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AN ECONOMIC EVALUATION OF FARM MECHANIZATION IN EGYPT

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AN ECONOMIC EVALUATION OF FARM MECHANIZATION IN EGYPT

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Introduction: Egypt, like many developing countries, faces major decisions on how rapidly it should mechanize its agriculture and on the role of the puplic and private sectors in this process. In fact , there are many policies which affect mechanization ,at the one extreme, government may simply allow forces in the free market to decide the rate of mechanization and accept the social impacts. At the other extreme , government may be directly involved in controlling the mechanization process. Also, there are many alternatives of mechanization involved in such process.

The economic analysis of mechanization policies and alternatives may be considered at two levels of abstraction: First ,there is more technical question of the amount of change in output, employment, and income which will result from each policy. Second, there is the question of "who" will bear the costs and "who" receive the benefits, i.e., what will be the result of each policy on the distribution of income, wealth,and power in society.

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The objectives of this study are: to look at the effects of mechanization on the production, income and employment. Also, to study the demand side and the supply side of mechanization. The third objective is to present the current situation of farm mechanization in Egypt. The fourth objective is to evaluate economically the most important benefits of mechanization in Egypt.

The present situation of farm mechanization in Egypt:

The use of mechanization in Egypt is small considering the cultivated area of about 6 million feddan and the cropped area of about 11 million feddan.

Where mechanization has superseded animal traction, small-scale mechanization are the rule among small holding farmers. Large scale mechanization (combine harvesters) would find no market among farmers who till, seed, harvest, and thresh the produce of small farms. Historically, The tractor of 40 HP minimum has been the first and main step in mechanization, the modern one is 60 HP and in fact there are very few tractors larger than this size in Egypt. But this modern tractor is too expensive for the small farmers, but more important, he has no sufficient use for it to justify its purchase economically. However, farm mechanization is limited largely to tractorization of primary tillage and the threshing of wheat and rice.

1- The World Bank, Agricultural Development Project, menufia- Sohag, May 31, 1978, p.8.

The chisel plough is the most common tillage implement , the reasons for this are "similarity" to the traditional animal drawn (wooden) plough and ease of introduction to the conservative farmers . The animal sled method of threshing , with hand winnowing is succeeded by belt or hand drive mechanical drum type thresher winnower of local manufacture .

The potential areas for mechanization can be divided into the following categories:
1-land preparation 2- seeding 3-leveling 4-irrigation water lifting 5-fertilizer application 6- spraying of chemicals 7-harvesting 8- cutting and picking 9-threshing 10- winnowing 11-transportation .

To date , tractors have been the central focus of mechanization. In 1977there were about 21,000 tractors in Egypt, almost entirely in the 45-65 HP category,servicing a land of six million feddans . This figure is up from 17,500 in 1971. In the 1977 Farm management Survey , estimated that tractors plough 66 percent of the crop area, on average,but that they reach only 50 percent of the area for farms of one feddan and less. Animals plough an estimated 19 percent of the area, while 15 percent is not ploughed.Tractors are used for a growing but unknown proportion of agricultural transportation, while animals provide the balance. To date,there has been almost no mechanization of seeding . Fertilizer application is also an almost entirely hand broadcast operation. Land leveling is accomplished either with traditional animal drawn drag devices or poorly designed local tractor scrapers.

Spraying of pesticides is mainly confined to cotton, thus far, it is carried out through government agencies, and it is almost totally mechanized. However, there may be opportunities for psticide use on other crops ,such as in fruits and in aphid control for maize and wheat. These may constitute latent demands which ha ve yet to be met .

Irrigation water lifting is carried out by a varifty of traditional and modern implements. Motor pumps ,some of which are tractor powered, ser vice an average of 42 percent of the land area . Here the variation with size is important, however, since only 17 percent of the area on onc feddan and less farms is motor pumped, compared to 39 percent for one to three feddan farms, and to more than 65 percent for farms over 10 feddans. Twelve percent of the area is serviced by gravity flow, and the remaining 46 percent is reached with traditional animal powered sakias, i.e.water wheels. Here, the opposite relationship to size exists,since more than 50 percent of the area for farms of less than three feddans is serviced by sakia.

