ratio of Value of Crop Production ÷ Crop Expenses
for the Study Cases at Abu-Raia Site (1978-1979)

Farm No.	Area Feddan	Value of Crop Production				Total Crop Expenses L.E.	Ratio of Value of Crop Production ÷ Crop Expenses	Remarks
		Livestock Feed L.E.	Home Use L.E.	Sales L.E.	Total Value L.E.			
1	6.38	376.0	248.0	1072.5	1696.5	444.8	3.81	
2	6.79	644.5	213.6	1038.9	1897.0	398.8	4.76	
3	8.33	444.5	356.5	1789.4	2590.4	814.0	3.18	
4	4.00	131.0	76.5	419.0	626.5	161.6	3.88	
5	6.67	523.5	173.8	1209.4	1906.7	578.7	3.29	
6	10.75	610.5	347.2	3171.5	4129.2	862.8	4.79	
7	3.00	308.0	197.0	584.5	1089.5	215.2	5.06	

Analysis of Individual Enterprises[11]

Much information relating to individual enterprises can be gleaned from the general set of farm accounts and records if only a small amount of detail is added. For individual enterprises records to be meaningful general expenses must be allocated to each of several enterprises as accurately as possible. Enterprise records should be kept on the accrual basis.

The important details to record relate to the variable cost elements. These are useful data for management purposes. In planning for short-time production periods of one year or less, the variable costs are the key considerations relative to production volume and methods.

Both cash cost and opportunity cost should be considered in enterprise analysis. Supplementary enterprises and activities should never be charged for feeds, labor, or other resources that have no value (zero opportunity costs) except when utilized in the supplementary enterprise or activity.

Enterprise records can be helpful to the manager or decision maker in several ways. These records can pinpoint the level of profitability and the factors affecting this profitability during the enterprise accounting period, and if the records are kept over time, the level of performance from year to year can also aid the manager in making wise decisions relative to the future.

Crop production analysis would normally be on the basis of one production cycle or on a calendar year basis. Where is some double-cropping, deviation from this may be feasible. In crop enterprise analysis it must be realized that land is a fixed cost to the operator. If necessary to include land costs, it may be on the basis of an interest charge on the land if it is owned, cash rent if it is rended, or a share of the crop if under a crop-share lease. The decisions on crop production may be on an annual basis in some instances and on a

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[11] Farm Accounting and Business Analysis. Second edition. Sidney C. James and Everette Stoneberg. Chapter Eight.

length of rotation basis in others. Two conceptual problems arise when constructing enterprise costs and returns.[12] One is an allocation problem; it is concerned with how general purpose equipment and general farm overhead items are allocated among alternative enterprises. The second is a distribution problem. It is concerned with how the total costs of producing a given enterprise are partitioned or divided between the various items used in the production process.

Economists differ as to how the allocation and distribution problems are handled.

In developing these enterprise budgets of Egyptian crops, these problems were faced in our discussions of the budgets, we shall attempt to be as explicit as possible in describing how the allocation and distribution issues were met.

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[12] Miller, Thomas H. and Melvin Skold, "Uses and Users of Costs and Returns Data." A needs analysis proceedings. Great Plains Committee on Farm Management and Production Economics, GPC-10. Lincoln, Nebraska. 1980.

Cost Enterprise Data at Egypt

Cost enterprise data has been prepared for the following crops:

1.	Berseem	at Abu-Raia site
2.	Wheat	
3.	Cotton	
4.	Rice	
5.	Maize	
6.	Flax	at Mansouria site
7.	Squash	
8.	Artichoke	
9.	Tomatoes	
10.	Cabbage	
11.	Eggplant	

These enterprise cost studies are shown in the Appendix. These cost studies are based upon data from five study cases; the budgets represent an average of the five cases. Cash and opportunity costs are computed for both variable and fixed costs.

In the future, data needed for enterprise costs will be obtained from farm records.

Table 44 summarizes the costs and returns for the enterprise budgets developed to date.

Table 44
Summary for 11 Crop Enterprise Cost Study
(each operation cost includes labor cost)

Crop	Period Month	Total Income L.E.	Variable Costs L.E.									Fixed Costs L.E.	Grand Total Costs L.E.	Return Above all Costs L.E.
			Plowing Smoothing	Organic Fertilizer	Seeds Transplant	Chemical Fertilizer	Irrigation	Hoeing Weeding Insecticide	Harvesting	Transportation	Total Variable Cost			
Wheat	7	100.00	3.75	8.70	6.6	8.3	10.20	1.20	17.55	3.60	59.90	36.00	95.90	4.10
Berseem	5	145.00	--	--	12.30	5	29.89	3	11.6	3.60	65.39	42.00	107.39	37.61
Cotton	7	190.00	13	12	4.02	14.2	34.20	23.22	25.20	4.5	130.34	54.00	184.00	5.66
Rice	6	168.50	6.5	13.70	11.6	12.2	91.06	2.4	14.2	8	157.66	48.00	205.66	-37.16
Maize	4	115.00	10.82	20.4	1.38	16.68	14.28	3.60	10.56	5.60	83.82	24.00	107.82	7.19
Flax	6	220.00	9	--	14	6.8	19.04	9	13.5	9	80.34	42.00	122.34	97.66
Squash	3	374.00	34.20	26	9.60	30.15	23.10	41.84	13.5	15	193.39	25.13	218.51	156.07
Artichoke	3	759.00	15	80.02	75	61.5	42	85.4	46.8	36	441.72	77.00	518.72	240.28
Tomatoes	4	455.00	15	--	22.5	42.5	48.96	89.5	48	--	266.46	136.00	402.46	52.54
Cabbage	6	720.00	90	33	31.5	37.5	32.64	46	36	30	336.64	32.00	368.64	351.36
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	45	[illegible]	96.00	[illegible]	227.62

The total income was calculated by knowing the yield and the price of each unit which the farmer received. Most prices are determined in a free market but for some crops like cotton and rice the government set the prices received. Farmers who raise cotton must deliver their production to governmental companies with fixed prices; for rice, the farmers have to deliver two-thirds of their rice yield to the Agricultural Cooperative and receive a fixed price; they keep one-third for their home consumption or sale on the free market.

For land plowing and smoothing the actual costs for operations such as hiring tractors are applied. If the farmer used his own equipment, the opportunity cost for his equipment, animals, and his family labors is used in the budget estimates.

Organic fertilizer costs are computed according to its opportunity cost; one donkey load of organic fertilizer costs 0.050 L.E.

The seeds and nursery plant costs are computed according to their market value, even if it was raised on the farm.

Chemical fertilizers, insecticides, and herbicides costs are computed according to the actual prices which the farmers pay for the item. For the rest of the variable costs like irrigation, hoeing, weeding, harvesting, thrashing, transportation, and storing, actual estimated costs of operations are computed when possible. Otherwise, opportunity costs are applied.

Fixed costs contain land rent and a management charge. Land rent is computed on the basis of the actual rent which the farmers pay to the land owner, even it is not the legal fixed rent. (It is almost twice or more than the legal rent.)

The management charge was estimated by our economists. Their estimates take into consideration the period of each individual crop, the complexity of the agriculture operations, and the required expertise of the farmer.

APPENDIX

Governorate:....................

District :....................

Site :....................

Agric.coop.:....................

Pass number:....................

Address :....................

FARM RECORD

October 1st 19 to

30 September 19

Farmer's Name :..........................

Feddan Kerat

Size of farm :..........................

No.	Owned F.	Owned K.		No.	Rented F.	Rented K.
...	...	...	X	...	...	...
...	...	...	X	...	...	...
...	...	...	X	...	...	...
...	...	...	X	...	...	...
			X			

Data gatherd by:............

— EWUP ECONOMICS TEAM —

INVENTORY OF CAPITAL EQUIPMENTS

DESCRIPTION	BEGINING OF YEAR		END OF THE YEAR		REMARKS
	NO.	LE	NO.	LE	
TOTAL					

INVENTORY OF LIVE STOCK

DESCRIPTION	BEGINING OF YEAR		END OF THE YEAR		REMARKS
	NO.	LE	NO.	LE	

INVENTORY OF POULTRY

KIND	BEGINNING OF YEAR		END OF THE YEAR		REMARKS
	NO.	LE	NO.	LE	
TOTAL					

INVENTORY OF GRAIN, FORAGE AND SUPPLIES

ITEM	KIND OF UNIT	BEGINING OF YEAR		END OF THE YEAR		REMARKS
		NO.	LE	NO	LE	
TOTAL						

INVENTORY OF LAND, CASH, LIABILITIES AND REAL ESTATE

IMPROVEMENTS

DESCRIPTIONS	KIND OF UNIT	BEGINING OF YEAR		END OF THE YEAR		REMARKS
		NO.	LE	NO.	LE	
TOTAL						

LIVESTOCK PRODUCTION RECORD

DATE OR PERIOD	DESCRIPTION	KIND OF UNIT	HOME USE		OTHER		SALES		REMARKS
			NO.	LE	NO.	LE	NO.	LE	
TOTAL									

DESCRIPTION OF AGRICULTURAL OPERATIONS AND IT'S COSTS

NAME OF CROP PERIOD FROM: TO : AREA F. K. FIELD NO:

ITEMS	DATE	LABORS		EQUIPMENTS		ORGANIC		CHEMICAL Fert.			Seeds		INSECTICIDES			OTHERS		REMARKS
		NO.	LE	KIND	LE	QUAN.	LE	KIND	QUa.	LE	Quan.	LE	Kind	Quan.	LE		LE	
TOTAL																		LE

CROP PRODUCTION RECORD

KIND OF CROP	AREA		UNIT OF PR.	LE	YIELD PER FED.	TOT. YIELD	LE	ANIMAL FED		HOME USE		SEEDS						REMARKS
	F.	K.						AMT.	LE	AMT.	LE	AMT.	LE	AMT.	LE	AMT.	LE	
TOTAL																		

ANIMAL FEED RECORD

DATE OR PERIOD	KIND OF FOOD	KIND OF UNIT	NO.	COST IF PURCHASED	REMARKS
TOTAL					

WORK DONE BY ANIMALS

DATE OR PERIOD	KIND OF ANIMAL	KIND OF WORK	NO. OF HOURS	REMARKS

DESCRIPTION OF OTHER EXPENSES

DATE	ITEM	LE	REMARKS
TOTAL			

DESCRIPTION OF OTHER INCOME

DATE	ITEM	LE	REMARKS
TOTAL			

FARM RECORD SUMMARY

EMOP Economics Team

for the agricultural year from oct. 1, 1978 to oct. 31, 1979

Farmer's Name: Serriah Mustafa abdu Farm Size: (feddan)* 8.3 Location: abu Raia - Kafr Elshiekh

Inventory Change

ITEM	Beginning of the year LE	end of the year LE	+ or −	Changing Value LE	REMARKS
Inventory of Equipments	410	410			
Inventory of Livestock	590	1323	+	733	
Inventory of Poultry	12	21	+	9	
Inventory of Grain and Forage	384	203.5	−	180.5	
Inventory of Land and Real Estate	14800	19200	+	4600	
TOTAL	16196	21157.5	+	5161.5	

Animal and Crop Production

ANIMAL PRODUCTS					CROP PRODUCTS				
Animal feed LE	Home Use LE	Sales LE		TOTAL	Animal feed LE	Home Use LE	Sales LE		TOTAL
	188.6	50		238.6	444.5	356.5	1789.4		2590.4
TOTAL				238.6	TOTAL				2590.4

1 feddan = 4200.8335 Sq. meter = 1.0381 acre = 0.4201 hectar

Crop Expenses

CROP	Field No.	Area Fed.	Labors LE	Equipments LE	Org. Fert. LE	Chem. Fert LE	Seeds LE	Insecticides LE	OTHER LE	TOTAL LE
Berseem	2A	1		3		1.1				4.1
Wheat	1A	1.5	23.7	16.8		9.5				50
Berseem	1B	0.3				4.8				4.8
Flax	1C	1.2	29	3.5		11			3.3	46.8
Broad Beans	2B	0.8	3.5	4						7.5
Berseem	2C+D	1.3	5.5							5.5
Flax	3A	0.3	5.7	1		4.1			0.8	11.6
Wheat	3B	1.2	10.7	12.8		8.5				32
Watermellons	2D	0.3	0.7			3.6	0.7			5
Maize	2B	0.7	10.3			16.6	1.6			28.5
Rice	3B1B1C	2.3	72.4	14.1	3.8	20.3			11.2	121.8
Maize Forage	2D	0.3	1.5			2.5				4
Berseem	3C	0.8	6	1.2	4.8				1.1	13.1
Rice	1A,B+C	3.0	101.5	40.5		31.7	18		14	205.7
Cotton	2A+C	2.0	19.5	13		15.8	4.2	40	5	273
TOTAL LE		xxx	465.5	109.9	8.6	130.1	24.5	40.0	35.4	814.0

Non-Crop Expense

KIND OF EXPENSE	LE	KIND OF EXPENSE	LE
Purchased animal feed	65	Clearing Drain	11
Land [illegible]		- others	46
Taxes	45		
Coop. commission	23		

TOTAL NON-CROP EXPENSES = LE 190.00

Summary of Income	
Animal Products	239
Crop	2590
[illegible]	505
[illegible] if +	5162

Summary of Expenses	
Crop Expenses	814
Non-Crop Expenses	190
Capital Purchases	590
Inventory change if −	
Non-Purchased Animal Feed	445

