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Further Mechanization Of Egyptian Agriculture

ERA 2000 INC.

FURTHER MECHANIZATION

OF

EGYPTIAN AGRICULTURE

Prepared by

ERA 2000, INC.
Gaithersburg, Maryland

AID Contract No. AID/NE-C-1513
Project No. 263-0025

April 15, 1979

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April 15, 1979

Regional Operations Divison - NE
Office of Contract Management
Agency for International Development
Washington, D.C. 20523

RE: Contract No. AID/NE-C-1513

Gentlemen:

We are pleased to submit this final report in accordance with the reference contract to carry out a feasibility study on farm mechanization in Egypt.

Our entire Study Team appreciated the opportunity to participate in this project. These personnel include the following:

Libert Ehrman, Project Manager
Ronald Wade Jones, Team Leader
Dr. Merton B. Badenhop, Agricultural Economist
Dr. William J. Bellows, Econometrician
Dr. Filmore Bender, Econometrician
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Dr. Samuel P. Hayes, Economist
Dr. Amihud Kramer, Food Processing Technologist
Dr. William Liebhardt, Agronomist
Dr. Errol D. Rodda, Agricultural Engineer
Dr. Howard H. Stonaker, Animal Husbandry Specialist
Dirk van der Voet, Agronomist

The cooperation of personnel in many Government agencies, universities, private associations, corporations and cooperatives in Egypt provided opportunities for discussions with the Team and provided available data. These discussions concerned many aspects of Egyptian agriculture and farm mechanization problems. In the course of field work, we were able to meet with Egyptian farmers to gain insights concerning Egyptian farming and the conditions essential to successful mechanization. We are pleased to acknowledge this assistance.

Regional Operations Division - NE - AID
March 1, 1979
Page Two

We are particularly endebted to Dr. Ralph J. Edwards and Niel M. Dimmick of AID/Cairo and Robert Morrow of AID/Washington. They helped the Team establish the necessary contacts in Egypt, identify sources of data and develop the logistical support essential to the daily operations of the group. Most important was their guidance and comments on technical issues raised in the course of the work.

From the outset, we received the enthusiastic endorsement for our efforts of Dr. Mahmoud Mohmed Dawood, Minister of Agriculture. This helped to provide the framework for cooperation by the ARE that was essential to the entire effort.

We express our appreciation particularly to personnel of the Ministry of Agriculture of the Egyptian government. A continued source of helpful guidance was Dr. Aly El Hossary, Undersecretary for Engineering Affairs, without whose support our study could not have been completed in the time allotted for our field work.

Dr. Ali A. el Khishen, Professor of Agronomy of the College of Agriculture in Alexandria, and Dr. George Bassily Hanna, Chairman of the Department of Agricultural Engineering at the University of Cairo, made themselves constantly available for consultation. They were generous in imparting their knowledge and data concerning Egypt's soils, cropping practices, agricultural problems and utilization of farm machines that were prerequisites to the Team's understanding of the agricultural and mechanization situation in the nation.

We also acknowledge the participation of personnel in Egypt who, operating under contract, assisted the work of the Study Team through specialized surveys that are described in the text.

The results of the analysis make clear that further mechanization of agriculture in Egypt would be a profitable undertaking, both for the Egyptian farmer and the nation as a whole. Consequently, we hope this report will be of assistance to the government of Egypt in implementing an enlarged program and to AID for consideration in planning its support program for the agricultural sector.

Sincerely yours,

ERA 2000, INC.

Libert Ehrman

Libert Ehrman
President

SUMMARY AND RECOMMENDATIONS

Overview

The project undertook to determine whether increased mechanization of agriculture in Egypt would be worthwhile. Essentially, the study determined that from an economic and production standpoint, substantial benefits to the nation and to individual farmers would accrue if a comprehensive program were undertaken. Such a program requires a high order of management and coordination among a variety of activities to provide machines and machine services, financing, parts and repair, training in use of equipment and, among others, research, development and data. With these, intensity of agriculture could be increased from its present high level, land where yields are currently low could be improved and the general production level of agricultural commodities could be enhanced. Egypt possesses experience and a fleet of tractors. Egyptian farmers are accustomed to procurement of custom services. Thus, a foundation for expanding mechanization exists; in general, farmers are prepared for next steps and look forward to taking them.

This study was designed to address two different audiences. The first was Egyptian decision-makers for whom the study aimed to provide an informed basis for reviewing farm mechanization policy and programs in light of current and prospective developments. The second was USAID, which commissioned this project and sought to develop a basis for evaluating courses of action it might consider to further Egypt's farm mechanization effort. In light of the responsibility to the second group, it was perhaps inevitable that the report and recommendations might seem to imply that Egyptian farm mechanization depends far more

heavily on AID participation than is warranted. Egypt has its own resources and access to technical and financial assistance from others. However, the present study could not address all such alternatives in the detail accorded those that appear best suited to possible AID participation.

To plan a program geared to assessment of near term priorities, the Study Team took as a basis a five-year period as the shortest time span in which reasonable progress could be expected toward establishing a systematic optimal approach to mechanization. During this period, necessary assumptions as to price relationships, production patterns, availability of farm labor and other factors could be expected to remain fairly valid. While the precise dates for the beginning and end of the five-year period were not of critical concern, and considering the lead time typically required by AID funding and staffing processes, October 1979 was adopted as an appropriate time to inaugurate operations for the recommended program. For convenience, the program period generally is referred to in this report as 1980-1984.

The strategy alternatives took into account the implementation implications of Egypt's Open-Door Policy. With respect to substance, the Study Team interpreted its terms of reference to signify that recommendations were sought for an AID farm mechanization assistance program whose pace and content would maximize the contribution of further mechanization to increasing Egyptian farm output. At the same time, it was understood that the program would be subject to the constraints of economic and technical feasibility and should keep social dislocation within acceptable bounds. Interestingly enough, for reasons developed in the report, "social impact" appears not to be a significant constraint.

In broad terms, priority opportunities for mechanization to increase farm production in the near term can be visualized most easily as forming four links

in a typical means-end chain. Taking the desirability of increased farm production for granted, the end-point of this sequence becomes those on-farm operations that directly affect output. The preceding link comprises the equipment and inputs of technical expertise which enable and/or encourage farmers efficiently to mechanize farming operations. Standing as a means toward that intermediate end is the Egyptian support system comprising a wide range of elements from broad program management to repair facilities and extension services. In the context of AID-assistance planning, the final link consists of particular AID-provided inputs necessary to enable Egypt to optimize the contribution of mechanization to an increase in farm production during the next five years.