Harvesting is another area there is a great mixture of devices. To date, almost 100 percent of the cutting and picking is still done by hand. Threshing varies from crop to crop. The Farm Management Survey showed that about 75 percent of the area of crops requiring threshing was serviced by motor driven threshing devices or by tractor "floor threshing"i.e. by tractors driving over the crop piled on the ground, which is the dominant system for rice. However, only 60 percent of the relevant area for farms with less than one feddan was served by motorized threshing . Very few of the thresher machines which are used have integral winnowing devices. Winnowing is still mostly by hand throwing, with the wind, in Middle and Upper Egypt,but, in lower Egypt separate winnowing machines dominate, most of which are still hand driven.

The crops requiring threshing, togther with thier current areas,are the flowing:wheat(1.38),barley(0.11), rice(1.03),sorghum(0.43),broad beans(0.27),chickpeas(0.01), lentils(0.04),berseem clover for seed 0.24 million feddans.

More than 80 percent of wheat and barley are currently serviced by tractor powered "drum threshers" of local manufacture, which do not winnow. The remainder is still threshed by the traditional norag(wooden sled), formerly drawn in a circle by animals but now more typically by tractors. Wheat and barley threshing, which is done in May requires a tractor at a season when tractors are in high demand for land preparation for summer crops. The accompanying hand winnowing operations require labor when it is also scarce.

Rice, grown in the north Delta areas, is less demanding in that it is a far simpler crop to thresher. Typically, tractors are driven over the paddy, which is simply piled on the ground. This results in high kernel breakage, soiling, and loss,and it still requires hand winnowing in the peak fall harvest season. The drum thresher is not suitable for rice.

Sorghum, a summer crop which is grown predominantly in Upper Egypt, has been threshed almost entirely by hand flailing until the present time, since no suitable machines have been found for this job.The high labor cost, again at a peak labor demand period, is said to be threatening the economic vaiability of this crop, which is grown for home consumption and livestock feed. Broad beans, lentils, chickpeas, and seed berseem are often threshed with the drum thresher, but it is not particularly well designed for these crops, and there is often breakage and heavy loss.

Machinery supply in Egypt: until the end of August 1977, 27000 tractors of the 50-65HP range has been either imported (35%), or locally assembled(65%). The rate of increase has accelerated from only about 1300 unit p.a. before 1974 to 2700 in 1974 and 3600 in 1977.

About 14% of these are in non-agricultural use and about 75% of tractors are owned by private individuals 11% owned by cooperatives, and 14% in the public sector.(1)

Tractor production in egypt is by the Nasr Automotive Co. (NASCO) at Helwan. Tractors are sold by (NASCO) to any body who can put dowen payment in advance. Delivery may be up to 12 months but the price is fixed at the time of ordering.

Production of chisel ploughs is adequate to match present and increased demand. There are many factories produce these ploughs: Behera (state) company makes mouldboared ploughs, Fahim Ragab Co. (private company) north Cairo, many small workshops espicially in Zagazig, Mansora, and Tanta.(2)

(1)The World Bank, Agricultural Development Project, Menofia- Sohag, May 31, 1978.

(2)Goodwin, P.R., Agricultural Machinery, Egypt, SEMA, IDCAS, Metra Consulting Group, January, 1978.

Diesel pumps 6-16HP are made by the puplic sector (Helwan Diesel Company) which include Shubra Diesel Co. There are some private sector assemply of engins(impoted) with Egyptian made pumps set, for the crop spraying machinery, the ingine driven mobile spray unit now in common use by ministry of agriculture units are american in design and assembled at ministry owned factory.