NET FARM INCOME
with Land Appreciation = LE 6452
without Land Appreciation = LE 1852

FLAX AT BANI-MAGDOUL AREA(1)

Prepared by: 4 STUDENTS&FAROUK ABDELAL — EGYPT WATER USE & MANAGEMENT PROJECT
Identifier Code: TP-1,frk-1,f-9
Date Prepared: AUGUST 20 , 1979

Item	Unit	Number of Units	Price or Value per unit L.E.	Total Income or Costs L.E.
Income				
Flax seeds	Kg.	600.0	0.250	150.00
Flax stalks	Ton	2.0	35.000	70.00
Total income				220.00
Variable Costs				
Plowing	Tractor hour	4.0	1.500	6.00
Land smoothing	Tractor hour	2.0	1.500	3.00
Seeds	Kg.	50.0	0.250	12.50
Labor for seeds planting	Man hour	6.0	0.250	1.50
Weeding (2 times)	Man hour	36.0	0.250	9.00
CHEMICAL FERTILIZER		0.0	0.000	0.00
Ammonium nitrate (33-0-0)	Kg.	100.0	0.053	5.30
Labor to spread chem. fert.	Man hour	6.0	0.250	1.50
IRRIGATION (2)		0.0	0.000	0.00
Sakia rent	Sakia hour	28.0	0.080	2.24
Cow or Buffalo rent	C. or B.hour	28.0	0.300	8.40
Boy or Girl to observe sakia	B. or G.hour	28.0	0.050	1.40
Labor to spread water	Man hour	28.0	0.250	7.00
HARVESTING (3)		0.0	0.000	0.00
Labor for harvesting	Man hour	36.0	0.250	9.00
Labor to take stalks off	Man hour	18.0	0.250	4.50
Transport stalks by camel	Camel load	12.0	0.500	6.00
Labor to load the camels	Man hour	12.0	0.250	3.00
Total Variable Costs				80.34
Return Above Variable Costs				139.66
Fixed Costs				
Land rent	Month	7.0	5.000	35.00
Management charge	Month	7.0	1.000	7.00
Total Fixed Costs				42.00
Grand Total Costs				122.34
Return Above All Costs				97.66

FOOTNOTES:

* This study for an area of one feddan.
(1) These data was collected from 4 study cases at BANI-MAGDOUL site by ADEL ABDEL MONEM,GAMAL BRKAT,MAHMOUD ABDELMONEM and ASHRAF KENNAWY Students from FACULTY OF AGRICULTURE-AIN SHAMS UNIVERSITY,ECON.DEPART.
(2) FLAX needs one 8-hour irrigation before planting and five 4-hour irrigation after planting, 1F. needs about cu. meters.
(3) FLAX is an early-maturing winter crop which is usually planted in NOVEMBER and harvested in APRIL and early in MAY , flax is grown as a dual-pupose crop for both FIBER and SEEDS .

LABOR DISTRIBUTION — WATER DISTRIBUTION, CU METERS

	Man Hours	Woman Hours	Boy/Girl Hours	First Irrig.	Second Irrig.	Third Irrig.	Fourth Irrig.
October	0	0	0	0	0	0	0
November	18	0	8	0	0	0	0
December	14	0	8	0	0	0	0
January	22	0	4	0	0	0	0
February	22	0	4	0	0	0	0
March	4	0	4	0	0	0	0
April	0	0	0	0	0	0	0
May	62	0	0	0	0	0	0
June	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0
Total	142	0	28	Total Water Applied=		0 cu meters	

CROP ENTERPRISE COST STUDY *
TOMATOES AT BANI MAGDOUL AREA (1)

Prepared by: LOTFI NASR&FAROUK ABDELAL — EGYPT WATER USE & MANAGEMENT PROJECT
Identifer Code: TP-1,Trk-0,F-3
Date Prepared: December 1978

Item	Unit	Number of Units	Price or Value per unit L.E.	Total income or Costs L.E.
Income				
Tomatoes fruits	KG.	13000.0	0.0350	455.00
Total Income				455.00
Variable Costs				
Plow by tractor	Tractor hour	4.0	1.5000	6.00
Labor to balance ferrows	Man hour	36.0	0.2500	9.00
Nursary plants	Thousand	12.0	1.5000	18.00
Labor for transplanting	Man hour	18.0	0.2500	4.50
Chemical fertilizer		0.0	0.0000	0.00
Super phosphate (0-15.5-0)	KG.	500.0	0.0270	13.50
Ammonium nitrate (33-0-0)	KG.	400.0	0.0500	20.00
Labor to spread chem. fert.	Girl hour	90.0	0.1000	9.00
Hoeing,weeding (5 times)	Man hour	132.0	0.2500	33.00
Irrigation: (2)		0.0	0.0000	0.00
Cow or buffle rent	C.or B. hour	72.0	0.3300	23.76
Sakia rent	Sakia hour	72.0	0.0500	3.60
Boy to observe the sakia	Boy hour	72.0	0.0500	3.60
Labor to spread water	Man hour	72.0	0.2500	18.00
Insecticides:		0.0	0.0000	0.00
Flaxon & Malathion	Liter	10.0	1.4500	14.50
Sprayer rennt	Sprayer hour	60.0	0.0500	3.00
Labor to spray	Man hour	60.0	0.2500	15.00
Fungicide	Can	3.0	5.0000	15.00
Labor to spread fungicide	Man hour	36.0	0.2500	9.00
Harvesting (3)		0.0	0.0000	0.00
Labor for harvesting	Man hour	192.0	0.2500	48.00
Total Variable Costs				266.46
Return Above Variable Costs				188.54
Fixed Costs				
Land rent	Month	8.0	15.0000	120.00
Mangement charge	Month	8.0	2.0000	16.00
Total Fixed Costs				136.00
Grand Total Costs				402.46
Return Above All Costs				52.54

FOOTNOTES:

* This study for an area of one feddan.
(1) Tomato is grown in almost equal areas during the three cropping season but the yields are higer in the summer and nili crops than wintercrop
(2) Tomatoes need from 7 to 8 irrigations one before planting for 8 hours the others for 6 hour irrigation each 12 dayes .
1est irrigation befor planting — 8 hours
2end irrigation after 3 dayes — 4 hours
then one irrigation each 12 dayes, (5x12 hours) — 60 hours
Total time for irrigation — 72 hours
(3) one labor (man,woman,boy or girl) can harvest 2 loads (140 KG.)

	LABOR DISTRIBUTION			WATER DISTRIBUTION, CU METERS			
	Man Hours	Woman Hours	Boy/Girl Hours	First Irrig.	Second Irrig.	Third Irrig.	Fourth Irrig.
October	72	0	12	240	240	0	0
November	90	0	18	240	240	0	0
December	66	0	12	240	240	0	0
January	42	0	6	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	0	0	0	0	0	0	0
June	60	0	12	0	0	0	0
July	60	0	36	320	160	0	0
August	66	0	36	240	240	0	0
September	90	0	30	240	240	0	0
Total	546	0	162	Total Water Applied=	2880 cu meters		

FOOTNOTES:

Footnotes for water requirements and labor
- Water requirements based on Enginering office paper dated on 7.15.1978
- 1 manday = 6 hours

CROP ENTERPRISE COST STUDY *
CABBAGE AT EL HAMMAMI AREA (1)

Prepared by: ELSHINNAWY&FAROUK ABDELAL   EGYPT WATER USE & MANAGEMENT PROJECT
Identifier Code: TP-1,Trk-0,F-5
Date Prepared: March 7, 1979

Item	Unit	Number of Units	Price or Value per unit L.E.	Total income or Costs L.E.
Income				
Cabbage	One cabbage	12000.0	0.0600	720.00
Total Income				720.00
Variable Costs				
Org. Fert. transportation	Camel load	100.0	0.3000	30.00
Labor to spread org. Fert.	Man hour	12.0	0.2500	3.00
Labor for digging	mann hour	240.0	0.2500	60.00
Labor for land leveling	Man hour	60.0	0.2500	15.00
Labor for making ferrows	man hour	60.0	0.2500	15.00
Nursary plants	Thousand	18.0	1.2500	22.50
Labor for transplanting	Man hour	36.0	0.2500	9.00
Labor for hoeing (2 times)	Man hour	66.0	0.2500	16.50
Labor for weeding	Man hour	30.0	0.2500	7.50
CHEMICAL FERTILIZER		0.0	0.0000	0.00
Ammonium nitrate (33-0-0)	KG.	600.0	0.0500	30.00
Labor to spread chem. fert.	Man hour	30.0	0.2500	7.50
IRRIGATTON (2)		0.0	0.0000	0.00
Cow or Bufflo rent	C.or B. hour	48.0	0.3300	15.84
Sakia rent	Sakia hour	48.0	0.0500	2.40
Boy or Girl to observe sakia	B. or G.hour	48.0	0.0500	2.40
Labor to spread water	Man hour	48.0	0.2500	12.00
INSETISIDES		0.0	0.0000	0.00
Dinethweat	Liter	4.0	4.2500	17.00
Spray motor rent	Motor hour	5.0	0.4000	2.00
Labor to spray	Man hour	12.0	0.2500	3.00
HARVESTING		0.0	0.0000	0.00
Labor for harvesting	Man hour	72.0	0.2500	18.00
Labor for taking plants off	Man hor	72.0	0.2500	18.00
Transportation to the Market	Wagon load	10.0	3.0000	30.00
Total Variable Costs				336.64
Return Above Variable Costs				383.36
Fixed Costs				
Land rent	Month	4.0	6.0000	24.00
Management charge	Month	4.0	2.0000	8.00
Total Fixed Costs				32.00
Grand Total Costs				368.64
Return Above All Costs				351.36

FOOTNOTES:

* This study for an area of one feddan.
(1) The best period for transplanting cabbage is during JULY and AUGUST.
(2) Cabbage needs about 8 irrigations ,IF. needs about 2800 cu meters
    1est irrigation before transplanting 8 hours
    2end irrigation after 3 dayes of transplantting 4 hours
    Then one six hour irrigation each 15 dayes (6x6) 36 hours
    Total time for irrigation 48 hours

	LABOR DISTRIBUTION			WATER DISTRIBUTION, CU METERS			
	Man Hours	Woman Hours	Boy/Girl Hours	First Irrig.	Second Irrig.	Third Irrig.	Fourth Irrig.
October	78	0	12	360	360	0	0
November	90	0	12	360	360	0	0
December	120	0	12	280	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	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0
August	372	0	4	480	0	0	0
September	78	0	8	240	360	0	0
Total	738	0	48	Total Water Applied=	2800 cu meters		

FOOTNOTES:

Water requrements based on Enginering office paper dated on 7.15.1978.
One working day = 6 hours.

CROP ENTERPRISE COST STUDY *
EGGPLANT AT EL HAMMAMI AREA(1)

Prepared by: ELSHINNAWI&FAROUK ABDELAL — EGYPT WATER USE & MANAGEMENT PROJECT
Identifer Code: IP-1,IRK-0,F-1
Date Prepared: February 26,1979

Item	Unit	Number of Units	Price or Value per unit L.E.	Total income or Costs L.E.
Income				
Eggplant	KG.	10000.0	0.0700	700.00
Straw	Camel load	3.0	2.0000	6.00
Total Income				706.00
Variable Costs				
Transportation for org. fert.	Donkey load	300.0	0.0800	24.00
Labor to spread org. fert.	Man hour	12.0	0.2500	3.00
Labor for land digging	Man hour	240.0	0.2500	60.00
Labor to make ferrows	Man hour	30.0	0.2500	7.50
Nursery plants	Thousand	16.0	1.0000	16.00
Labor for transplanting	Man hour	36.0	0.2500	9.00
Labor for hoeing (5 times)	Man hour	90.0	0.2500	22.50
Labor for weeding	Man hour	18.0	0.2500	4.50
Chemical fertilizer		0.0	0.0000	0.00
Ammonium nitrate (33-0-0)	KG.	1000.0	0.0500	50.00
Labor to spread chem. fert.	Girl hour	96.0	0.1000	9.60
Irrigation (2)		0.0	0.0000	0.00
Cow or buffle rent	C.or B. hour	96.0	0.3300	31.68
Sakia rent	Sakia hour	96.0	0.0500	4.80
Boy or Girl to observe sakia	Boyor G.hour	96.0	0.0500	4.80
Labor to spread water	Man hour	96.0	0.2500	24.00
Insectisides		0.0	0.0000	0.00
Dimethweat	Liter	2.0	2.0000	4.00
Ssulpher	KG.	100.0	0.0750	7.50
Sprayer motor rent	Motor houur	5.0	0.4000	2.00
Labor to spray	Man hour	12.0	0.2500	3.00
Harvesting (3)		0.0	0.0000	0.00
Labor for harvesting	Man hour	180.0	0.2500	45.00
Labor for taking plants off	Man hour	18.0	0.2500	4.50
Transportation to the market	Wagon load	3.0	15.0000	45.00
		0.0	0.0000	0.00
Total Variable Costs				382.38
Return Above Variable Costs				323.62
Fixed Costs				
Land rent	Month	12.0	6.0000	72.00
Management charge	Month	12.0	2.0000	24.00
Total Fixed Costs				96.00
Grand Total Costs				478.38
Return Above All Costs				227.62

FOOTNOTES:

* This study for an area of one feddan.
(1) Eggplant is grown in almost equal areas during the summer and winter cropping season, previous crop may be maize forage or berseem
(2) Eggplant needs from 16 to 18 irrigations
  fest irrigation before transplanting — 8 hours
  2end irrigation after 3 dayes of transplanting — 4 hours
  then 14 six hour irrigation except flowering time — 84 hours
  Total time for irrigation — 96 hours
(3) Harvesting begins after 3 monthes of planting the farmer can Harvest 14 times during the rest of the season .