The various parts of the proposed mechanization program outlined in this report are interdependent. Consequently, the on-farm interface between mechanization and actual farm production must be kept in mind, so that the consequences of increasing, decreasing or omitting particular AID and/or ARE inputs proposed can be evaluated. This does not suggest that the Study Team recommendations must necessarily be taken or left in toto. Rather, this cautionary note is intended only to stress the interrelated character of the suggested program elements, hence the necessity for making appropriate adjustments in other parts of the system should a given component be modified. As regards overall scope and level, the Team considers the proposed program to be as ambitious as Egypt can now realistically undertake. It is also the Team's judgment that should retreat from the concept of an interrelated system prove necessary, modifications could be made with less damage to projected outcome by shrinking the entire program or shortening its overall time span than by eliminating components.

RECOMMENDATIONS

Near-Term Priorities

From its comprehensive analysis of alternatives, the Study Team concluded that the most promising areas of opportunity for directly increasing production by further mechanizing farming operations are:

1. Better seedbed preparation, which can result if farmers use more appropriate equipment, achieve a higher tractor density and have a better understanding of the relationship between tillage practices and crop yields.
2. More timely planting which – assuming no change in relative product prices – again depends mainly upon increased tractor density, use of more appropriate equipment and, importantly, better appreciation by farmers of the relationship between timely planting and crop yield.
3. Increased sub-soiling coverage or precision leveling operations: Sub-soiling of the roughly three million feddans of Class III and IV lands so that yields – particularly for cotton – can be dramatically increased and leveling the one million or so feddans – mainly in upper Egypt – which are sorely in need of it for efficient irrigation.
4. Replacement of animal-drawn sakias with motor-driven pumpsets which would have the result of increasing milk and meat production significantly.
5. More diversified use of tractors, i.e., extending tractor usage from plowing and threshing operations to which it typically is presently limited to additional tasks in land preparation, planting and cultivation. More diverse use of tractor power is part and parcel of the "more appropriate equipment" prerequisite for achieving the

yield-increasing effects of better seedbed preparation and more timely planting alluded to above. Achieving more diverse tractor usage, however, depends upon an increased number of tractors, keeping those available running and reducing the inefficient use of tractors for powering drum threshers.

6. Placing thresher-winnowers and mechanical grain harvesters into general use to save-grain, free tractors for more efficient operations in field work, ease current peak season shortages of both power and labor and, in turn, permit more timely planting of maize, in particular, and other affected crops in general.

Relieving Equipment Constraints

As implied by the preceding summary of priorities to optimize the contribution of machines to Egyptian farm production, a significant increase in both the number and types serving Egyptian agriculture is required. Priority needs for additional equipment include:

1. Tractors to expand custom operations and make tractor services available to farmers on a more timely basis.
2. Subsoiling and land leveling equipment to enable the Soil Amelioration Organization to at least double its subsoiling operations over the next five years and to demonstrate the benefits of precision land leveling sufficiently to develop a market for private custom work in this field.
3. New types of land preparation, planting and cultivation equipment to capitalize upon the yield-increasing potential of improved tillage, better seed placement and the freeing of labor from hand cultivation during the summer peak season for more timely attention to other crop operations.

4. Self-powered thresher-winnowers and mower-binders to reduce grain losses, release tractors for field work and reduce turn-around time between summer crops to make possible more timely planting of crops folowing wheat, rice and grain sorgum.
5. Motor-driven pumpsets (mostly diesel) to free cows and buffaloes from draft work, thereby to increase production of milk and meat and to relieve children, women and elderly family members from the drudgery of minding the animals pulling sakias.

Improving the Support System

Opportunities in this area can be exploited advantageously even if the existing stock farm machinery were not augmented. With additional numbers and types of equipment, aggressive action on the fronts indicated below becomes an essential prerequisite so that investments in machines yield an acceptable return.

1. Better management of machines by farmers and custom operators to improve the contribution of equipment to increased farm production. Significant opportunities were found for small-shop fabricators to increase their effectiveness in meeting urgent needs for spare parts. Mainly, what is needed is a better understanding among farmers and others in the food production chain as to the importance of and methods for equipment management.
2. Improve repair facilities and availability of spare parts which would have the same effect as increasing the farm equipment stock by reducing down-time and lengthening the useful life of machines.
3. Modernize local manufacture capacity for farm equipment other than tractors to ensure an adequate supply of new types of machines to meet

functional requirements of Egyptian agriculture. Managers of these plants should orient their efforts to market development and establishment of local dealerships with on-hand stocks of major machinery items and spare parts.

4. Expand and improve farm mechanization research and development to provide an improved basis for policy planning, program administration, extension education and to develop new types of equipment to take advantage of opportunities as they arise for further mechanization of particular crop operations.
5. Increase effectiveness of on-going machinery introduction programs by broadening the range of items to include required new types of equipment and by gearing machinery introduction efforts more positively to market development.
6. Increase the supply of trained mechanics available to man the local repair facilities essential to efficient repair and maintenance of farm equipment.
7. Establish a more effective management information system to provide program leadership on a timely basis with a flow of information needed for policy planning and program guidance.

Post-harvest Care and Utilization of Farm Products

In the course of this study, opportunities to improve post-harvest availability, utilization and exports of farm products were identified. An examination of these opportunities is contained in the Appendix.

Program Summary and Proposed Budget

Summarized below are the estimated requirements for the recommended AID assistance to the respective components of the recommended 1980-84 farm mechanization program. While the program covers the entire period, AID participation in some areas would be required for only two or three years. Local costs are included to the extent that AID financing is considered essential to prevent financial constraints from seriously restricting activities vital to program effectiveness. As a consequence, this summary greatly understates the ARE contribution to the farm mechanization effort. The composition of line item cost estimates is shown in the budget accompanying each of the program components and is described in appropriate chapters of this report. All local costs are shown in U.S. dollars at the present incentive exchange rate of pt 70 per dollar. Component cost estimates include allowance for an annual inflation rate of 10 percent and an additional 20 percent allowance for contingencies.