Thereshers are made by BEHERA company and by TANTA motor company. Farm trailers are made by private sector companies: Sisman, El Sheati, Tanta motor co., Naguib, and by the public sector Behera co.

Machinery Demand in Egypt: There are many social and economic factors affecting demand for mechanization in Egypt. From these factors, the uncontrolled prices of livestock products, fuel subsidies, the increasing wages, the bottlenecks in improving yields, cropping intensification, the ownership patterns and other factors affecting the emergence of hire-service markets.

There are some estimates for the requirements of agricultural machineries, rather than economic study of the demand for mechanization. The government policy as stated in the last five year plan is to secure a gradual expantion of agricultural mechanization so as to liberate animals from agricultural work, and human labor from drudgery for productive employment in industry.

The target is to achieve full mechanization of primary tillage by 1985. This would require an increase of 3500 tractors annually to reach a total of 35000 tractors in operation. For irrigation pumps, demand is estimated at 3000 diesel sets, and the total number required from threshers or machine threshing (tractor power) with full mechanization is about 50000 threshers, while the present population is about 10000, therefore some 40000 theresher would need to be made (and marketed) by 1986. This suggested a rate of some 5000 units annually.[1]

Benefits of mechanization: The introduction and use of mechanization is often associated with some effects on production, income and employment.

A. Production effects: mechanization increases total production because of additional power resulting from the use of improved technologies. In this concern, there are many hypothesis:

1-Cropping intensity (number of crops per year on the same land) is higher on mechanized than on non-mechanized farms. One of the most striking differences between small and large farms is the sharp decline in crpping intensity from 2 (with smallfarms) to 1.5-1.75 range (with big farms). The operators of non-mechanized large farms skip either a winter or summer crop on a fraction of their land in order to get the succeeding crop in at the proper time.[1]

2-Cropping paterns on mechanized farms contain a higher proportion of higher valued crops than on non-mechanized farms.

3-Intensity of resource use (non-land inputs per feddan per crop) is higher on mechanized than on non-mechanized farms.

4-Total resource productivity (ratio of value of output to value of input) is higher on mechanized than non-mechanized farms.

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(1) The World Bank, opcit, p.37.

5-Both pre-harvest and post harvest losses are lower on mechanized than on non-mechanized farms.

6- The difference between the ideal date of planting or harvest as preceived by farmer , and the actual date of completion of planting or harvest is less for mechanized than for non-mechanized farms . By comparing small and big farms , it was found that draft power would not limit the timeliness of any operation on small farms as two animals required for plowing,the operator of such a farm would have to work out a sharing arrangement with his neighbor or rent animals. On the big farms there would be enough animal power to meet requirements, but only if individual cropping operations requiring draft power were spread over a larger time period. This affects the timeliness of planting some crops on the larger units, and with the actual availability and cost of hired labor, seems lagely to explain why large farmers have a lower cropping intensity than do small ones(even at high degree of mechanization).

B. Mechanization is generally expected to increase net income in two ways: first, mechanization is thought to reduce the cost of production and the cost of post-production related tasks. second, mechanization is expected to increase gross income through higher levels of

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(1) ERA 2000,INC., Further Mechanization Of Egyptian Agriculture, April 15,1979.

(2)IRRI, The consequences of small farm mechanization on rural employment, incomes, and production in selected countries of Asia, a workshop report,september 11-13, 1978.

production or production of higher quality and higher valued crops. It was found that big farmers gain relatively more than small ones from increased crep production when fully mechanized. The relatively small gain in crop production on small farms results from the assumption that even under non-mechanized conditions small farmers double crop thier entire cultivated area. On big farms, nearly sixty percent of increase in the value of crops production results from the increazed crop intensity that would be practicable under full mechanization .The remaining forty percent would result from more timely planting.