	LABOR DISTRIBUTION			WATER DISTRIBUTION, CU METERS			
	Man Hours	Woman Hours	Boy/Girl Hours	First Irrig.	Second Irrig.	Third Irrig.	Fourth Irrig.
October	330	0	12	200	100	0	0
November	54	0	12	150	0	0	0
December	54	0	12	150	0	0	0
January	30	0	6	0	0	0	0
February	54	0	24	150	150	0	0
March	36	0	24	150	150	0	0
April	36	0	24	150	150	0	0
May	36	0	24	150	0	0	0
June	36	0	18	150	150	0	0
July	24	0	18	150	150	0	0
August	24	0	18	150	0	0	0
September	18	0	0	0	0	0	0
Total	732	0	192	Total Water Applied=	2400 cu meters		

FOOTNOTES:

- Water requirements based on Enginering office paper dated on 7.15.1978
- One working day = 6 hours

CROP ENTERPRISE COST STUDY *
ARTICHOKE AT BANI-MAGDUEL

Prepared by: MOHAMED LOTFI NASR — EGYPT WATER USE & MANAGEMENT PROJECT
Identifier Code: IP-1,Trk-o,F13
Date Prepared: DECEMBER 15 1979

Item	Unit	Number of Units	Price or Value per unit L.E.	Total income or Costs L.E.
Income				
Ears	Ear	25300.0	0.030	759.00
Total Income				759.00
Variable Costs				
Plowing By Tractor	Hour	4.0	1.500	6.00
Labor To Smooth Ferrows	Man Hour	36.0	0.250	9.00
Seed		0.0	0.000	0.00
Small Plant From Nursery	Plant	6000.0	0.010	60.00
Labor For Transplanting	Man Hour	60.0	0.250	15.00
ORG Fertilizer	Donkey Load	300.0	0.150	45.00
Transportation Org Fert	Cart Load	5.0	3.000	15.00
Labor To Spread Org Fert	Man Hour	48.0	0.250	12.00
Labor To Spread Org Fert	Girl Hour	48.0	0.167	8.02
Chemical Fertilizer 31-0-0	KG	750.0	0.070	52.50
Labor To Spread Chme Fert	Man Hour	36.0	0.250	9.00
Weeding And Hoeing	Man Hour	204.0	0.250	51.00
Irrigation		0.0	0.000	0.00
Sakia Rent	Sakia Hour	60.0	0.040	2.40
Cow Or Donkey Rent	C-D Hour	60.0	0.330	19.80
Boy Or Girl To Drive C Or D	B-G Hour	60.0	0.080	4.80
Labor To Distribute Water	Man Hour	60.0	0.250	15.00
Insecticide Malthyon-Flaxon	Liter	6.0	3.150	18.90
Labor To Spread Insectcide	Man Hour	50.0	0.250	12.50
Sprayer To Spread Isectcide	Sprayer Hour	50.0	0.060	3.00
Harvisting		0.0	0.000	0.00
Labor To Picking Ears	Man Hour	144.0	0.250	36.00
Labor To Picking Ears	B-G Hour	144.0	0.075	10.80
Transportation	Cart Load	12.0	3.000	36.00
Total Variable Costs				441.72
Return Above Variable Costs				317.28
Fixed Costs				
Land Rent	Month	10.0	6.200	62.00
Management Charge	Month	10.0	1.500	15.00
Total Fixed Costs				77.00
Grand Total Costs				518.72
Return Above All Costs				240.28

FOOTNOTES:

* This study for an area of one feddan.
Planting Date Start Agust 15 To September 15
Harvisting Start At The End Of September
Organic Fert Added After 3-4 Months Of The Planting Date
6 Times For Insecticide
Previous Crop May Be Maize Or Maize Fourge
Usually Farmer To Plant Artichoke On There Own Land
Artichoke Haristing Is About 10-12 Times With 2000-2500 Ears Per Har.

	LABOR DISTRIBUTION			WATER DISTRIBUTION, CU METERS			
	Man Hours	Woman Hours	Boy/Girl Hours	First Irrig.	Second Irrig.	Third Irrig.	Fourth Irrig.
October	74	0	12	0	0	0	0
November	100	0	36	0	0	0	0
December	108	0	48	0	0	0	0
January	70	0	38	0	0	0	0
February	68	0	41	0	0	0	0
March	40	0	30	0	0	0	0
April	22	0	23	0	0	0	0
May	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0
August	110	0	12	0	0	0	0
September	46	0	12	0	0	0	0
Total	638	0	252	Total Water Applied=		0 cu meters	

FOOTNOTES:

Irrigation Before Planting 8 Hours
Next Irrigtion After Planting 4 Hours
8 IRRIGATIONS During Growing Time 8 Hours For Each Irrigation
15 Days Between Each Two Irrigations in Summer And 8 in Winter

CROP ENTERPRISE COST STUDY *
SQUASH AT EL-HAMMAMY

Prepared: MOHAMED LOFTY NASR
Identifier Code: tp[illegible]trk 0,f15
Date Prepared: JANUARY 10 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				
Fruit	KG	4162.0	0.090	374.58
Total Income				374.58
Variable Costs				
Plowing And ferrowing	Hour	9.0	3.000	27.00
Labor to smooth ferrows	Man Hour	24.0	0.300	7.20
SEED	KG	2.0	3.000	6.00
Labor to plant	Man hour	12.0	0.300	3.60
ORG Fertilizer	Donkey load	320.0	0.070	22.40
Labor to spread org fert	Man hour	12.0	0.300	3.60
Chemical fertilizer 31-0-0	KG	325.0	0.090	29.25
Labor to spread chem fert	Man hour	3.0	0.300	0.90
Weeding And Hoeing	Man hour	48.0	0.300	14.40
Irrigation		0.0	0.000	0.00
Sakia Rent	Sakia hour	30.0	0.050	1.50
Donkey to turn sakia	D-hour	30.0	0.350	10.50
Boy to drive donkey	B-hour	30.0	0.070	2.10
Labor to ditribute water	Man hour	30.0	0.300	9.00
Insecticide		0.0	0.000	0.00
Lannate	Gram	460.0	0.019	8.74
Rayfolan	CM	220.0	0.009	1.99
Numroad	CM	360.0	0.003	1.08
Labor to speard insectcide	Man hour	18.0	0.300	5.40
Sprayer to spread insetcide	sprayer hour	18.0	0.400	7.20
Feul for sprayer	Liter	22.0	0.090	1.98
Fungicid	KG	15.0	0.070	1.05
Harvisting		0.0	0.000	0.00
Labor to picking fruit	Man hour	45.0	0.300	13.50
Transportation	Cart Load	6.0	2.500	15.00
Total Variable Costs				193.39
Return Above Variable Costs				181.19
Fixed Costs				
Land rent	Month	2.5	8.300	20.75
Managament Charge	Month	2.5	1.750	4.38
Total Fixed Costs				25.13
Grand Total Costs				218.51
Return Above All Costs				156.07

FOOTNOTES:

* This study for an area of one feddan.
Planting date start September first to 15
Harvisting start after 40 days of planting and continue 40 days more
Harvisting each 2 days and the averge for the frist four harv-80 kg
Plowing costs is high because of deep plowing
Organic fertilizer spreaded frist fallowed by an irrigation
Previous crop may be maize or sunflower
Ferrows wedth was 95 cm

	LABOR DISTRIBUTION			WATER DISTRIBUTION, CU METERS			
	Man Hours	Woman Hours	Boy/Girl Hours	First Irrig.	Second Irrig.	Third Irrig.	Fourth Irrig.
October	69	0	18	0	0	0	0
November	3	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	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0
August	12	0	0	0	0	0	0
September	108	0	12	0	0	0	0
Total	192	0	30	Total Water Applied=		0 cu meters	

FOOTNOTES:

Total Number hour of Irrigation was 30 hours
The average number of hour per irrigation 2 hours

CROP ENTERPRISE COST STUDY *
WHEAT AT ABU-RAIA AERA (1)

Prepared by: 4STUDENTS&FAROUK ABDELAL — EGYPT WATER USE & MANAGEMENT PROJECT
Identifier Code: Tp-1,Trk-1,f-7
Date Prepared: AUGUST 20, 1979

Item	Unit	Number of Units	Price or Value per unit L.E.	Total income or Costs L.E.
Income				
Wheat grains	Ardab	8.0	8.000	64.00
Wheat straw	Camel load	6.0	6.000	36.00
Total Income				100.00
Variable Costs				
Org. Fert. transportation	Donkey load	150.0	0.050	7.50
Labor to spread org. fert.	Man hour	6.0	0.200	1.20
Plowing	Tractor hour	2.0	1.250	2.50
Land smoothing	Tractor hour	1.0	1.250	1.25
Seeds	kaila	6.0	1.000	6.00
Labor to spread seeds	Man hour	3.0	0.200	0.60
Weeding	Boy hour	12.0	0.100	1.20
CHEMICAL FERTILIZER		0.0	0.000	0.00
Ammonium nitrate (31.5-0-0)	Kg.	150.0	0.050	7.50
Labor to spread chem.fert.	Man hour	4.0	0.200	0.80
IRRIGATION (2)		0.0	0.000	0.00
Sakia rent	Sakia hour	15.0	0.080	1.20
Cow or Bufflo rent	C.or B. hour	15.0	0.300	4.50
Girl or Boy to observe sakia	B.or G. hour	15.0	0.100	1.50
Labor to spread water	Man hour	15.0	0.200	3.00
HARVESTING		0.0	0.000	0.00
Labor for harvesting	Man hour	36.0	0.200	7.20
Thrashing	Machine hour	6.0	1.150	6.90
Winnowing	Machine hour	3.0	1.150	3.45
TRANSPORTATION		0.0	0.000	0.00
Labor for loading	Man hour	3.0	0.200	0.60
Transport grains by camel	Camel load	3.0	1.000	3.00
Total Variable Costs				59.90
Return Above Variable Costs				40.10
Fixed Costs				
Land rent	Month	6.0	5.000	30.00
Management charge	Month	6.0	1.000	6.00
Total Fixed Costs				36.00
Grand Total Costs				95.90
Return Above All Costs				4.10

FOOTNOTES:

* This study for an area of one feddan.
(1) These data was collected from 4 study cases at ABU-RAIA site byIBRAHIM ELSHENNAWY, MOHAMED ELGAZZAR, ABDELHALIM ELSHERBINY and MOHAMED SALAMA Students from FACULTY OF AGRICULTURE AT KAFR ELSHEIKH-ECONOMICS DEPARTMENT
(2) Wheat needs about 5 irrigations , 1F. needs about 1600 cu. meters .

	LABOR DISTRIBUTION			WATER DISTRIBUTION, CU METERS			
	Man Hours	Woman Hours	Boy/Girl Hours	First Irrig.	Second Irrig.	Third Irrig.	Fourth Irrig.
October	0	0	0	0	0	0	0
November	12	0	3	180	0	0	0
December	3	0	3	400	0	0	0
January	0	0	12	0	0	0	0
February	7	0	3	345	0	0	0
March	3	0	3	348	0	0	0
April	3	0	3	327	0	0	0
May	39	0	0	0	0	0	0
June	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0
Total	67	0	27	Total Water Applied= 1600 cu meters			

FOOTNOTES:

Water requirements based on our project research stations' data .
- Working day = 6 hours .