PROPOSED BUDGET

Amounts in Thousands

Program Component		5-Year Total Cost
1. Tractors 3,000 65 hp units in 1980 and 1981 respectively as components for NASCO assembly or assembled units, if necessary, to make up 6,000 units during those two years.		$30,000
2. Land Improvement		4,681
Subsoiling equipment	3,781.0	
Land leveling equipment	900.0	
3. Sakia Replacement		16,065
Incentive Loan Fund	15,000.0	
Support Costs	1,065.2	
4. Machinery Management Extension		5,705
Personnel	5,579.5	
Support Costs	125.4	
5. Service Center Development		5,329
Incentive Loan Fund	5,000.0	
Personnel	302.4	
Support Costs	26.8	
6. Research and Development		3,830
Applied Research Fund	1,000.0	
Collaborative Res. Prog.	245.9	
Personnel	2,000.2	
Center Establishment	268.8	
Support Costs	315.5	
7. Local Manufacture		8,000
Plant Modernization	6,500.0	
Technical Collaboration Contract	1,500.0	
8. Machinery Introduction Introductory imports of new types of farm machinery preparatory to subsequent local manufacture		1,355

PROPOSED BUDGET (Pg. 2)

Program Component		5-Year Total Cost
9. Apprenticeship Training		1,599
Personnel (central and governorate offices)	219.7	
Support Costs (central and governorate staffs)	75.0	
Training Costs for 400 apprentices per year	1,304.0	
10. Participant Training		1,403
Personnel (Egyptian Director Staff)	58.5	
Long Term Training	780.2	
Short Term Training	563.9	
11. Planning and Evaluation		-----
Only AID input would be part of Team Leader's time included in TAAG total below		
12. Technical Assistance Group [1]		1,134
Personnel[1]	864.0	
Machinery Mgt. & Extension	(5,184.0)	
Service Center Development	(302.4)	
Sakia Replacement	(950.4)	
Research and Development	(1,728.0)	
TAAG Total	(9,028.8)	
Support Costs	270.0	
Total Program		79,101
Less MOA contribution to shared local costs[2]		226
Recommended AID Assistance		$ 78,875

[1] Amounts in parentheses are included in respective sub-project totals shown separately. They are shown here as non-add items to reflect the total magnitude of the proposed technical assistance inputs.

[2] Local cost sharing applies only to Machinery Management, Sakia-Replacement and Research and Development subprojects.

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INTRODUCTION

The Climate for Farm Mechanization

Egypt stands today once more at a crossroads of agricultural mechanization policy. Faced in the mid-1960's with a similar need for mechanizing agricultural production to feed a rapidly growing population while maintaining cotton exports, the Egyptian Government responded with an innovative approach to mechanization geared to the circumstances of the time.

Prior to the land reforms of 1952 and 1961, mechanization progressed as large land holders found it advantageous. While representing only one percent of Egypt's farms in 1960, units of more than 50 feddans comprised 20 percent of the total cultivated area. Consequently, though the distribution of benefits under the pre-reform land-holding pattern did more than a little violence to any reasonable concept of social justice, that system did bring a measure of technological improvement to Egyptian agriculture.

Recognizing that Egypt's typically very small farms could not individually mechanize economically, the Government induced a dramatic increase in mechanization in the mid-1960's through cooperative-based custom services which blended the goals of technological improvement and social justice. From a pilot experiment in two governorates in 1965, this innovative system spread rapidly under strong government encouragement to bring the benefits of mechanization within reach of even the smallest farms. With limited built-in capacity for growth, the cooperative-operated system could not keep pace with the effective demand for custom services. Nor has it in fact served all farmers equally well. In

addition, the system developed early on administrative difficulties characteristic of such centrally-controlled enterprises. Noting these difficulties, however, takes nothing away from the vital role played by the cooperative-based custom services in pioneering an approach to agricultural mechanization uniquely adapted to the structure of Egypt's agricultural economy. That it succeeded so well in that respect no doubt resulted in large measure from its consonance with traditional practice among Egyptian farmers of shared use of work animals, water lifting equipment and other equipment and activities through joint ownership or other arrangements. All concerned today with future mechanization policy would do well likewise to build upon the strength of that traditional method by which farmers, through their own initiative, long have made "lumpy" investments divisible.

Basically what the Government-initiated launching of cooperative-based custom services did was to build a viable market for custom services. As that market developed, private custom operators entered the field in rapidly increasing numbers. Today, privately-owned tractors outnumber by two to one those owned by co-ops. Even with this new initiative, the availability of custom service has lagged behind effective demand. For a combination of reasons external to agriculture the number of tractors - Egypt's predominant requirement for <u>imported</u> farm machinery - increased little between 1965 and 1973. This marked a period of substantial disinvestment of the tractor capital earlier injected by Government into the cooperative-based system. Private custom operators apparently entered the custom service market to a marked extent with rehabilitated machines imported in an earlier period.

Egypt's "Open-Door Policy" adopted in 1973 brought in its wake the makings of another era of agricultural mechanization. Freed to import tractors and

other types of farm equipment not manufactured in volume in Egypt, private dealers aggressively pursued the Egyptian farm machinery market.. Tractor imports jumped from the 1965-73 plateau of about 1200 per year to 6000 in 1977.

In its effect the Open-Door Policy made obsolete the co-op-based tractor custom service system as an instrument of government initiative for fostering agricultural mechanization. More correctly, success of the co-op system in pioneering custom service operations together with the Open-Door Policy,which gave private operators access to the equipment needed for expanding their operation,rendered obsolete the originally conceived purpose of engaging co-ops in the supply of custom tractor services. The government has implicitly recognized the changed role of co-ops by essentially putting them on their own with respect to the financing of replacement machines. Today, each co-op wishing to replace a worn-out tractor must have the necessary financing in hand - from custom revenues or local borrowing on its own account - before ordering new machines. The only advantage co-ops receive in terms of price or other conditions is that resulting from pooled import procurement by government-managed tenders. Considering the time inevitably required by the pooling and tendering process, some co-ops no doubt would argue they pay a dear price for the relatively small price savings gained by large-scale procurement. That, however, is but a part of a much larger question, that of the optimal role of government vis-a-vis cooperative-supplied custom machinery services.