C. Employment effects: Total labor use per feddan per year on non-mechanized farms is higher than on mechanized farms. Under non-mechanized conditions small farms are essentially self-sufficient. As non-mechanized units big farms would require roughly 440 man equivalent days of hired labor per year for rice farms, and 480 days for cotton farms. Full mechanization would reduce those totals to approximatly 255 days in each case.(1) Labor productivity, defined as the value of output per man day (or per value) of labor input, is higher on mechanized than on non-mechanized farms.

Empirical Estimation of Mechanization Benefits: The actual estimation of mechanization benefits is an extremely difficult task. At first thought it would seem a simple

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(1)ERA 2000, opcit, p. xxv 12.

matter of cmparing mechanized versus non-mechanizd farms.However, many factors inter into any direct comparison. That is ;the mechanized farms may have more access to credit to buy fertilizer than non-mechanized farms,and the estimation must allow for the contribution of fertilizer input to yields,and not attribute that part of yield difference to mechanization. In fact, there are a whole range of possible confounding factors biasing benefits in favor of either mechanized or non-mechanized farms. ...

It must be mentioned that this study utilized a portion of the data collected for the Farm Management Survey in 1977. Two samples were selected from the entire data set, one for lower Egypt and one for upper Egypt. The data for lower Egypt focused on the region of Sharkia governorate, sampling 11 villages from the governorate and nearby regions. The upper Egypt sample include 10 villages from both upper and middle Egypt as a comparison to the lower Egypt sample.

<u>Yield benefits</u>: The estimation of yield benefits requires the use of covariance analysis, which for yields is equivalent of estimating a production function with dummy variables for each type of mechanization. The benefits from mechanization can then be interpreted as the coefficient of the dummy variable, using t-test to evaluate the coefficient's statistical significcance. The Cobb-Douglas production function for each crop was of the general form:

$$Y = a + bP + cI + dN + eM + fH + gF + hS$$

where all variables in logs exept dummy variables:

Y = yield in ardebs per feddans
P = dummy variables for type of plowing
I = dummy variables for type of irrigation
N = chemical fertilizer (nitrogen kg)
M = organic fertilizer
H = hired labor in days
F = family labor in days
S = size of field in feddans

Tables 1 and 2 present the results of the covariance analysis. The fit of the equations is not very good, with R squared being quite low. The impotant input factors do not have consistently significant coefficients and, at, times have the wrong sign. However, when input factors have the wrong sign they are never statistically significant and there are consistencies across equations.

The effect of field size on yields differs significantly between the two regions. In lower Egypt the coefficient for field size is negative in nine of the ten equations and statistically significant in five of the estimates. Hence, there appears to be higher yields on the small farms, a characteristic attributed to the higher input levels that small farmers frequently use. In contrast, Upper Egypt's equations have positive coefficients in six of the eight estimates but are significant in only one case. The higher yields on large farms could be due to Upper Egypt's slower pace of development enabling only large farmers to utilize the best techniques.

The major issue of the covariance analysis on uields is mechanization effects on yields. For lower