CROP ENTERPRISE COST STUDY *

BERSEEM AT ABU RAIA ARIA (1)

Prepared by: GENE , YUSEF , GAMAL AYAD — EGYPT WATER USE & MANAGEMENT PROJECT
Identifier Code: IP-1,Tek-1,F-3
Date Prepared: September 15,1978

Item	Unit	Number of Units	Price or Value per unit L.E.	Total income or Costs L.E.
<u>Income</u>:				
3 cuts sold standing	Kerat cut(2)	72.0	1.500	108.00
X24 kerats.		0.0	0.000	0.00
1 cut for seed.	Kaila (3)	8.0	4.000	32.00
Straw.	Load	4.0	1.250	5.00
Total Income				145.00
<u>Variable Costs</u>				
Seeds.	Kaila	1.5	8.000	12.00
Labor to spread seeds.	Man hour	2.0	0.150	0.30
Chemical fertilizers:		0.0	0.000	0.00
Super phosphate (0-15.5-0).	Kg	100.0	0.022	2.20
Ammonium nitrate (31-0-0).	""	50.0	0.050	2.50
Labor to spread chem. fert.	Man hour	2.0	0.150	0.30
Cleaning drain (LE 0.01/M).	""" ""	12.0	0.250	3.00
Harvesting 4th cut (4).	""" ""	18.0	0.200	3.60
Transporting by camel.	Camel load	6.0	0.500	3.00
Labor to load camel.	Man hour	3.0	0.200	0.60
Threshing by tractor.	Tractor hour	2.0	1.750	3.50
Labor for threshing.	Man hour	6.0	0.250	1.50
Winnowing.	""" ""	12.0	0.250	3.00
Irrigation: (5)		0.0	0.000	0.00
Cow or buffalo rent.	C.or B. hour	49.0	0.330	16.17
Sakia rent.	Sakia hour	49.0	0.080	3.92
Labor to spread water.	Man hour	49.0	0.200	9.80
Total Variable Costs				65.39
Return Above Variable Costs				79.61
<u>Fixed Costs</u>				
Land rent.	Month	7.0	5.000	35.00
Management charge.	""	7.0	1.000	7.00
Total Fixed Costs				42.00
Grand Total Costs				107.39
Return Above All Costs				37.61

FOOTNOTES:

* This study for an area of one feddan.
(1) Planting date is October 20 to November 15.The immediate preceeding crop may be rice,maize.Cotton is not an altarnative following crop since it must be planted by march 10.
(2) On the average 1 kerat cut of green berseem weighs 320 Kg.
(3) The price of seeds at planting time is higher than price at harvest time.
(4) The final harvest is before May 20.
(5) Irrigation at planting time 4 hours
Second irrigation after 1 month 5 hours
Third irrigation after 25 days 5 hours
Fourth irrigation after winter closure 7 hours
Then 1 irrigation each 11 days (7X4 hrs.) 28 hours
TOTAL time for irrigation 49 hours

	LABOR DISTRIBUTION			WATER DISTRIBUTION, CU METERS			
	Man Hours	Woman Hours	Boy/Girl Hours	First Irrig.	Second Irrig.	Third Irrig.	Fourth Irrig.
October	0	0	0	0	0	0	0
November	6	0	0	181	0	0	0
December	6	0	0	227	0	0	0
January	6	0	0	317	0	0	0
February	9	0	0	181	181	181	0
March	18	0	0	181	181	181	0
April	12	0	0	181	0	0	0
May	9	0	0	0	0	0	0
June	38	0	0	0	0	0	0
July	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0
Total	104	0	0	Total Water Applied=	1992 cu meters		

FOOTNOTES:

--Water distribution estimation based on ELTOBGY'S book.
--One working day= 6 hours.

CROP ENTERPRISE COST STUDY *
COTTON AT ABU RAIA AREA (1)

Prepared by: GENE , YUSEF & GAMAL AYAD — EGYPT WATER USE & MANAGEMENT PROJECT
Identifier Code: (P-1,irk-1,F-)
Date Prepared: August 20,1978

Item	Unit	Number of Units	Price or Value per unit L.E.	Total income or Costs L.E.
Income				
Unginned cotton	Kentar (2)	5.0	35.000	175.00
Stalks.	Camel load	5.0	3.000	15.00
Total Income				190.00
Variable Costs				
Organic fertilizer.	Cubic meter.	20.0	0.600	12.00
Plow with tractor,(3 times).	Feddan	3.0	2.000	6.00
Smooth with cows and drang.	Feddan	1.0	2.000	2.00
Furrow "" "" """ plow.	Feddan	1.0	2.000	2.00
Clean ditch.	Man hour	10.0	0.200	2.00
Smooth with cows and drang.	Feddan	1.0	1.000	1.00
Seeds.	Kaila (3)	7.0	0.300	2.10
Plant seeds by hand.	Woman hour	24.0	0.080	1.92
Chemical fertilizers:		0.0	0.000	0.00
Super phosphate (0-15.5-0).	Kg.	100.0	0.022	2.20
Ammonium Nitrate (33.3-0-0).	Kg.	200.0	0.050	10.00
Spread chem. fert.by hand.	Man hour	10.0	0.200	2.00
Irrigation:		0.0	0.000	0.00
First irrigation.	Man hour	6.0	0.200	1.20
Second irrigation.	""" ""	4.0	0.200	0.80
Third irrigation.	""" ""	4.0	0.200	0.80
Fourth irrigation.	""" ""	4.0	0.200	0.80
Fifth irrigation	""" ""	4.0	0.200	0.80
Sixth irrigation.	""" ""	4.0	0.200	0.80
Seventh irrigation.	""" ""	4.0	0.200	0.80
Eighth irrigation.	""" ""	4.0	0.200	0.80
Nineth irrigation.	""" ""	4.0	0.200	0.80
Pumping water with d.pump.	Pump hour	38.0	0.700	26.60
Thin by hand.	Boy hour	18.0	0.050	0.90
Hoeing (two times).	Man hour	14.0	0.200	2.80
Weeding (three times).	Boy hour	36.0	0.070	2.52
Pick insect eggs as needed.	Feddan	1.0	9.000	9.00
Chemical control of insects.	"""	1.0	8.000	8.00
The first cotton pick. (4)	Woman hour	120.0	0.080	9.60
The second cotton pick. (5)	""" ""	120.0	0.080	9.60
Transport unginned cotton.	Feddan	1.0	1.000	1.00
Cut stalks.	Man hour	30.0	0.200	6.00
Transport stalks.	Camel load	5.0	0.500	2.50
Labor to load stalks.	Man hour	5.0	0.200	1.00
Total Variable Costs				130.34
Return Above Variable Costs				59.66
Fixed Costs				
Land rent. (6)	Month	9.0	5.000	45.00
Management charge.	"""	9.0	1.000	9.00
Total Fixed Costs				54.00
Grand Total Costs				184.34
Return Above All Costs				5.66

FOOTNOTES:

* This study for an area of one feddan.
(1) Cotton planted during the period Feb. 20 to March 10, the previous crop is berseem or ,very rarely, a fallow.Most farmers grow berseem as a winter crop.The previous summer crop is usualy rice or Maize.
(2) 1 kentar of unginned cotton = 157.5 Kg.
(3) 1 kaila of cotton seeds = 10 Kg.
(4) The first pick of cotton = 3.5 kentar.
(5) the second pick of cotton = 1.5 kentar.
(6) Cotton requires only 8 months growing season,but there is much preparation required to shape the land and irrigation ditches.This requires almost one additional month making a total of nine months.

	LABOR DISTRIBUTION			WATER DISTRIBUTION, CU METERS			
	Man Hours	Woman Hours	Boy/Girl Hours	First Irrig.	Second Irrig.	Third Irrig.	Fourth Irrig.
October	50	120	0	538	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	40	0	0	860	0	0	0
March	14	24	18	645	0	0	0
April	10	0	12	538	0	0	0
May	13	0	12	538	0	0	0
June	6	0	12	538	0	0	0
July	13	0	0	538	0	0	0
August	6	0	0	538	0	0	0
September	6	120	20	538	0	0	0
Total	158	264	74	Total Water Applied= 5271 cu meters			

FOOTNOTES:

--One working day = 6 hours.
--Water distribution estimation based on ELTORGY'S book.

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

Prepared by: 4Students& FARUUK ABDELAL — EGYPT WATER USE & MANAGEMENT PROJECT
Identific Code: tp-1,irk-1,f11
Date Prepared: AUGUST 20,1979

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
Puddling	Puddling/F	1.0	4.000	4.00
Nursery planting seeds	Kilo	6.0	0.800	4.80
Labor to spread seeds	Man hour	1.0	0.200	0.20
Nursery plants pulling	Man hour	18.0	0.200	3.60
Transplanting	Boy hour	30.0	0.100	3.00
Weeding	B.or G. 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 Triple	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 buffalo 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 bundling	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
Threshing	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.IF.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	42	0	12	2520	0	0	0
August	42	0	12	2520	0	0	0
September	32	0	0	1232	0	0	0
Total	229	0	54	Total Water Applied=	8800 cu meters		

FOOTNOTES.

- Water requirement 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 .

CROP ENTERPRISE COST STUDY *

MAIZE AT ABU-RAIA AREA (1)

Prepared by: GENE, YUSEF & GAMAL AYAD — EGYPT WATER USE & MANAGEMENT PROJECT
Identifier Code: IP-1, Irk-1, F-5
Date Prepared: September 15, 1978

Item	Unit	Number of Units	Price or Value per unit L.E.	Total income or Costs L.E.
Income				
Maize grain	Ardeb (2)	13.0	8.000	104.00
Green tassles for		0.0	0.000	0.00
animal feed.	Estimated	1.0	5.000	5.00
Straw	Camel load	6.0	1.000	6.00
Total Income				115.00
Variable Costs				
Organic fertilizer includes		0.0	0.000	0.00
transportation.	donkey load	300.0	0.060	18.00
Labor to spread manure.	Man hour	12.0	0.200	2.40
Land preparation:		0.0	0.000	0.00
rent of two cows.	Cow hour	24.0	0.180	4.32
Labor to balance plow.	Man hour	12.0	0.200	2.40
Rent of a plow.	Plow day	2.0	0.250	0.50
Seeds.	Kaila (3)	1.5	1.250	1.88
Labor for making ditches.	Man hour	6.0	0.200	1.20
Labor for cleaning ditches.	" ""	6.0	0.200	1.20
Labor for thinning.	" ""	6.0	0.200	1.20
Ammonium nitrate (31-0-0)	Kilogram	300.0	0.050	15.00
Labor to spread fertilizer ,		0.0	0.000	0.00
two times.	Girl hour	24.0	0.070	1.68
Weeding.	Man hour	18.0	0.200	3.60
Irrigation: (4)		0.0	0.000	0.00
Rent of cows.	Cow hour	28.0	0.180	5.04
Rent of wheel.	Wheel hour	28.0	0.080	2.24
Labor to spread water.	Man hour	28.0	0.200	5.60
Boy to drive animal, for wheel	Boy hour	28.0	0.050	1.40
Harvesting:		0.0	0.000	0.00
Cut stalks.	Man hour	18.0	0.200	3.60
Pull cobs, tie straw in bundle	" ""	18.0	0.200	3.60
Carry straw to village by		0.0	0.000	0.00
hired camel.	Camel hour	6.0	0.350	2.10
Carry cobs to village by don-		0.0	0.000	0.00
key.	donkey hour	10.0	0.100	1.00
Labor to load donkey.	Man hour	10.0	0.200	2.00
Boy to drive donkey.	Boy hour	10.0	0.050	0.50
Thresh corn by hand.	Woman hour	48.0	0.070	3.36
Total Variable Costs				83.82
Return Above Variable Costs				31.19
Fixed Costs				
Rent of land.	Month	4.0	5.000	20.00
Management charge.	Month	4.0	1.000	4.00
Total Fixed Costs				24.00
Grand Total Costs				107.82
Return Above All Costs				7.19

FOOTNOTES:

* This study for an area of one feddan.
(1) Planting date is May 1 to May 31. Harvesting time is Sep. 1 to Sep. 30. Previous crop is wheat, flax, berseem or broad beans. Previous summer crop is cotton or rice.
(2) One ardeb of maize grain = 140 kilogram.
(3) One kaila = 1/12 ardeb = 11.67 kilogram.
(4) Irrigation before planting 4 hours
""""" after one month 3 hours
""""" after 1 month + 11 days 3 hours
""""" each 12 days (6x3 hours) 18 hours
TOTAL irrigation hours 28 hours

	LABOR DISTRIBUTION			WATER DISTRIBUTION, CU METERS			
	Man Hours	Woman Hours	Boy/Girl Hours	First Irrig.	Second Irrig.	Third Irrig.	Fourth Irrig.
October	0	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	34	0	4	350	0	0	0
June	20	0	20	275	275	0	0
July	17	0	19	275	275	275	0
August	17	0	9	275	275	275	0
September	46	48	10	0	0	0	0
Total	134	48	62	Total Water Applied=	2550 cu meters		

FOOTNOTES:

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Staff Paper #27

THE BENI MAGDOUL WATER BUDGET[2]

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June 1980

Introduction

To maximize the benefits of water in irrigated agriculture it is necessary to know how much water is available, how it moves from source to its final destination, and what demands are placed upon it when it reaches the farm field. A systematic accounting for all the water in these processes results in a water budget which is a valuable water management tool. The water budget can be used to predict the effect that changes in water management will have on water losses, drainage problems and salinity buildup. Also, it is useful for interpreting consumptive use estimates and water table changes. The water budget forms the basis for effective water management.