As in 1965, the crossroad of mechanization policy at which Egypt now stands concerns primarily the question of the optimal role of government in agricultural mechanization development over the years ahead. Consequently, it is with providing an analytic base for deciding among plausible alternative strategies that this report on the feasibility of further mechanization of Egyptian agriculture is primarily addressed. Broadly stated, the strategy options appear clear cut:

1. Drift with the times, while maintaining modest government intervention through operational control over key aspects of cooperative custom-service operations, while permitting private custom operators and equipment importer/dealers to fare as best they can without a significant help or hindrance from government.
2. Intervene with aggressive government action to reach in the shortest possible time a technologically optimum state of agricultural mechanization, with a primary view towards maximizing the contribution of mechanization to national food security and agricultural export objectives.
3. Pursue a laissez-faire-assisted strategy in which government would take responsibility for promoting those ancillary support services which neither private entrepreneurs nor cooperatives functioning on a sound financial basis can be expected to develop rapidly enough.

All three strategies obviously seek the same basic objective: an optimal pace and content of farm mechanizaiton over a period of time. It is equally manifest, however, that the concept of what is "optimal" cannot be identical in all three cases. The social impact of mechanization in particular will be found to differ significantly among the alternatives cited. So will the consonance of preferred implementing practices and procedures with the Open-Door and/or other national policies to which the Arab Republic of Egypt gives high priority. It goes without saying that whichever basic strategy Egypt elects to follow, there are alternative means of implementation which afford differing combinations of advantages and disadvantages. This report seeks to identify and weigh various options in the context of the respective strategies.

In very broad outline, the preceding paragraphs set the overall purpose, scope and content of this report. Principally, it seeks to develop and appraise

the consequences of alternative courses of program action at various levels of generalization. Recommendations are made on particular points to give readers the benefit of the Study Team's appraisal of pertinent options. That the analysis of alternatives and/or recommendations offered may suffer from innocence of the subtleties of the Egyptian scene is recognized as a risk that appears to be worth taking. Similarly, the possibility that present practices may incorrectly have been cast in an unfavorable light is also understood. These points of view are nonetheless presented since they strongly influence the Study Team's analyses and recommendations.

Mention must be made of the two different audiences this study and report were designed to address. Overall, the study was intended to provide concerned Egyptian decision makers an informed basis for reviewing on-going national mechanization policy and programs in light of current and prospective circumstances. Additionally and specifically, it was intended to provide USAID a basis for deciding what, if any, assistance it might advantageously give to further Egypt's farm mechanization effort. Given this latter responsibility, it is inevitable that the report may appear to imply that the farm mechanization effort Egypt can undertake depends far more heavily upon USAID participation than reality may warrant. Egypt has resources of its own and access to technical and financial assistance from other donors. However, it was not practicable in the present study to develop all such program possibilities in the detail accorded those that appear best suited to AID participation.

To keep the study within manageable bounds, mechanization was considered primarily in terms of the seven basic crops that constitute the typical crop rotations and comprise some 75 percent of all crops grown in Egypt: cotton, maize, wheat, rice, sugar cane, catch crop berseem and full term or "permanent" berseem. Fruits and vegetables, which account for about 12 percent of the

total harvested acreage, were excluded from specific consideration as they afford comparatively limited scope for further mechanization at this time. Minor crops, such as sorghum, broad beans and soybeans were likewise not treated separately. They were taken into account, however, in estimating overall machinery and labor requirements and the impact of mechanization in those parts of the country where particular crops like sorghum are grown extensively. Additionally, fruits and vegetables are examined in terms of their nutritional, processing and export potential characteristics.

The place of New Lands development in Egypt's overall mechanization effort is treated in a general way. It must be stressed, however, that this study concerns itself predominately with the Old Lands - including the "Old New Lands" - that comprise the 6.1 million cultivated feddans upon which Egypt now depends for its agricultural production. The New Lands are so different in the way they are organized, managed, and used, as to suggest a completely different universe. To do justice to that component would require a separate study directed explicitly to the New Lands' unique characteristics.

CHAPTER I

METHOD OF STUDY

General Approach

A general plan was developed as a framework to carry out this study of further mechanization of Egypt's agriculture. It took into account the necessity of maximizing the utilization of existing data, supplementing it with original research only where essential and emphasizing analysis of the agricultural situation by a Study Team consisting of experts in the fields relevant to the project.

Throughout the period of work in Egypt, close cooperation was obtained from professionals in agencies of the government, universities, industries, associations and knowledgeable individuals. These organizations and personnel not only provided data, but also gave insights into the Egyptian situation that greatly assisted the Team to understand the nation's agricultural history, problems and developments.

During the entire period, the Team worked in coordination with the Ministry of Agriculture, AID/Cairo and AID/Washington offices. Their support made possible the necessary initial contacts with organizations and personnel in Egypt that served as basic sources of information.

Chart I. 1 illustrates the plan that was followed. As tools to accomplish the scope of work, the Team obtained and utilized secondary source data and was assisted to obtain an understanding of Egyptian agriculture by a variety of local experts. Three special surveys were completed. Field trips were made, crop budgets were developed. A linear program was devised to manipulate data on a large