TABLE 1

COVARIANCE ANALYSIS ON YIELDS
LOWER EGYPT

	Intercept	Plowing Technology: Animal	Plowing Technology: Mech.	Plowing Technology: None	Irrigation Technology: Animal	Irrigation Technology: Mech.	Irrigation Technology: Gravity	Nitrogen Fertilizer	Manure	Hired Labor	Family Labor	Field Size	No. of Obs	R^2
Wheat	5.80*	0.09	0	0	-0.01	0	–	0.20*		-0.03	0.15*	0.01	111	0.20
	(11.32)	(0.19)	(0.02)		(0.15)			(2.43)		(0.71)	(3.19)	(0.20)		
	8.70*	0.25	0	–	0.17	0	–	-0.02	-0.38*	-0.11	0.20	-0.15	34	0.45
	(7.24)	(1.[illegible])			(1.07)			(0.13)	(2.24)	(1.09)	(1.94)	(1.06)		
Maize	7.72*	-0.03	0	–	-0.04	0	–	-0.11		-0.01	0.02	-0.28*	92	0.21
	(12.43)	(0.34)			(0.40)			(1.08)		(0.31)	(0.44)	(3.80)		
	6.54*	0.08	0	–	-0.12	0	–	-0.06	0.17	0	0.03	-0.17*	71	0.31
	(9.04)	(0.99)			(1.34)			(0.57)	(1.79)	(0.12)	(0.57)	(2.59)		
Rice	6.53*	0.63*	0.63*	0	0.07	0	0.20	0.19*		-0.06	-0.08	-0.26*	101	0.33
	(13.10)	(2.00)	(2.15)		(0.97)		(0.77)	(2.10)		(1.53)	(1.63)	(4.16)		
	7.21*	0.09	0	–	-0.01	0	-0.35	0.25*	-0.12	0	-0.06	-0.31*	76	0.42
	(15.72)	(0.90)			(0.12)		(1.04)	(2.30)	(1.42)	(0.05)	(1.19)	(4.78)		
Perm. Berseem	4.13*	-0.12	0.14	0	0.16	0	1.55*	0		0.04	0.07	-0.07	50	0.15
	(5.39)	(0.43)	(0.73)		(0.84)		(2.27)	(0.02)		(0.54)	(0.94)	(0.57)		
Short Berseem	2.86*	0.11	-0.10	0	0.02	0	–	0.11		0	0.18*	-0.19	32	0.35
	(3.23)	(0.42)	(0.68)		(0.15)			(0.60)		(0.13)	(2.18)	(1.69)		
Cotton	6.28*	-0.32	-0.11	0	0.04	0	–	-0.01		0.12*	0	-0.13*	85	0.22
	(12.07)	(1.25)	(0.47)		(0.54)			(0.16)		(2.96)	(0.12)	(2.39)		
	5.35*	-0.21	0	–	0.04	0	–	-0.04	0.22	0.09	-0.02	-0.10	63	0.22
	(6.74)	(1.88)			(0.34)			(0.34)	(1.81)	(1.64)	(0.45)	(1.34)		

* – significant at 5% level

Note – number in parentheses is T-statistic

TABLE 2
COVARIANCE ANALYSIS ON YIELD
UPPER EGYPT

	Intercept	Plowing Technology			Irrigation Technology			Nitrogen Fertilizer	Manure	Hired Labor	Family Labor	Field Size	No. Obs.	R^2
		Animal	Mech.	None	Animal	Mech.	Gravity							
Wheat	6.34* (13.34)	-0.01 (0.14)	-0.20 (1.39)	0	0.34* (4.00)	0	- -	0.09 (0.99)		0.0 (0.17)	-0.01 (0.16)	0.08 (1.48)	72	0.24
	6.15* (6.92)	0.42 (1.60)	0.47 (1.55)	0	-0.38 (1.23)	0	- -	0.10 (0.70)	-0.09 (0.73)	-0.13 (1.06)	0.38* (3.67)	0.12 (1.05)	18	0.75
Maize	3.71 (1.93)	0.03 (0.09)	1.05 (2.00)	0	0.32 (1.56)	0	- -	0.40 (1.39)		0.19 (1.09)	-0.02 (0.19)	0.20 (1.88)	35	0.50
	4.68* (2.92)	-1.01* (2.74)		0	1.04* (3.91)	0	- -	0.01 (0.04)	0.15 (1.12)	0.15 (0.51)	0.32* (3.42)	0.43* (4.43)	10	0.97
Sorghum	6.37* (5.69)	0 (0.01)	-0.15 (0.28)	0	-0.03 (0.15)	0	0.06 (0.14)	0.16 (0.90)		-0.12 (0.98)	-0.04 (0.37)	-0.08 (0.40)	46	0.05
	11.46 (1.12)	-0.51 (0.27)	-2.20 (0.36)	0	-0.02 (0.01)	0	0.58 (0.21)	-0.15 (0.13)	0.04 (0.01)	-0.72 (0.44)	-0.65 (0.48)	0.47 (0.29)	13	0.31
Sugar-cane	2.23* (6.04)	0 (0.03)		0	0.07 (0.38)	0	0.19* (2.46)	0.09 (1.51)		0.13* (2.98)	0.08* (2.32)	-0.02 (0.52)	38	0.59
Cotton	3.70* (5.11)	0.07 (0.59)	0.50* (2.42)	0	0.58* (3.29)	0	0.15 (0.58)	0.42* (3.71)		-0.08 (1.37)	0.08 (1.43)	0.13 (1.66)	21	0.87