The development of a water budget is illustrated by applying the water accounting processes to the Beni Magdoul area, a study area of the Egypt Water Use and Management Project. The Beni Magdoul area (see Figure 1) is in the southern portion of the Mansouria Irrigation District and consists of approximately 842 feddans, with approximately 748 feddans under cultivation (Table I). The study area (see Figure 2) is a well defined hydrologic unit. The entire area is bounded by drains and water is supplied by the Beni Magdoul Canal. The surface soils of this area consist primarily of sandy clay, sandly clay loam and sandy loam[1]. The log of the well installed for the deep pumping test located at the intersection of the Beni Magdoul Canal and the branch canal SE quandrant is given in Table II. The clay layer in the upper seven meters was

[1]EWUP Technical Report No. 2

[2]The authors wish to acknowledge the following for their contributions to the Beni Magdoul Water Budget paper. They are: W. F. Mankarous, M. R. Semaika, E. V. Richardson

Table 1. 1979-1980 Crop Areas in Beni Magdoul

Crop		Area Feddans
Berseem		577.96
Wheat		42.29
Onion		18.25
Group including:		31.04
Beans, green pepper, artichoke, lupin, flax		
Group including:		2.43
Tomato, radishes, cabbage		
Group including:		51.43
Carrots, spinach, dill parsley, leeks, chard		
Group including:		24.63
Oranges, citrus, date palm		
	TOTAL	748.03

Table II. Soil Classification of Deep Well

Depth Meter	Classification
0-7	Clay
7-11	Fine sand
11-14	Clay with sand
14-15	Fine sand
15-20	Medium sand
20-26	Sand with gravel
26-27	Coarse sand, big gravel
27-34	Coarse sand
34-40	Fine sand

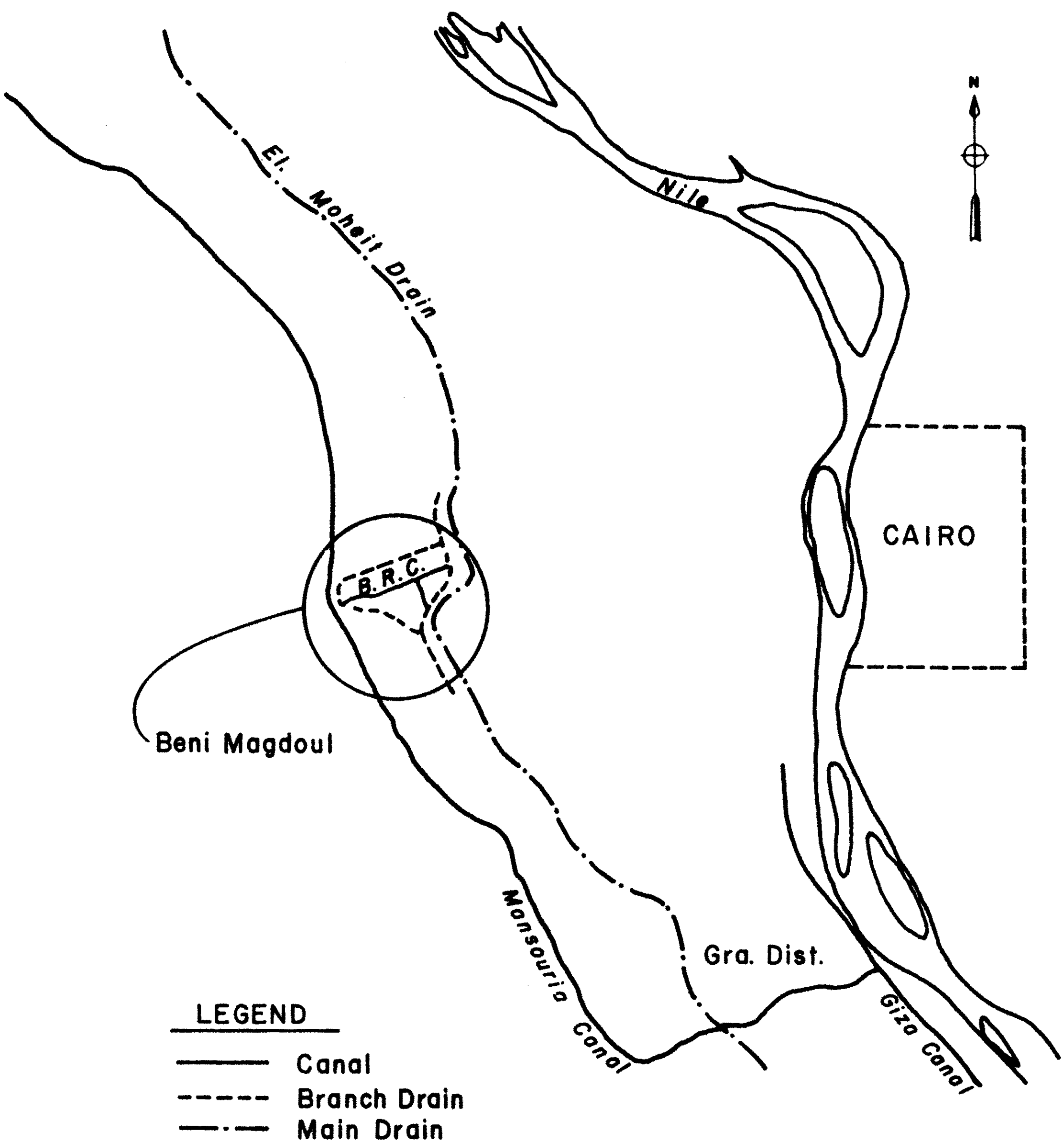


Figure 1. Mansouria Irrigation District Showing Beni Magdoul

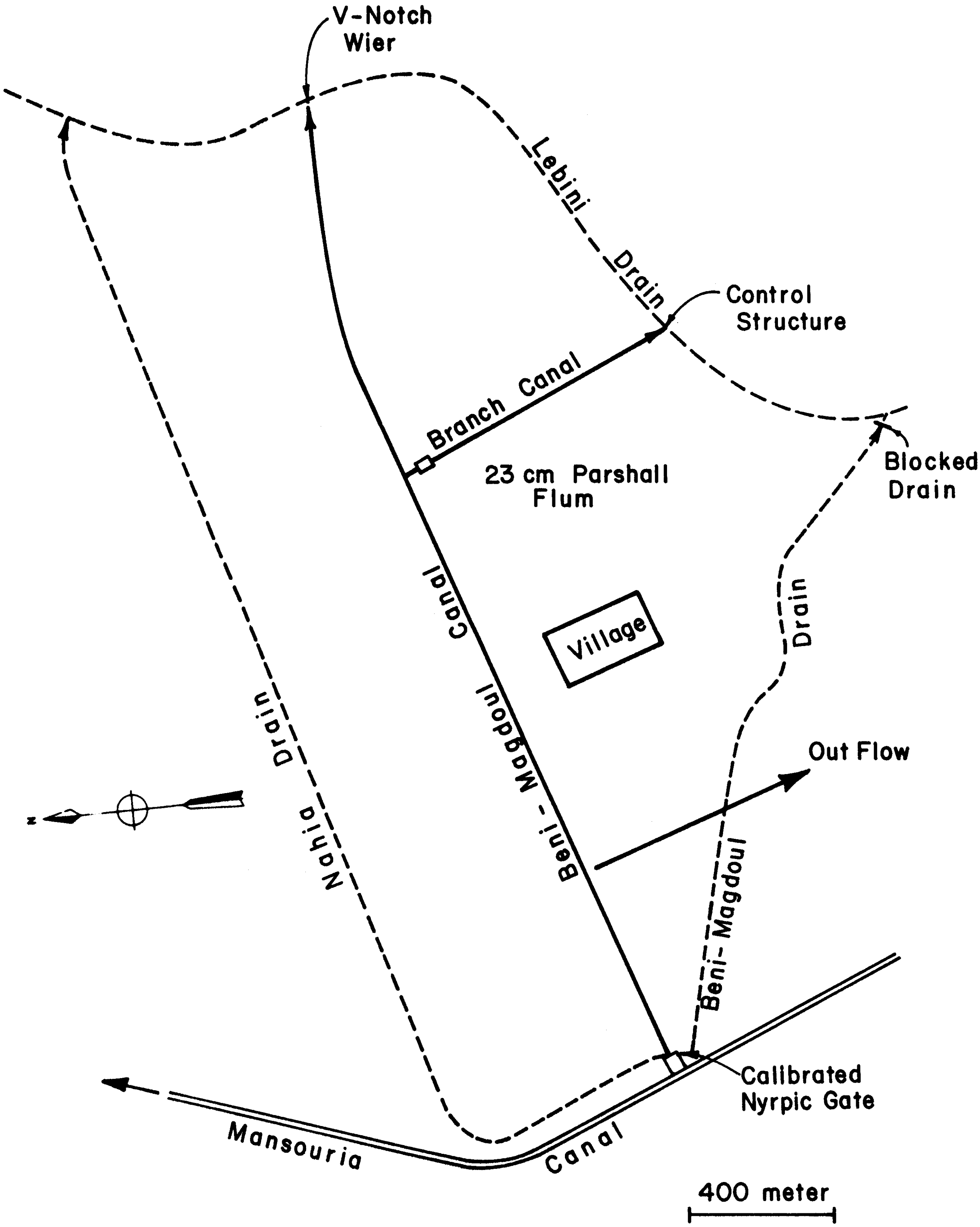


Figure 2. Beni Magdoul Study Area

encountered in the drilling of the domestic water supply well for Beni Magdoul village and in a preliminary exploration hole drilled along the Nahia Drain about 300 meters east of the Mansouria canal. The clay layer appears to be extensive based upon these observations. This clay layer would effectively limit deep vertical seepage of irrigation water and is in effect an impermeable subsurface boundary for the area.

The Water Budget Model

The general equation for the water balance is:

$$I - O = \Delta S$$

All units are in cubic meters per time period.

Inflow terms for the Beni Magdoul area have been identified as:

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

where I_M is the inflow from the Mansouria canal, I_A is the inflow from adjacent areas, I_P is inflow by pumping from wells or drains and P is the precipitation.

The outflow is composed of:

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

where U is the consumptive use, E is the evaporation from free water surfaces, O_G is the net subsurface outflow, O_{SD} is the surface flow to drains and O_A is flow to adjacent areas.

The changes in storage are:

$$\Delta S = \Delta S_G + \Delta S_S$$

where ΔS_G is the change in groundwater storage, ΔS_S is the change in surface water storage. Each of these terms is discussed in detail.

Mansouria Canal Inflow, I_M

The flow is controlled by a head gate at the junction of the Mansouria and the Beni Magdoul canals. Measurement is by a calibrated

Nyrpic gate which has seven gated openings. Schematic views of the gate and openings are shown in Figure 3. The Nyrpic gate was calibrated by current meter measurements in April and May of 1979. Equations derived from these measurements are:

$$Q = 1.443\ W(WL - 16.77)^{1.487}$$

for the weir flow and

$$Q = 0.4856\ W^{0.8427}\ (WL - 16.77)^{0.6453}$$

for the sluice gate flow

where Q is the discharge in cubic meters per second,

W is the total width of the gate opening - meters,

WL is the water level elevation in forebay above the gates - meters

The equation defining the change point for the change from weir flow to sluice gate flow is

$$H_i = 0.2756\ W^{-0.1869}$$

where H_i is the head at the intersection of the two flow mode curves.

It is recommended that the calibration be checked once a year or after any maintenance work is done on the gate which might alter the calibration. Tabulations of daily inflow are in the appendix.

Inflow from Adjacent Areas, I_A

A 15 feddan portion in the northwest corner of the research area (see Figure 4) is supplied with water from the Nahia canal to the north. This water must be added as part of the total inflow. A study of flows measured by flumes and of the estimated duration of the flows suggested that the 15 feddans in question were receiving irrigation water in