SCHEMATIC FRAMEWORK OF AGRICULTURAL MECHANIZATION STUDY

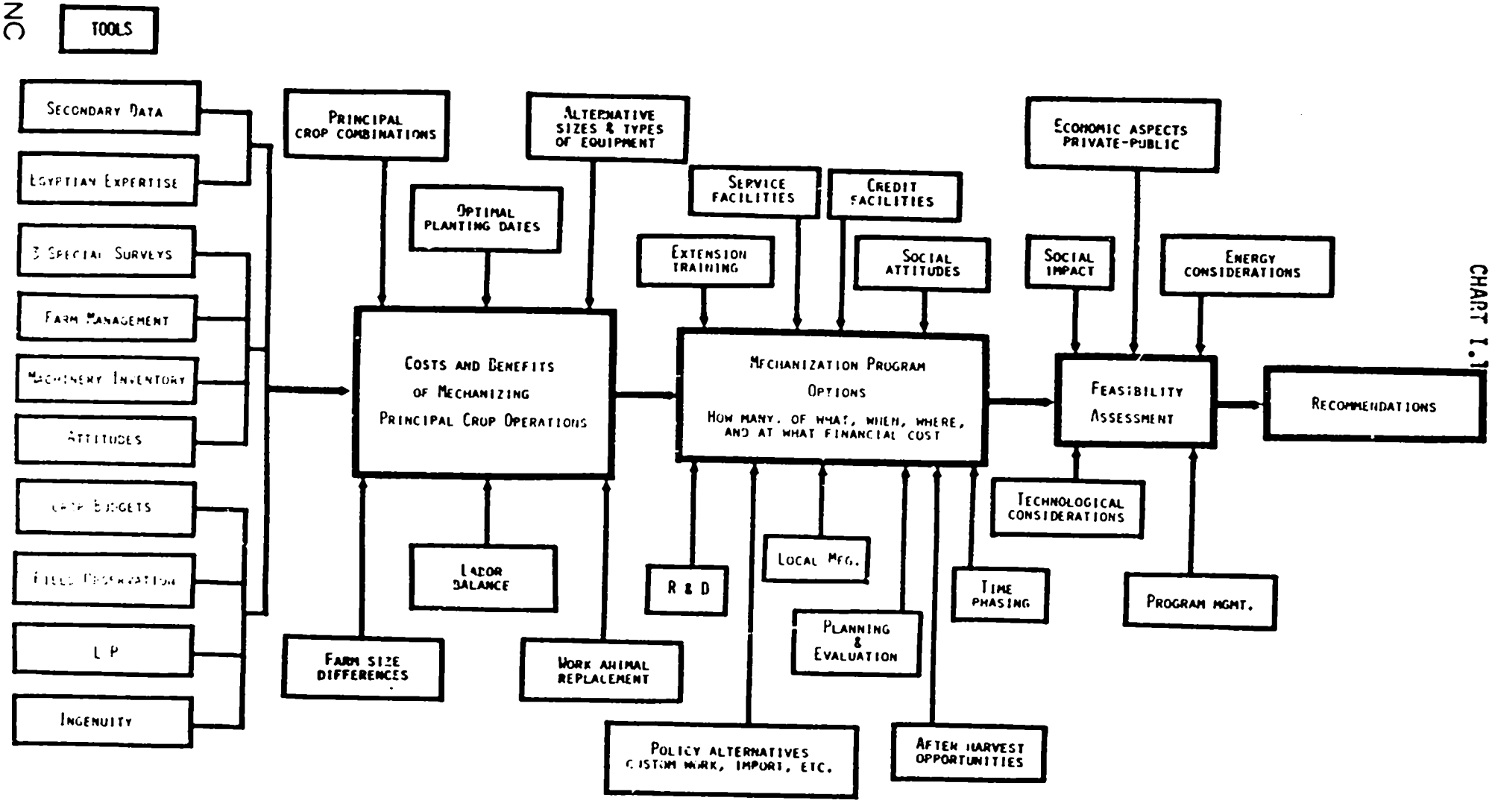

CHART I.1

number of variables and to make it possible to determine the probable outcome of alternative assumptions concerning mechanization strategies. Early draft materials were prepared by the Team in Egypt. These and the linear programming work were completed in the home office of ERA 2000, Inc.

Utilization of Secondary Source Data and Egyptian Expertise

To economize on data assembly and at the same time to meet the requirements of the scope of work within the brief time available for completion of the project, primary dependence was essential on secondary sources of relevant information and on Egyptian specialists.

Experience with this process impressed deeply on the Study Team the urgent need that Egypt find ways significantly to expand and improve the consistency of the research base for farm mechanization policy planning and administration. The typical paucity of directly relevant research results necessitated extensive recourse to informed judgements about the probable effects of mechanizing particular crop operations. That these professional opinions were as often contradictory as complementary made determinations as to the facts difficult. In many respects, the chronic problem was one of too little solid data on the one hand and too much conflicting information on the other. Piecing the research data together and reconciling the welter of other information to obtain a meaningful result posed a constant challenge.

A number of types of data as to the economy and the agricultural sector in general were provided to the Team, largely by Government agencies. This included information regarding the characteristics of the population, such as age distribution, estimates of population growth, migration trends, crop production, by type,

animal population, exports, imports, Government policies and a host of other types of data, much of which will be found in this report.

In the critical process of building the data base specifically for farm mechanization, the Study Team was fortunate in having continuous recourse to a number of experienced Egyptian specialists and received, with unstinting readiness, information and advice from numerous other personnel in Government, universities and private business as well as formers, co-op managers and a host of others.

The ERA 2000 Study Team itself comprised specialists in various aspects of agricultural engineering, agronomy, economics, credit, sociology, livestock production, food technology and project planning and evaluation. Some served for all or most of the entire six-month field-study period, others for one to three months. In combination, the Study Team brought a depth of experience on all significant aspects of Egyptian agricultural mechanization that was enhanced in almost all instances by prior experience in other less developed countries. Together, they culled information from a variety of sources, and subjected the whole to the analysis.

Survey Research

In three critical areas it was found necessary to supplement secondary source data and Team member field inquiries with structured surveys. These were as follows a broad-spectrum farm management survey involving personal interviews with a random sample of 406 farm operators throughout Egypt; a two-part, semi-mailed farm machinery survey in which 4000 Ministry of Agriculture representatives at the village level (where they also serve as co-op managers) were asked to supply detailed

information about the number of tractors, their use, condition and other characteristics; the third, also conducted by personal interview, focused on farmers' attitudes toward mechanization. The second survey above also served as the basis for an inventory of other types of farm machinery.

In those instances where more than one survey covered the same aspect of mechanization, results yielded essentially the same results. However, each survey was directed toward a specific and different purpose, addressed a somewhat different universe of respondents and sought differing degrees of coverage within its universe. Much of the variation in specific results cited in subsequent contexts appeared attributable to basic differences in survey design. As both the Farm Management and the Attitude surveys were conducted through personal interviews, by trained interviewers, of a random sample of respondents, the quality of the responses was, as expected, understandably higher than in the case of the Farm Machinery Survey.

The Farm Management Survey was conducted by present and former Alexandria University agricultural graduate students under the direction of Professor Mahmoud Sherif of that University's Agricultural Economics Department. The Attitude Survey was carried out by graduate students at Cairo University under the direction of the Chairman of that institution's Agricultural Extension Department, Professor Khairy Abul Seoud.