* - significant at 5% level

Note - number in parentheses is T-statistic

Egypt, animal plowing has superior yields over tractor plowing in five out of ten cases. However, the significant differences are for tractor plowing's increase in yields for cotton and the superiority of both animal and tractor plowing over no tillage in the rice crop. In Upper Egypt, the significant differences are between tractor plowing and both animal plowing and no tillage for maize and cotton, with tractor yields being superior. All other effects were insignificant.

The fact that the better yields for mechanized tillage appears in maize (for Upper Egypt) and cotton (for both regions) is interesting in light of informal field interviews. Farmers indicate that they typically use more plowing for yhese two crops than for wheat, sorghum, rice or berseem. Therefore, if seedbed preparation was to be significantly better with tractors, the cotton and maize crops would be the expected occurences. The wheat crop, for example, usually receives only a single tractor plowing ,it is hardly adequate to improve yields through improved seedbed conditions.

<u>Timeliness effects</u>: Even though maize and cotton are probably the crops most sensitive to timely planting, this is not the reason for the improved yields . as there was no difference between tractor and non-tractor farms in planting dates. This result is expected given the method of tractor use in Egypt. Tractor are not utilized solely on the owners'farms, but also provide hired services that give access to mechanical inputs to all farmers in the village. Therefore, a single tractor is likely to be kept busy through the entire

planting season until all fields had been planted. As a result, when planting dates for tractor and non-tractor farms were compared, there was no difference due to both technologies being used over the entire planting season.

Farms utilizing animal plowing could even show more timely planting because the large supply of animal power allows some concenteration of work in the critical planting period whereas the tractor is fully utilized untill all plowing is finished. In this case , animal plowing would have an earlier average planting date than the tractor. Nevertheless, the tractor could improve planting dates by adding to the plowing capacity of the village. The effects would appear, however, at the village level in a before and after tractor comparison and not through a cross sectional farm survey.

There are general indications to support the claim that the introduction of tractors reduces the period of operations at the village level, even though the cross sectional data provided no evidence. Farmers in Upper Egypt with very few tractors utilize a combination of tractor-powered threshers and animal-powered norags to accomplish the wheat threshing. Because of the constraint on power during this season, the wheat threshing for the village took 45 days to complete . In contrast, villages in Sharkia governorate had more tractors available and no longer required the norag to complete the threshing . In these villages the wheat threshing season varied from

15 to 30 days, depending on the number of tractors.

The effect of irrigation technology on yields is also presented in Tables 2and 3 , but the results seem unclear. In upper Egypt, animal water lifting had significantly better yields than mechanized pumping in three cases and gravity flow had one case better yields than mechanized pumping. These results could be due to the quality of land reflected in the irrigation technology or to the farmer's dependence on others for timely irrigation in the case of mechanized pumping. In upper Egypt, some large stationary pumps are owned by individual farmers who sell the water to surrounding farmers.The dependence on this pump owner for water delivery may make timely irrigation more difficult than gravity flow and animal irrigation,where the farmer has more control over the irrigation operation.