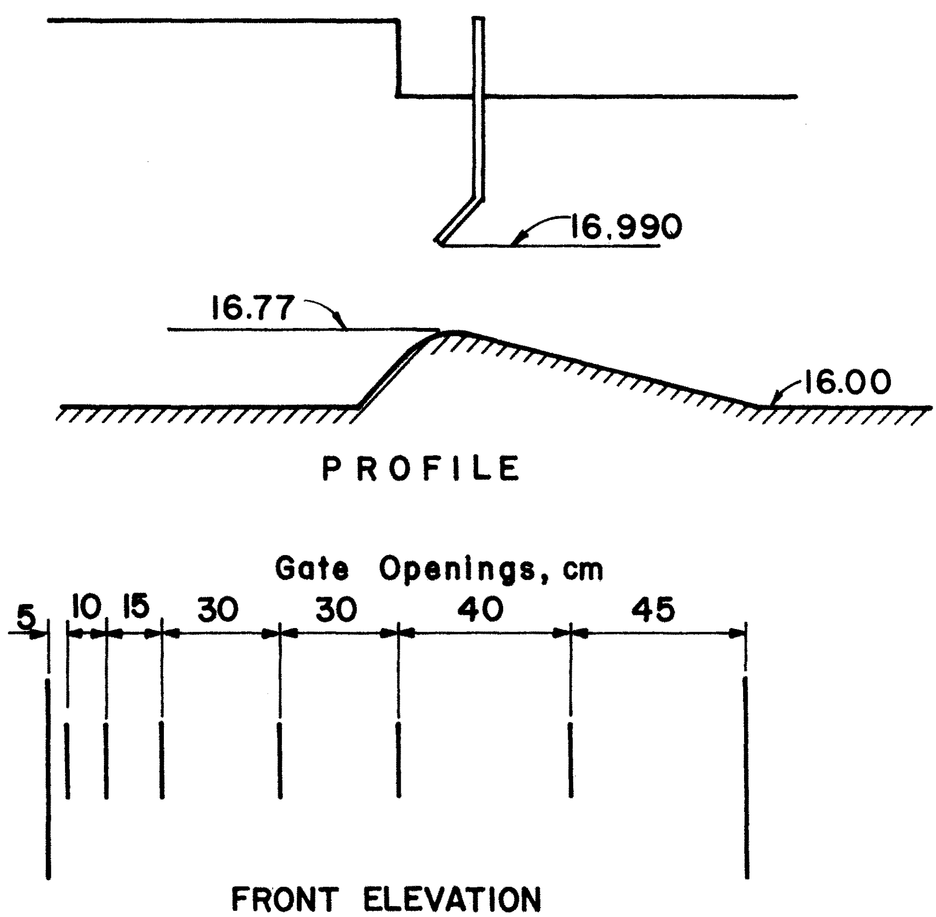


Figure 3. Beni Magdoul Inlet Structure - Nyrpic Gate

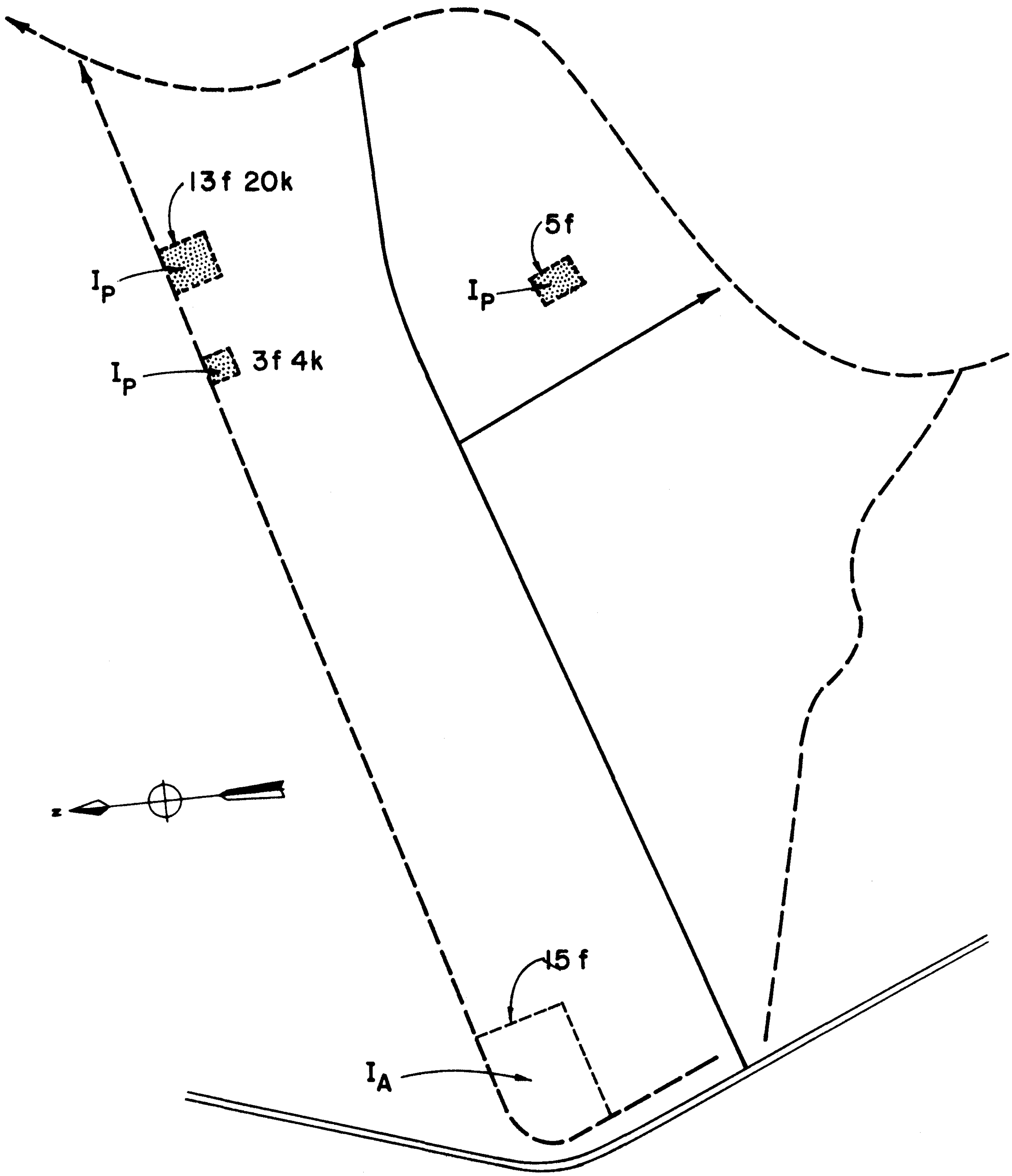


Figure 4. Beni Magdoul Research Area Showing Portions Receiving Water from Adjacent Area, I_A, and from Drains and Wells I_p, by Pumping

about the same amount per feddan as the area supplied by the Beni Magdoul canal and is approximately equal to 2 percent of I_M.

Inflow Supplied by Pumps, I_P

Three areas comprising twenty-two feddans (13f,20k; 3f,4k; 5f) are irrigated with water from the drains or deep wells. Their locations are shown in Figure 4. No measurements of the pumping rates have been made. However, an estimate of the pumping rates can be made by assuming that the "pumped" area receives an amount of water equal to that received by the rest of the area. The pumped inflow, I_P, would be approximately 3 percent of I_M.

The wells take water from a depth of 30 meters. Experience with the well pumping test indicates that this source has little or no communcation with the water in the upper layer. The well water constitutes an additional source of water. The water pumped from the drains is also considered to be new water because in the water budget development. The drains lie just outside the hydrologic area.

Precipitation Inflow, I_P

The volume of inflow due to an average annual precipitation of 17 mm is 60,100 m^3.

Consumptive Use, U

Consumptive use is assumed to be equal to potential evapotranspiration, ET, as estimated by the Blaney-Criddle formula. The constants in the Blaney-Criddle equation for most crops are based on values reported in "Consumptive Use of Water by Crops," in Arizona Technical Bulletin 169, Agricultural Experiment Station, University of

Arizona, 1976. The constants for corn are taken from "K Semi-monthly, Corn Evapotranspiration" by H. W. Towshos, et. al., 4th Conf. of Soil Science, 1969, Cairo, U.A.R. A table giving the calculated ET for the cropped area for the 1979 to 1980 winter season is included in the Appendix 2.1.

The non-cropped area including the village and the road, covers about 90 feddans and an estimated water use for this portion must be added to yield a consumptive figure for the entire area. Daily ET for the cropped area was increased to account for uncropped area by 1.2 percent to arrive at a total consumptive use.

Evaporation, E

This component is the evaporation from open water surfaces in the canals and meskas. The area of these surfaces has been estimated to be 14,600 square meters. Daily pan evaporation data modified by a pan coefficient of 0.7 are applied to the estimated surface area to obtain the estimate of evaporation loss given in Appendix A2.2.

Subsurface Outflow, O_G

The approach was to estimate groundwater outflow by applying the Darcy law to a pair of wells defining a short reach perpendicular to the Nahia drain, wells 120 and 121. Data are available for these two wells for March and April 1980, only. The average difference in the well levels for March was used and a solution of Darcy's equation was made just to obtain an order of magnitude of the outflow. This turned out to be 0.0012 m^3 per meter of width per day based upon a value of 0.26 m/day for hydraulic conductivity from auger hole tests. For the 3000 m length of drain the flow for March has been estimated between a minimum of 113 m^3 and a maximum of 990 m^3. The conclusion that can be drawn is the groundwater outflow is a small quantity with respect to the other water budget components.

Surface Outflow, O_{SD} and O_A

The flow of surface water directly into the drains or onto adjacent areas was assumed to be negligible. However, from April 1980 onward, there may be flow (see Figure 4) to a 38 to 51 feddan area lying outside the project area.

Change in Groundwater Storage, ΔS_G

The change in groundwater storage can be computed over any reasonable time period. A period of two weeks was selected and the results are tabulated in the Appendix A3.1. The well hydrograph indicates, for practical purposes, little net change in water table elevation over the year period. Consequently the yearly change in groundwater storage is a small quantity. Water levels are measured for 24 wells .

Results

Biweekly values of the components of the water budget are given in Appendix A4.1 with the yearly values summarized in Table III. Approximately 3 percent of the inflow is not accounted for in the water balance. This amount is small and is well within the accuracy of measurements of any single variable in the water balance equation. The two largest variables are inflow from the Beni Magdoul canal and outflow due to consumptive use. These two flows account for approximately 94 percent of the total volume balance.

Table III. Summary of Volume Flow in Beni Magdoul Area

Units in $m^3 \times 10^{-6}$

Period	I_M	I_A	I_P	P	U	E	O_a	O_{SD}	O_G	ΔS[2]	Unaccounted[3]
January 1, 1979 December 31, 1979	5.37	0.11	0.17	0.06	5.55[1]	-	0	0	0.01	-0.01	+0.16
January 1, 1980 April 30, 1980	1.29	0.03	0.04	0.02	1.38	-	0.02	0	-	-0.03	+0.01

[1] Data estimated from "On-Farm Water Management in Egypt", Ph.D. dissertation by Mona Mostafa El Kady, Ain Shams University, Cairo Egypt, 1979.

[2] Minus sign indicates a lowering of water table

[3] Plus sign indicates excess inflow

There is very little subsurface outflow which would indicate that salinity buildup within the area could be a more serious problem in the future unless the subsurface outflow is increased. Periodic salinity measurements of all waters including soil paste extracts should be made in order to evaluate the potential salinity problem. Some areas have been reported to show high saline soil conditions (EWUP Technical Report No. 2).

Since subsurface outflow is small, a critical balance between inflow and consumptive use must be established to control water table elevations at desired levels. Presently, water table levels (within 140 cm of ground surface) are at what is probably the highest level that can be maintained and still obtain a reasonable crop yield. The high water table coupled with low subsurface outflow and salinity buildup would indicate that the subsurface outflow for this area should be increased.

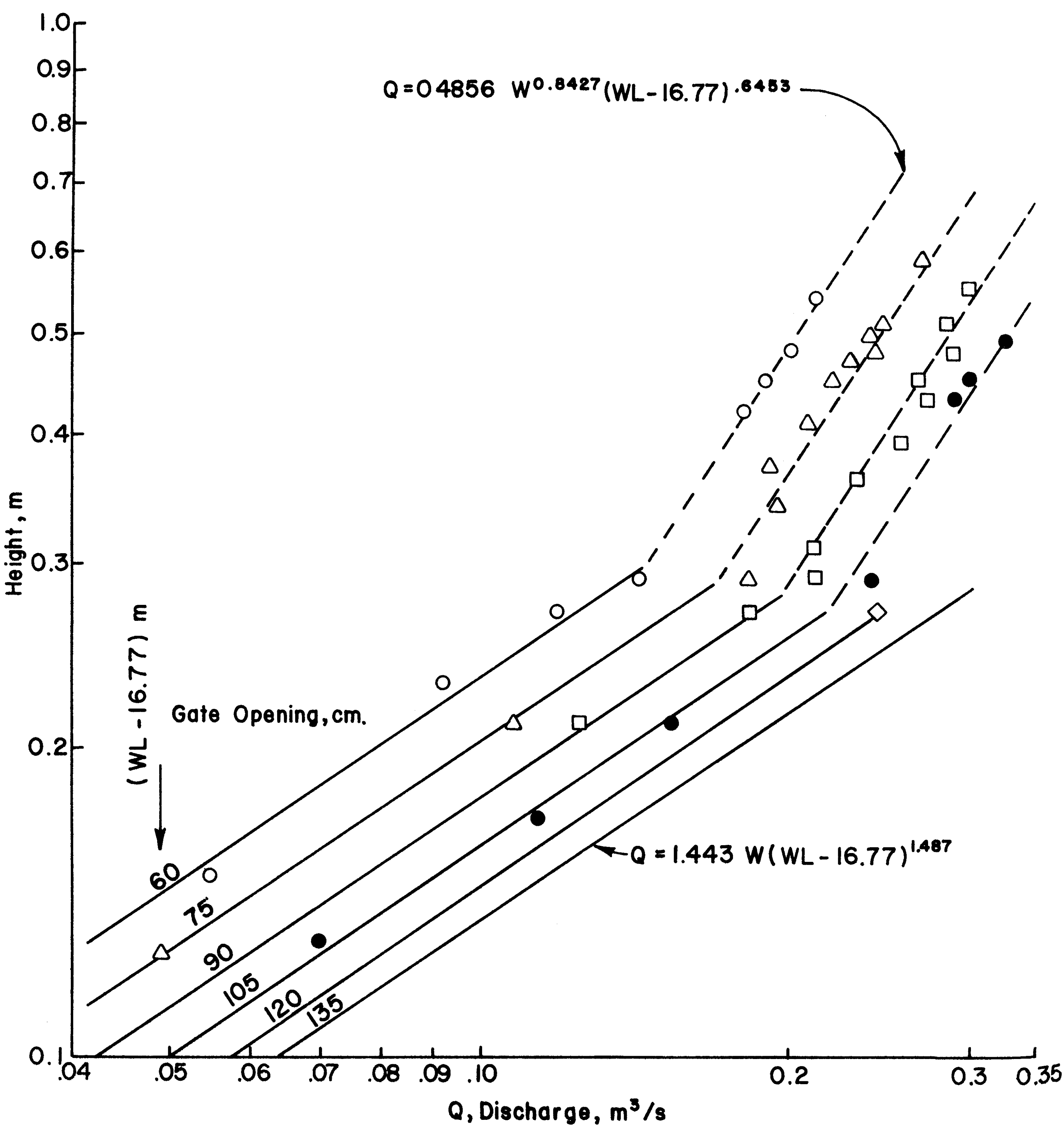
REFERENCES

1. Dotzenko, A.D., Zanati M., Abdul-Wahed, A.A., and Keleg, A.M., "Preliminary Soil Survey Report for the Beni Magdoul and El Hamanami Areas," Egyptian Water Use and Management Project, EWUP Technical Report No. 2, Cairo ARE and Fort Collins, Colorado, March, 1979.

2. Erie, L.J., French, O.F., and Harris, K., "Consumptive Use of Water by Crops in Arizona," Technical Bulletin 169, Agricultural Experimental Station, University of Arizona, September 1965.

3. Tawdros, H.W., et. al., "K Semi-monthly, Corn Evapotranspiration," paper presented at the 4th Conference of Soil Science, Cairo, UAR, 1969.