Although limited in coverage to 158 families in nine villages representing areas of dominant agricultural activity, the Attitude Survey produced a satisfactory basis for generalization about its principal topics, namely farmers' attitudes toward mechanization. It understandably yielded less reliable indications of physical magnitudes such as tractor numbers than did either of the other two surveys.

For some reason, the Farm Management Survey results were somewhat skewed toward the broad range of middle-size farms. However, this limitation was overcome, as the sample was large enough to permit stratification and/or weighting to reflect more accurately the Egyptian agricultural economy. Initially, these survey data were summarized by major crop areas, with the expectation that significant differences would be found among geographic regions. However, examination of the results indicated this was not the case. On the contrary, results from the different agricultural belts produced surprisingly uniform indications for practically all major matters when all sample farms in a belt were considered collectively. Some size-of-farm differences did appear, as did variations by type of crop combination reported. In general, though, such differences appeared to be related primarily to land use and affected mechanization practices very little, except for the generally lower degree of mechanization in Upper Egypt compared with the Delta and the special circumstances of the comparatively small number of farms producing sugar cane.

What the two-part Farm Machinery Survey lacked in sophistication of data collection, it largely made up in extent and volume of coverage. One-half of Egypt's approximately 4000 village-level MOA representatives were sent one type of questionnaire and the other half a different type --both through the channels of the governorate organization for agricultural cooperatives. Mailed questionnaire surveys are by no means commonplace in Egypt and both sets of respondents were requested to provide a great deal of information. Given these circumstances, the number and general quality of returns were gratifying.

Starting as it did at the beginning of Ramadan, many returns were received too late to process for the present study. Nonetheless, full or partial returns from 17 of Egypt's 20 governorates were available for analysis. Collectively,

nearly 2500 completed questionnaires were returned, roughly the same proportion by type as were sent out. The tractor inventory component provided information on nearly 7000 individual tractors. Together, the two parts of the survey yielded data from more than half of all the villages in Egypt. Considering the circumstances, data as to the magnitude of the principal types of equipment and other items were surprisingly consistent within governorates and between the two parts of the over all survey which covered the same topics in different ways. For the most part, the data obtained by this survey were not previously available in Egypt, certainly not in the detail which this undertaking provided.

Constraints Analysis

In approach, the over all study concentrated its initial phase on identifying constraints to increased agricultural production which practicably could be relieved by mechanization. This process naturally entailed a reasonably comprehensive exploration of existing circumstances and assessment of the prospective costs and benefits of alternative means of performing different crop operations. One significant product of this aspect of the work was the development of detailed crop budgets which set out for each of the seven major crops and an aggregate for miscellaneous crops, the labor and power requirements by operation and the period during which each operation is typically performed. Developed initially from secondary data for non-mechanized crop production as a base point, these budgets subsequently were amended with the aid of data from the Farm Management Survey to reflect the ranges in time period during which farmers said they performed the respective operations during the 1977 crop year, and to reflect the mix of hand labor, animal labor and tractor power Egyptian farmers now are applying to their

different farming operations.

Linear Program

To broaden the range of alternatives that practicably could be considered, a linear program was constructed to take into account the interdependencies among the various options available to operators of typical farms of different sizes and types in arriving at estimates of the production and income effects of mechanization. Here, attention was focused primarily upon those areas which the field study identified as particular opportunities in which mechanization could result in direct production increases and/or in a reduction in production costs. The results of the linear program analysis significantly reinforced conclusions reached in other aspects of the study.

CHAPTER II

AN OVERVIEW OF EGYPTIAN AGRICULTURE

Historical Perspective

The Nile Delta and its lifeline, the Nile River Valley extending southward some 600 miles, is one of the oldest agricultural areas of the world, having been under continuous cultivation for at least 5,000 years. Up to the beginning of the 20th century, it sustained a predominantly rural or agrarian economy, except for its export markets for cotton, rice and a few minor crops. Domination of the country for centuries by numerous foreign powers contributed little to its agriculture or industrial development.

Relative to the size of the country, the amount of land under cultivation in Egypt is extremely small. Taken as a whole, the land mass of the nation consists of an estimated 386,198 square miles. However, of this total, apparently only 13,500 square miles at most is cultivated. In fact, some would place this figure much lower - at about 9,700 square miles. This represents only some 2.5 to 3.5 percent of the total. The remainder consists essentially of uninhabited desert regions.

Population of Egypt is currently estimated at about 40,000,000. Although reliable data are not available, probably less than half the population can be considered rural. Further, estimates made in connection with this project place the farm population at about 14,400,000. Since the inhabited area of the country is so small, primarily along the Nile, population density is considered to be one of the highest in the world.

In many respects, Egypt entered the 20th century after the 1952 Revolution by launching numerous economic and social programs, many of which were directed specifically at the agricultural sector. To cite a few: Agrarian reform was introduced in 1952; economic planning, including an agricultural research and development plan, was started in 1960; consolidation of the utilization of fragmented holdings has been completed since the early sixties; the first phase of the High Dam for irrigation purposes was completed in 1965; large scale reclamation of new lands was carried out from the mid-sixties to the mid-seventies; a steady flow of new, improved, high-yielding varieties of the major crops were released and were supported by a strong seed renewal and multiplication program; fertilizer consumption more than doubled during the sixties; effective and integrated pest-control measures were developed; agricultural credit was liberalized and made available to all farmers; agricultural cooperatives were strengthened during the sixties; a high cropping intensity was even more intensified during the last 20 years by increasing the cropped area by some 1.8 million feddans*, while the area of the cultivated land remained practically static; and new, modern, strong and inclusive agricultural legislation was promulgated in 1966.

These agricultural programs were quite successful, and output increased at an annual rate of 3.5 to 4.0 percent from 1955 to 1965. Foreign currency earnings grew, food consumption per capita rose, and food prices for the urban population were held relatively low by means of public subsidies.

The country's economic system was drastically reorganized in many ways following the 1952 Revolution and most of the changes made are still in effect. A system of controlled prices was instituted for major farm products, as well as for the major inputs. Production quotas were established for the major crops

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* One feddan equals 1.04 acres.

to ensure increased quantities for export and to minimize imports. An elaborate organizational system was set up to distribute inputs and to insure delivery of requisition crops. Also, several governmental organizations were created to directly produce poultry, meat and milk under a subsidized price system.