Cropping Pattern Changes: One common argument for increasing the mechanization on farms is that it allows for changes in cropping patterns, either increasing the cropping intensity or switching to higher value crops. The greater benefits would come from increasing cropping intensity. A regression was done to test the effect of mechanization on cropping intensity.The independent variables were the confounding farm characteristics that might influnce cropping intensity plus an index for mechanization, varying from zero to one, that represented the percentage of tilled land that was tractor plowed. The results from the regressions are reported in Table 5 , with no significant effect from mechanization. The effect of mechanization on the cropping pattern is more complex than the effect on cropping intensity. Not only do farm variables crrelated with mechanization influence cropping patterns, but the calculated mechanization index is dependent on the cropping pattern because certain crops are more likely to not be tilled. Hence, for the regression analysis, the mechanization variable is derived partly from the cropping pattern itself. As a result, the mechanization index cannot be used as an independent variable in any regression on crpping pattern.

Table 3
Regression on Cropping intensity

	Lower Egypt		Upper Egypt	
	Coefficient	T-stat.	Coefficient	T-stat.
Intercept	187.96	30.67	197.67	29.76
Farm size	-0.44	1.66	-1.25	2.65
Percent land owned	-2.58	0.48	-3.77	0.47
Education	-0.93	1.37	0.02	0.03
Mechanization index	0.63	0.08	-8.41	0.92

<u>Labor Savings</u>: agricultural machines are able to perform operations more rapidly than the traditional agricultural implements. the technical superiority is a simple measurement and the resuling savings are listed

in table 4 . These will vary somewhat due to different farm conditions(soil conditions,lift of water, yield) and to the number of laborers working with the machine. With labor still relatixely cheep, most operators have many laborers working with the machine to keep the machine operating at full capacity. Table 5 presents the statistice from Farm Management Survey on labor use by crop technology used for plowing . It shows that mechanization permits a whole series of on farm processes to change, making it difficult to estimate actual labor displacement.

Table 4
Labor use By Type Of Technology

	Man-Days per feddan	Child- days per feddan
Seedbed preparation-Cotton		
Tillage - animal	4.0	-
Tillage - tractor	0.5	-
Harrowing - animal	0.5	0.5
Harrowing - tractor	0.125	-
Ridging - animal	0.75	-
Ridging - tractor	0.25	-
Irrigation - maize		
Saquia	0.49	0.49
Pump - 5 h p diesel	0.41	-
Pump - 16 h p diesel	0.15	-
Threshing/Winnowing- Wheat		
Norag /hand winnow	12.0	
Drum thresh/machine winnow	4.8	

Table 5

Labor Use By Level Of Mechanization [x]

(in man days)

	Lower Egypt		Upper Egypt	
	Low Mech.	High Mech.	Low Mech.	High Mech.
Wheat	27.7	24.3	30.0	27.5
Berseem, long	29.0	21.7	69.0	35.1
Berseem, short	6.0	12.5	76.1	45.4
Rice	58.7	54.6	-	-
Maize	38.9	43.0	44.3	54.6
Sorghum	-	-	42.6	46.2
Cotton	76.0	68.0	69.8	53.1

[x] Low mechanization includes no tillage .

Livestock displacement: Another cost reduction from mechanization is the elimination of animal work. In most countries specialized work animals are displaced and it is relatively simple to calculate the cost of keeping animals. However, Egyptian animal work is normally done by multi-purpose animals that also provide milk and meat to the farm. Therefore, the cost of replacing animal work with machine power depends on the farmer's decision to keep the animal or release it purchasing a machine . The first task is to determine if mechanization affects the number of dairy animals on the farm. Regression analysis was used to explain the number of dairy animals with independent variables on farm size, land tenure, man labor availability, child& woman availability, education and indicies for both tillage mechanization and irrigation mechanization.