APPENDIX



A1.1 Rating Beni Magdoul Canal Nyrpic Gate

DAILY INFLOW ESTIMATES

The daily inflow values tabulated on the following pages represent the best estimates selected from several different computations or sources. Wadie F. Mankarous provided one set of computations which he felt were relatively rough because he did not read every minor bend in the chart line. Niel Biggs calculated inflow by computer to provide another set. Mohamed Helal El Sherif and William O. Ree recalculated all discharcge values where there was disagreement. Finally, where chart data were lacking resort was made to the instructions to the gate operator.

A1.2 DAILY INFLOW, Ben Magdoul Canal, January - June, 1979

Date	January	February	March	April	May	June
1979						
1	13,798		12,068	13,056	21,574	14,057
2	14,226		12,071	14,271	21,889	20,736
3	12,686	14,840	11,521	16,804	19,480	18,403
4	17,114	19,098	13,758	18,182	14,710	17,366
5	13,138	16,099	14,086	18,672	12,814	18,403
6	14,849	20,562	15,454	19,192	13,208	11,126
7	3,192	23,414	14,565	15,445	17,225	12,415
8		28,379	13,959	16,386	11,726	14,030
9		17,634	16,468	16,049	13,285	12,520
10		16,099	15,172	16,394	17,650	10,196
11		16,680	13,430	12,254	16,167	18,610
12		17,818	17,140	8,714	18,091	21,461
13		24,316	13,565	7,979	13,559	20,528
14		14,798	11,103	13,250	8,508	22,083
15		12,641	12,566	19,761	27,588	19,293
16		12,417	5,738	18,194	20,619	21,305
17		11,465	10,749	18,122	26,591	22,057
18		11,465	13,655	17,895	25,359	20,727
19		11,465	13,158	20,770	18,627	17,834
20		8,503	14,491	16,124	18,109	19,126
21		7,837	14,497	20,567	17,332	24,883
22		7,837	11,360	23,321	17,932	22,706
23		7,837	11,139	14,950	18,716	20,538
24		7,837	17,788	20,904	21,595	20,839
25		7,837	19,364	17,855	21,595	18,576
26		7,837	18,615	12,235	20,909	22,083
27		7,837	12,636	6,297	17,477	22,861
28		7,837	13,723	17,064	18,422	24,883
29			12,250	21,947	18,397	27,216
30			13,320	20,303	17,905	29,545
31			13,792		10,677	
	89,003	360,389	425,251	495,057	555,736	586,599

A1.2 DAILY INFLOW, Ben Magdoul Canal, July - December 1979

Date	July	August	September	October	November	December
1979						
1	18,774	27,642	11,850	19,383	12,802	9,234
2	21,946	21,051	12,027	19,213	17,355	11,829
3	18,205	24,372	10,717	19,567	15,463	10,219
4	22,939	22,724	10,506	19,940	19,535	9,395
5	17,787	22,254	9,751	21,630	20,395	10,048
6	17,232	19,853	8,882	21,192	16,723	11,085
7	20,311	22,585	10,648	20,315	15,664	7,522
8	19,805	24,637	9,739	17,191	18,162	5,746
9	21,173	21,226	11,570	14,633	18,266	6,617
10	19,842	22,936	10,245	16,227	17,818	11,474
11	21,146	20,335	10,821	16,278	17,097	10,154
12	23,181	17,594	9,313	19,511	15,882	10,993
13	22,045	20,853	9,527	19,290	12,287	12,035
14	25,496	18,291	7,809	20,013	13,411	7,283
15	21,760	20,909	9,068	19,350	13,433	8,507
16	18,580	15,517	10,053	16,412	13,462	9,453
17	20,897	13,934	10,860	17,858	12,031	8,541
18	22,382	15,739	9,455	15,974	11,148	12,013
19	21,017	19,245	12,053	16,600	12,010	7,429
20	21,148	10,659	14,403	15,537	13,993	7,824
21	25,193	9,983	16,953	14,453	14,012	5,269
22	24,397	15,335	13,460	14,946	13,958	7,198
23	21,199	18,843	11,657	16,955	13,718	9,047
24	21,333	14,459	12,195	22,173	13,741	10,218
25	24,347	18,854	12,662	20,442	13,671	10,244
26	25,499	20,124	12,165	13,585	11,897	10,750
27	23,518	17,655	13,216	16,551	10,344	11,391
28	18,322	20,124	14,473	14,042	9,320	11,166
29	20,792	15,116	14,862	14,065	9,070	9,812
30	20,181	11,541	18,336	15,275	18,269	8,593
31	21,818	13,573		12,350		9,712
	662,065	577,971	348,079	545,951	428,837	290,791

A1.2 DAILY INFLOW, Ben Magdoul Canal, January - June 1980

Date	January	February	March	April	May	June
1980						
1		7,919	11,255	8,998		
2		12,707	9,807	7,722		
3		14,300	11,063	10,126		
4		14,087	9,426	11,837		
5		12,311	8,176	13,458		
6		8,143	8,557	12,387		
7		7,712	8,732	13,745		
8		11,192	5,380	15,168		
9		12,900	5,727	13,140		
10		12,524	7,775	12,676		
11		10,763	13,956	14,774		
12		11,203	17,841	16,738		
13		9,906	19,416	13,768		
14		10,508	18,276	15,559		
15		10,717	9,961	13,632		
16		9,963	11,702	11,817		
17		11,959	12,901	10,156		
18		11,280	13,100	14,903		
19		10,895	12,781	15,813		
20		11,060	12,323	18,150		
21		9,787	13,274	23,028		
22		13,633	13,833	12,936		
23		13,306	13,820	10,839		
24		17,446	11,477	14,666		
25		13,737	13,646	11,144		
26	5,583	12,024	16,717	17,687		
27	11,983	13,068	19,674	9,875		
28	14,613	13,114	22,723	13,453		
29	13,444	16,232	12,598	12,623		
30	10,217		9,700	17,524		
31	6,612		9,924			
		344,964	386,161	410,601		

CALCULATED CONSUMPTIVE USE "SEMI-MONTHLY FOR BANI MAGDOUL AREA

USING BLANEY - CRIDDLE FORMULA +

A2.1

Month	Period	T	P	Berseem 577.96 Fd			Wheat 42.29 Fd			Onion 18.25 Fd			Group Flax [1] 31.04 Fd			Group Cabbage [2] 2.43 Fd			Group Carrots [3] 51.43 Fd			Group Oranges [4] 24.63 Fd			Total 748.03 Per 1/2
				K																					
											Very Early++					Group Very Small Vegetables** 53.86 Fd									
May 1979	1-15	24.16	4.62	1.27	112.5	273089.1	.51	45.2	824.4	.35	31.0	2376.5	.79	70.0	9123.3				.06	5.3	1202.3	.47	41.6	4306.9	298122.
	16-31	24.50	4.92	1.10	104.6	253935.4	---	---*	-------	.40	38.0	2915.8	.59	56.1	7314.9				.20	19.02	4302.6	.47	44.7	4623.8	273092.
								Early Corn						Early Corn											
June	1-15	27.26	4.74	.87	84.9	206123.7	.48	46.8	8321.3	.48	46.8	3590.9	.48	46.8	6107.6				.27	26.4	5961.3	.55	53.7	5553.1	235657.
					Late Corn																				
June	16-30	29.31	4.75	.48	49.1	119150.6	.70	71.6	12714.3	.70	71.6	5486.8	.70	71.6	9332.1				.78	79.8	18043.4	.56	57.26	5923.9	170651.
July	1-15	27.66	4.65	.70	67.6	164142.6	.99	95.6	16986.3	.99	95.6	7330.3	.99	95.6	12467.6				1.32	127.5	28844.7	.58	56.0	5795.9	235567.
	16-31	28.22	4.96	.99	103.3	250672.6	1.21	126.2	22418.0	1.21	126.2	9674.3	1.21	126.2	16454.4				1.34	139.8	31618.8	.57	59.5	6150.5	336983.
August	1-15	28.08	4.50	1.21	114.2	277117.6	1.24	116.9	20779.7	1.24	117.0	8967.4	1.24	117.0	15252.0				1.36	128.3	29025.9	.66	62.3	6441.5	357584.
	16-31	28.03	4.74	1.24	124.4	298808.2	.95	94.3	16750.8	.95	94.3	7228.7	.95	94.3	12294.7				.81	80.4	18189.7	.59	58.6	6058.8	359330
Sept	1-15	23.95	4.16																			.63	50.0	5172.2	5172.
	16-30	27.90	4.17																			.65	56.6	5855.6	5555.
Oct	1-15	23.80	3.87	.92	67.7	164290.8																.68	50.8	5251.0	169541.
	16-31	22.80	4.12	1.20	91.7	222648.6				.26	19.9	1523.3							.05	3.8	825.5	.55	42.0	4348.8	229346.
Nov	1-15	19.30	3.60	1.22	74.5	180729.6				.38	23.2	1227.5	.68	41.5	5410.1	.07	4.3	43.6	.25	15.3	3295.6	.59	36.0	3724.7	194981.
	16-30	17.90	3.60	1.18	69.3	168203.7	.18	10.6	1877.4	1.06	62.3	4771.2	.81	47.6	6201.0	.23	13.5	137.8	.53	31.1	6722.8	.58	34.1	3523.3	191437.
Dec	1-15	13.20	3.46	1.34	65.7	159398.6	.25	12.3	2176.0	1.38	67.6	5183.5	.87	42.6	5558.1	.56	27.4	280.1	1.19	58.3	12596.4	.46	22.5	2331.9	187524.
	16-31	12.60	3.70	1.31	67.3	163411.4	.32	16.4	2920.8	1.28	65.8	5041.8	.90	46.3	6029.5	1.02	52.4	534.9	1.06	54.5	11766.2	.34	17.5	1807.4	191512.
Jan	1-15	11.80	3.45	1.42	66.3	160014.9	.40	18.7	3314.7	1.17	54.6	4184.0	.84	39.2	5109.1	1.33	62.1	633.3	.94	43.9	9472.9	.34	15.9	1640.9	184369.
1980	16-31	11.90	3.77	1.39	71.1	172600.0	.55	28.1	4997.2	1.03	52.7	4030.6	.86	44.0	5735.2	1.15	58.8	600.4	.86	44.0	9502.6	.44	22.5	2328.3	199802.
Feb	1-15	11.65	3.76	1.33	67.3	163324.1	1.28	64.8	11501.3	.99	50.1	3838.8	.82	41.5	5407.9	1.05	53.0	542.1	.89	45.0	9725.4	.43	21.8	2250.3	196589.
	16-28	12.35	3.26	1.30	58.4	141703.8	1.70	76.3	13559.0	.85	38.2	3925.7	.85	38.2	4976.0	.94	42.2	530.8	.75	33.7	7274.8	.52	23.4	2415.5	173385.
March	1-15	13.15	4.05	1.16	66.4	161255.7	1.84	111.1	19733.3	.80	45.8	3511.7	.81	46.4	6047.4	.89	51.0	520.2	.66	37.8	8164.3	.39	22.3	2310.4	201543.
	16-31	17.90	4.32	1.14	80.3	195002.2	1.22	96.0	15269.8	.75	52.3	4051.0	1.07	75.4	9829.8	.80	65.4	575.4	.69	48.6	10502.7	.43	30.3	3134.5	238365.
April	1-15	19.52	4.35	1.06	70.6	190867.2	.51	38.6	6863.1	.66	49.0	3752.6	1.24	92.0	11991.4				.40	29.7	6409.2	.42	31.2	3222.9	[illegible]
	16-30	20.23	4.36	1.39	105.3	255638.9	.51	38.6	6863.1				1.26	95.5	12445.3							.49	37.1	3840.4	[illegible]
May	1-15		4.62	1.27			.51						.79									.47			
	16-31		4.92	1.10									.59									.55			
June	1-15		4.74	.87																		.56			
	16-30		4.75																						

\+ Consumptive Use of Water by Crops in Arizona, Technical Bulletin 169, 1976. Agricultural Experiment Station, University of Arizona.

++Corn "K Semi-monthly" Corn Evapotranspiration by H.W. Tawdros, et. al., Th 4th Conf. of Soil Science, 1969 Cairo U.A.R.

* No crops for soil preparation after wheat because of wheat threshing.

**Group very small vegetables - parsley, lettuce, Egyptian leak, tomato

1 includes: beans, green pepper, artichoke, lupin, flax 2 includes tomato, raddish 3 includes spinach, garden rocet, dill, parsley, Egyptian leak, chard 4 includes citrus, palm trees.