In keeping with the trend in the agricultural sector, most firms in the industrial sector were nationalized in 1961, thus extending the role of the central Government across the entire economy.

The agricultural sector has faltered since 1965, as evidenced by a leveling off in crop yields, a lower output than was expected from reclaimed lands, and a shortage of foreign exchange for needed imports of fertilizer, machinery and equipment, and feed grains. Since 1965, population has continued to increase at an annual rate of 2.0 to 2.5 percent, and rural-to-urban migration has accelarated. This increased consumer demand for more and better foods and created marketing and distribution problems that the existing system was ill-equipped to handle.

As a result, in the past several years, it has been necessary to import an increasing proportion of key foodstuffs, especially wheat and wheat flour, cooking oils, beef, and feed grains for domestic livestock. Sharply higher international prices since 1973 have placed an additional burden on foreign exchange requirements that were not offset by increased earnings from exports. Since 1974, agricultural imports represented well over half of total imports, thus limiting funds available to import key raw materials, parts, and equipment for the industrial sector.

And so, the need for change in Egyptian agriculture is evident. In spite of its slow growth in the past decade, the agricultural sector still accounts for 57 percent of the rural population, 47 percent of employment, about 30 percent of the Gross National Product (GNP) and about 80 percent of export earnings. Unless

agriculture's growth rate can be restored, it will not be able to contribute to Egypt's economic growth as it did in the past and it will place a progressively heavier burden on the balance of payments. Furthermore, the economic and general welfare of the rural population will deteriorate, and major social and economic inconsistencies can be expected between the stated social and equity objectives of the country and the conditions of one of the largest single segments of its population.

In recognition of these realities, the Egyptian Government has made considerable investments in land reclamation projects, in irrigation improvements, and in providing various capital inputs to farmers -- seed fertilizer, pesticides, and traditional animal-powered equipment. The investment in engine-powered and animal-drawn equipment is small and the hand labor factor in production remains high. The result of this mix is high land yields and low labor productivity. By Western standards, a great deal of labor is still available to the agricultural sector. Yet, seasonal labor shortages appear, child labor is used, wage rates are rising and concern is expressed that, unless capital can be substituted for, or combined with the existing labor supply, land productivity may fall or potential growth opportunities in agriculture may remain unexploited.

Since increasing agricultural productivity is a high priority item for Egypt, a wide array of programs and reviews are being conducted simultaneously. The report Egypt: Major Constraints to Increasing Agricultural Productivity (a joint effort by the USDA, USAID and the Egyptian Ministry of Agriculture) identified the major obstacles faced by Egyptian agriculture today in its efforts to increase output. That report defined the following five projects as having top priority for implementation:

1. Program for Accelerating Installation of Drainage Facilities
2. National Program for Soil and Water Management
3. Streamlining Agricultural Research, Teaching and Extension
4. Comprehensive Dairy Improvement Project
5. Improvement of the Agricultural Marketing System - Especially for Fruits and Vegetables

This report focuses on the mechanization aspects of these five programs, including the research, training and extension activities judged essential to the successful implementation of the mechanization program developed during this study. Since no study answers all possible questions, a number of future projects are identified which deserve further study. These are clearly identified as being at the boundaries of project.

This project focuses chiefly on the role of mechanization as a means to help revitalize the farm production sector. Its objective is two-fold: 1) to determine the technical/economic feasibility of increasing support to agricultural mechanization and 2) if increased support appears warranted, to design a project which would place machinery and equipment in the hands of farmers to solve specific problems identified in the feasibility study.

The Land

Location

Egypt occupies the northeastern corner of Africa at the crossroads linking the Near East and Far East. It is located between latitudes 22 and 32 north and longitudes 24 and 37 east, and is bordered by the Mediterranean Sea to the north,

the Sudan to the south, the Red Sea to the east and Libya to the west.

The total area of the country is 1,001,450 square kilometers. Three quarters of this area, including all the inhabited and cultivated area, are located in the temperate zone; only one quarter (part of the desert and part of Lake Nasser) is located south of the Tropic of Cancer.

Geographic Regions

The country is usually divided into three main geographic regions:

The Nile Valley and Delta: The Nile Valley and Delta cover some 35,000 sq. km. (3.5 percent of the total area of Egypt) and extend from the Sudan border northward to the Mediterranean. The Nile River itself flows from its source in equatorial Africa in the south to the Mediterranean in the north, and its surrounding area forms this region which is customarily divided into two sub-regions: The Nile Valley of Upper Egypt and the Nile Delta of Lower Egypt.

The Eastern (or Arabian) Desert and Sinai: This region represents 28 percent of the total area of Egypt and extends from the Nile Valley to the Red Sea The Eastern Desert is a barren area which contains a chain of mountains some of which reach an altitude of 2,000 meters. East of the Suez Canal, the Sinai Peninsula is the eastern entrance to Egypt. It covers an area of some 60,000 sq. km. in the form of a triangle with its apex in the south and base (200 km) in the north.

The Western (or Libyan) Desert: This represents 68 percent, or two-thirds, of the total area of Egypt and stretches from the Nile Valley westward to the Libyan border with an average elevation of 500 m. It has a series of plateaus the three principal ones being separated by depressions which contain the oases

of Kharga, Dakhla, Farafra, Baharyia and Siwa. The Qattara Depression, lying southwest of Alamein and with an area of almost 20,000 sq. km. (2 million ha), is one of the largest of its kind in the world.

Climate

Egypt is characterized by a warm and almost rainless climate. The air temperature frequently rises to over 40°C (104°F) during the day in summer and seldom falls as low as 8°C (46°F) at night in winter. Table II. 1 gives the seasonal and annual averages of temperature, relative humidity, and rainfall for selected locations.

Average rainfall ranges from practically zero at Aswan to 24 mm at Cairo to 192 mm (about 8 in) at Alexandria. Most of the rainfall occurs during the winter months. Agriculturally, Egypt must be considered essentially a rainless country, dependent on irrigation to produce crops. The only exception is the north desert coast to a depth of about 15 km from the sea where some rainfed crops are grown.

The mean monthly relative humidity ranges between 60 and 77 percent in the Delta and 18 to 41 percent at Aswan.

Average annual lake surface evaporation ranges from about 0.9 m at Alexandria to 2.1 m at Cairo to 2.7 m at Aswan.