The results of the linear regression are reported in Table 6. The most important factors in determining the dairy herd are farm size and child /woman labor availability. Man labor avaialability has little effect because livestck tending is not considered a man's job. The mechanization of tillage had an unsignificant negative coefficient in lower Egypt and a nearly significant positive coefficient in Upper Egypt. The positive effect of mechanization on the number of dairy animals, along with much lower herd numbers as follows:

	Lower Egypt		Upper Egypt	
	Low Mech.	High Mech.	Low Mech.	High Mech.
Dairy animals (per feddan)	0.81	1.13	0.45	0.43

indicate that a capital constraint may be limiting animal numbers in Upper Egypt because mechanized farms are less likely to face capital constraints.

The same type of analysis was also performed for the number of specialized work animals on the farm , donkeys and camels. These regressions are summarized in Table 7. No effect of mechanization on animal numbers was found. Thus, the cost reductions in mechanization are not realized through the displacement of these animals. Farmers in Sharkia governorate reported they would not reduce the number of dairy animals if they completly mechanized their farms. The opportunity cost of animal labor as meat and milk losses was estimated. The fact that animal labor is costed through milk and meat production is crucial because of government policy in livestock sector. Import ristrictions on meat and milk have kept domestic prices above the international prices, making meat and milk the only farm prducts that are protected and not taxed . Domestic prices therefore overstate the costs of animal work (and benefits from mechanization) in social benefit-analysis. The involvement of government policy is critical in the calculation of benefits to mechanization. When the prices of crops are maintained at a low level as a matter of government policy, so that food prices are kept low. But,what would happen if crop prices were allowed to increase, which would allow the economy to expand, and in turn, create jobs in other sectors besides agriculture. Also the supply seems to meat the demand. If the prices of crops were higher,production would increase correspondingly, then of course, higher commodity prices would make mechanization benefits and returns more economical as well.

Mechanization benefits and price policy: The emprical estimates must be viewed in connection with current agricultural price policy. If prices wereset at proper shadow prices , there would be no reason for the intervention in farm mechanization. But with price distortions, care must be taken in examining the sources of benefits and costs. So,social benefit- cost analysis can be compared with the farmer's financial return to mechanization. The price policy may be influencing the allocation of tractor time because of the unequal taxation of crops : in case of cotton , domestic farm gate prices are currently less than half of their shadow prices. If cotton yields are sensetive to tractor tillage (the most notable finding in the empirical results), farmers may be using socially sub-optimal amount of tractor time for tillage because of the low output prices. Just as farmers move fertilizer allocated for cotton to more prfitable crops, This analysis does not justify any subsidization or government intervention for tractors because the implicit tax on tractor use through low cotton prices is more than offset by the protection on meat and milk markets and the input subsidy on diesel fuel. The financial return to the farmer would still be greater than the economic return measured by cost benefit analysis.

Table 6

Determinants Of dairy animal ownership

	Lower Egypt		Upper Egypt	
	Coeff.	T-stat.	Coeff.	T- stat.
Constant	0.144	0.27	-0.042	0.05
Farm size	0.216	10.49	0.063	1.2
Tenure-percent owned	0.62	1.65	0.875	1.02
Man labor available	-0.052	0.44	-0.3	1.02
Child/woman labor available	0.214	2.88	0.172	2.25
Education	0.095	2.05	-0.123	1.29
Tillage mech. index	-0.492	0.87	1.841	1.95
Irrigation mech. index	-0.549	1.44	-0.015	0.02

Table 7

Determinants Of Work Animal Ownership

	Lower Egypt		Upper Egypt	
	Coeff.	T-stat.	Coeff.	T-stat.
Constant	1.061	3.62	0.074	0.23
Farm Size	0.073	7.16	0.086	4.37
Tenure-PERCENT owned	0.094	0.47	0.249	0.78
Man labor available	0.058	0.92	0.388	0.56
Child/ woman labor available	0.009	0.3	0.015	0.52
Education	-0.061	2.49	0.001	0.02
Tillage mech. index.	-0.418	1.36	0.233	0.67
Irrigation mech. index	-0.131	0.64	-0.024	0.09

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