A2.2 Class L Pan Evaporation Data - Mansouria Matological Station

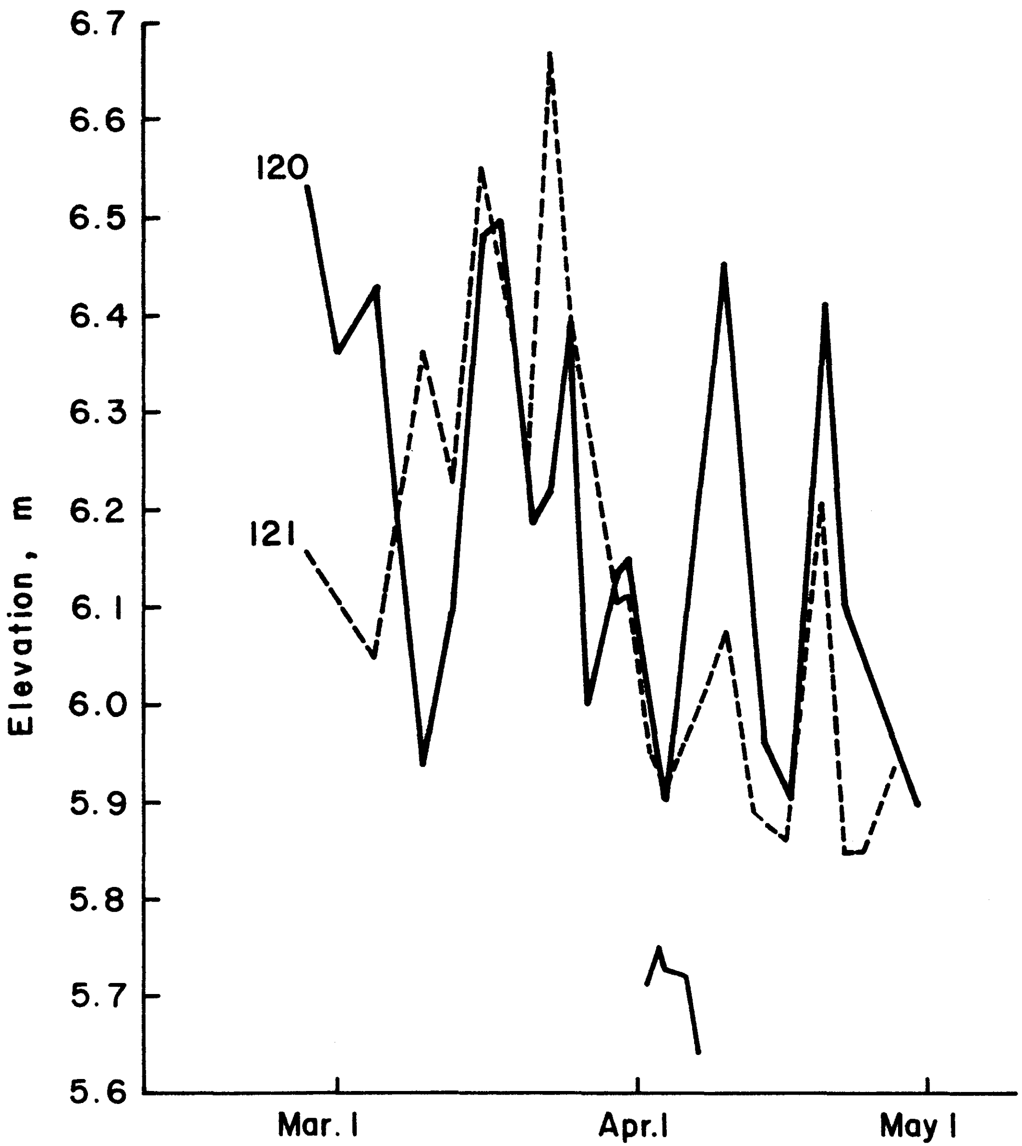
Date	July	August	September	October	November	December
1979						
1		.792	-	.584	-	.506
2		-	2.033	.634	-	.186
3		-	.771	.618	-	.257
4		2.144	.640	.522	2.501	
5		.704	.675	-	.319	.542
6	0.760*	.738	.605	-	.335	.172
7		.704	-	1.653	.522	
8		.715	1.245	.563	.443	.007
9	-	.421	.669	.587		
10	.540	-	.570	.523	.588	.300
11	.792	1.238	.656	.506	.255	.173
12	-	.633	.636	-	-	.189
13	-	.683	.625	1.102	.521	.286
14	2.410	.648	-	.503	.352	
15	.718	.533	1.363	.492	.353	.605
16	.576	.615	.657	.530		.195
17	.916	-	.692	.546	.561	
18	.804	1.535	.654	.447	.265	.406
19	-	.747	.670	-	.312	-
20	-	.712	.657	.865	.297	.080
21	2.071	.696	-	.378	-	-
22	-	-	1.160	.461	.355	.289
23	.600	-	.703	.562	-	.175
24	1.382	-	.667	-	-	.243
25	.777	0.659**	.632	.701	.724	.257
26	.869	-	.573	-	.390	.087
27	-	-	.679	.707	.222	.144
28	1.527	-	-	.427	.393	-
29	.795	.485	1.429	.359	.232	.387
30	.706	.716	.594	-	.253	.182
31	1.183	-		-	-	-

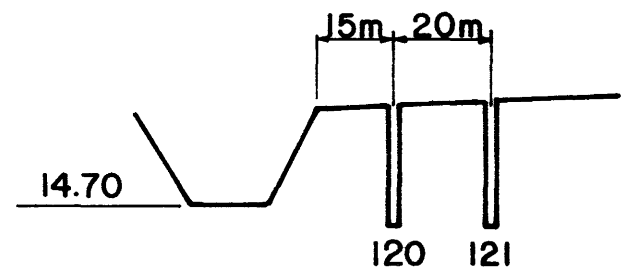
* Est. July Average 0.760

** Est August Average 0.659

A2.2 Pan Evaporation Data - Class L _Mansouria Matological Station

Date	January	February	March	April
1980				
1	.637	-	.934	-
2	.256	.592	.212	
3	.151	.285	.170	
4	-	.359	.273	
5			.289	
6	.878	-	.281	
7	.143	.717		
8	.159	-		
9	.168	.371	1.413	
10	.201	.013	.438	
11			.402	
12	.150	.403	.484	
13	.210	.457	.427	
14	.217	.565		
15	.201	-	.664	
16	.210	.525	.425	
17	.193	.521	.374	
18	-	.214	.502	
19	.341	-	.442	
20	.254	.466	.474	
21	.162	.361	-	
22	.186	-	.909	
23	.170	.617	.559	
24	.121	.320	.542	
25		.314	.600	
26	.296	.266	.398	
27	.305	.206	.357	
28	.335	.350	-	
29	-	-	-	
30	-	-	.458	
31	.729	-	.668	





A2.3 Well Level "Darcy" Reach

A2.4 Estimate of Groundwater Outflow by Darcy Reach #1

Date 1980	Well 120 Elevation	Well 121 Elevation	Drain
Feb. 7		16.49	
10		16.40	
13		16.30	
17		16.20	
19		16.14	
21		16.11	
23		16.06	
27	16.53	16.16	
Mar. 1	16.36	16.11	
4	16.43	16.05	
9	15.94	16.36	
12	16.10	16.23	
15	16.48	16.55	
17	16.50	16.44	
20	16.18	16.27	
22	16.10	16.67	
24	16.40	16.39	
26	16.00	16.25	
29	16.14	16.09	
30	16.15	16.11	
	16.23	16.29	
April 1	15.99	15.96	15.37
3	15.90	15.91	15.26
9	16.25	16.08	14.88
12	15.96	15.89	14.63
14	15.91	15.87	14.67
15	15.89	15.86	-
19	16.41	16.24	14.71
21	16.10	15.85	14.41
23	16.04	15.85	14.62
26	15.97	15.93	14.60
30	15.84	16.56	14.62
	16.04	16.00	

$$q = k \left(\frac{h_2^2 - h_1^2}{2\ell}\right)$$

let k = .26
(auger hole 3)

<u>Assume</u> March average value is OK

$h_2 = 16.29 - 14.70 = 1.59$

$h_o = 16.23 - 14.70 = 1.53$

$$q = 0.26 \left(\frac{1.59^2 - 1.53^2}{2 \times 20}\right)$$

$= .0012\ m^3/m$

N side 3000 m long

$9N = 3.65\ m^3/day$

$= 113\ m^3/March$

A2.5 Estimate of Groundwater Outflow by "Darcy" Reach #3 from Well to Drain

Avg. well elevation	=	15.88	15.88
Avg. drain elevation	=	14.61 + .50*	15.11
			.77

*seepage face height - estimate by Engineer Mostafa.

$h_2 = 15.88 - 14.70 = 1.18$

$h_1 = 15.11 - 14.70 = 0.41$

$$g = 0.26 \left(\frac{1.18^2 - 0.41^2}{2 \times 15} \right) = .0106 \ M^3/M$$

N side 3000 M long

$Q = 3000 \times .0106 = 31.83 \ M^3/day$

$= 955 \ M^3/March$

A2.6 Evaporation from the Non-cropped Areas Consisting of Village and Roads

---

Total Area	=	842 Feddans
Cropped Area	=	748 F
Canals		4
Non Crop		90
		842 Fed

Eldon Hanson suggests that evaporation from the non-cropped areas would not exceed 150 mm per year (personal communications).

$$\frac{150}{365} = 0.411 \text{ mm day}$$

Cropped area ET September 1 to April 30, 1980

$= 2{,}881{,}314 \ M^3$

$= 3.77$ mm day

$$\text{Ratio } \frac{NC}{C} = \frac{.411}{3.77} = 0.109$$

$$\frac{90}{842} \qquad \frac{= 0.107}{x = .0117}$$

Therefore increase ET estimates by 1.2% to obtain a total U figure.

A3.1 Average Groundwater Elevation and Station Change.

Date		"Large" Wells Wt.	Elev.	"Small" Wells Wt.	Elev.	Avg. Elev.	ΔE M	ΔS M^3
1979								
Jan.	1	12	16.01	4	15.95	16.00		
	16	20	15.67	5	15.66	15.67	-.33	-46680
Feb.	1	12	15.38	4	15.76	15.48	-.19	-26877
	16	12	15.77	4	15.81	15.78	+.30	+42437
Mar.	1	18	15.68	5	15.69	15.68	-.10	-14146
	16	18	15.83	5	16.02	15.87	+.19	+26877
Ap.	1	21	15.85	7	15.86	15.84	-.02	-2829
	16	16	15.75	7	15.80	15.77	-.08	-11316
May	1	20	15.80	7	15.92	15.83	+.06	+8487
	16	20	15.70	7	15.66	15.69	-.14	-19804
June	1	20	15.77	7	15.62	15.73	+.04	+5658
	16	20	15.70	6	15.64	15.69	-.04	-5658
July	1	20	15.77	7	15.71	15.74	+.05	+7073
	16	20	15.70	7	15.81	15.76	+.02	+2829
Aug.	1	18	15.75	7	15.68	15.73	-.03	-4244
	16	18	15.71	7	15.65	15.69	-.04	-5658
Sep.	1	18	15.70	6	15.66	15.69	0	0
	16	18	15.63	7	15.68	15.64	-.05	-7073
Oct.	1	19	15.77	7	15.56	15.68	+.04	+5658
	16	19	15.32	7	15.77	15.77	+.09	+12731
Nov.	1	11	15.82	6	15.82	15.82	+.05	+7073
	16	15	15.97	6	15.65	15.88	+.06	+8487
Dec.	1	17	15.87	7	15.77	15.84	-.04	-5658
	16	19	15.88	7	15.70	15.83	-.01	-1415
	31	19	15.99	5	15.70	15.93	-.10	-14146
								-9902
1980								
Jan.	1							
	16							
Feb.	1							
	16							
Mar.	1							
	16							
Ap.	1							
	16							
	30					15.73	-.20	-28291

A4.1

WATER BUDGET - BENI MAGDOUL
INFLOW COMPONENTS, M^3

Period	I_M	I_A	I_P	P	I
1979					
Jan 1-15	89003	1785	2454		93242
16-31	0	0	0		0
Feb 1-15	242378	4861	7500	48095	302834
16-28	118011	2367	3652		124030
Mar 1-15	206926	4150	6403	12024	229503
16-31	218325	4378	6755		229458
Apr 1-15	226609	4540	7006		237955
16-30	268648	5387	8313		282348
May 1-15	267676	6963	7657		260094
16-31	308262	5182	9538		322982
Jun 1-15	251627	5042	7780		264249
16-30	335172	6721	10371		352264
Jul 1-15	311642	6250	9643		327535
16-31	350423	7027	10843		368293
Aug 1-15	327262	6563	10126		343951
16-31	250709	5028	7758		263495
Sep 1-15	152473	3058	4718		160249
16-30	195606	3923	6053		205582
Oct 1-15	283733	5690	8779		298202
16-31	262218	5258	8114		275590
Nov 1-15	244293	4912	7559		256764
16-30	184544	3701	5710		193955
Dec 1-15	142141	2850	4398		149389
16-31	148650	2981	4600		156231
	5365729	106617	165730	60119	5698195

A4.1 OUTFLOW COMPONENTS, M^3

Period	U	E	O_9	O_{SD}	O_A	$O-O_G$
1979						
Jan 1-15	190000^e	50^e		0	0	190000^e
16-31	200000^e	50^e				200000^e
Feb 1-15	200000^e	60^e				200000^e
16-28	175000^e	60^e				175000^e
Mar 1-15	200000^e	80^e				200000^e
16-31	240000^e	110^e				240000^e
Apr 1-15	225000^e	120^e				225000^e
16-30	280000^e	125^e				280000^e
May 1-15		135^e				
16-31		140^e				
Jun 1-15		150^e				
16-30		155^e				
Jul 1-15		165				
16-31		179				
Aug 1-15		145				
16-31		158				
Sep 1-15	5234	143				5377
16-30	5925	142				6067
Oct 1-15	171575	121				171696
16-31	232098	100				233195
Nov 1-15	197321	78				197399
16-30	193734	59				193793
Dec 1-15	184774	43				189817
16-31	193810	42				193352