Population

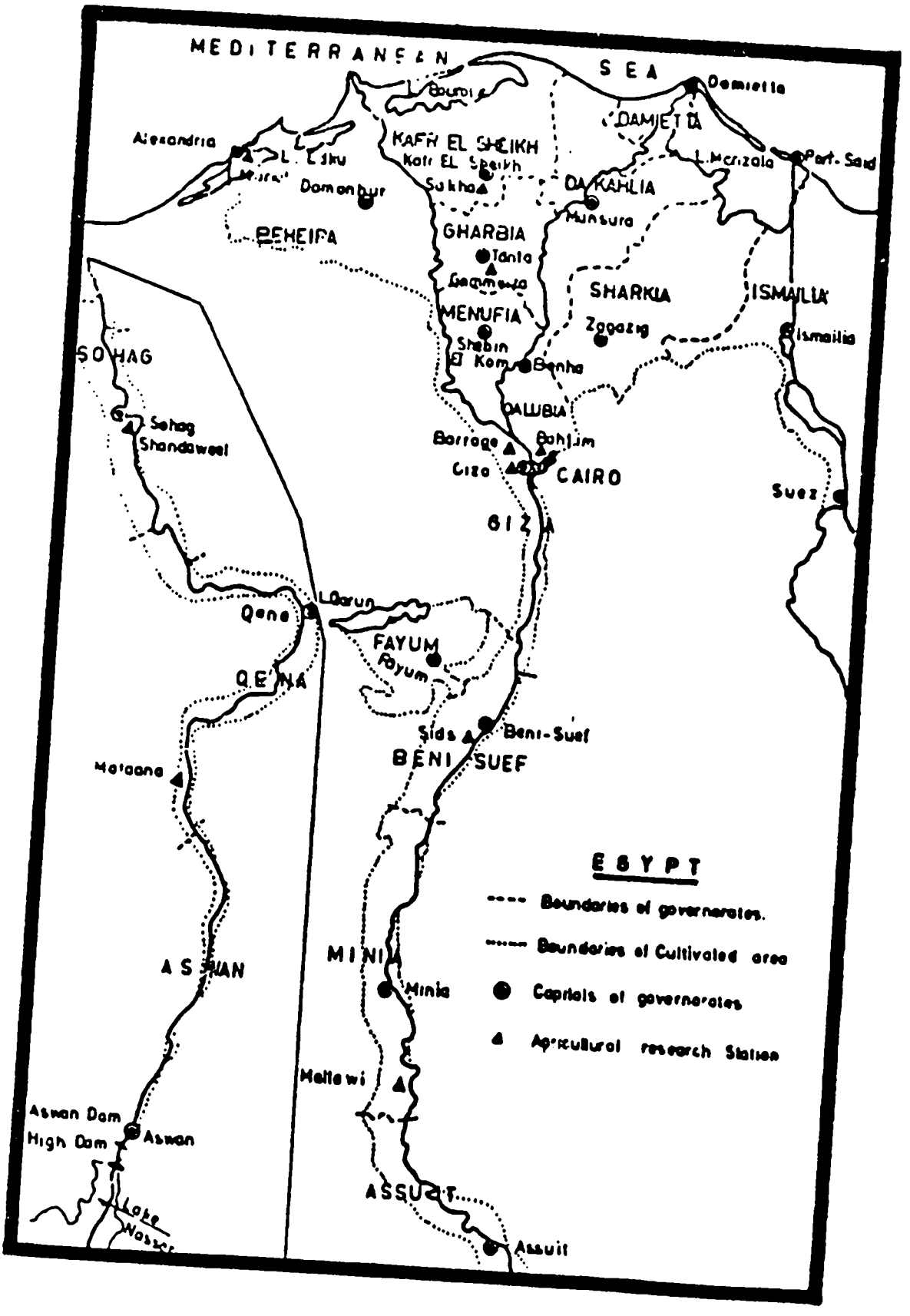
Egyptian population has grown rapidly in recent years and is a serious problem facing Egypt today. Total population in 1975 was 36.8 million, of which

TABLE II.1

CLIMATOLOGICAL NORMALS OF EGYPT

Locality	January averages			July averages			Annual averages			
	Temp. in°C max.	min.	Humid %	Temp. in°C max.	min.	Humid %	Temp. in°C max.	min.	Humid %	Rain mm
Mediterranean Coast										
Mersa Matruh	18.1	8.1	65	29.2	20.2	73	24.3	14.3	67	144.1
Alexandria	18.3	9.3	71	29.6	22.7	73	24.9	15.9	70	192.1
Port Said	18.0	11.3	73	30.4	24.1	74	24.6	18.5	72	66.3
Average	18.1	9.6	70	29.7	22.3	73	24.6	16.2	70	134.2
Delta										
Damanhour	19.6	7.7	75	32.5	20.2	76	27.0	14.4	76	93.6
Tanta	19.7	6.0	80	34.5	19.1	70	28.0	12.9	74	45.5
Mansura	19.9	7.3	79	34.9	20.7	69	28.0	14.5	72	54.8
Shebin El-Kom	19.8	7.3	74	35.0	20.7	66	28.2	14.3	70	34.2
Zagazig	20.1	6.1	82	35.0	20.2	68	28.3	13.7	74	29.3
Benha	19.4	6.8	81	34.8	20.6	76	27.9	14.3	77	22.6
Average	19.8	6.9	79	34.5	20.2	71	27.9	14.0	74	46.7
Cairo	19.4	8.6	59	35.4	21.5	52	28.1	15.4	55	23.8
Upper Egypt										
Giza	19.3	6.4	76	34.8	20.5	61	28.2	13.9	66	20.0
Fayum	20.3	6.1	71	36.7	21.2	51	29.5	14.5	58	13.7
Beni Suef	20.8	5.0	65	36.8	20.1	52	29.8	13.3	58	8.5
Minia	20.6	4.0	56	36.9	20.2	44	29.8	13.1	50	5.3
Assiut	20.8	6.6	43	36.9	22.3	32	30.4	15.4	35	0.4
Sohag	22.5	4.7	76	37.5	20.5	54	31.4	14.5	60	1.0
Qena	23.0	5.4	52	40.7	23.6	24	33.5	15.7	35	0.9
Aswan	24.2	9.5	44	41.9	26.1	24	34.9	19.1	31	1.4
Average	21.4	6.0	61	37.8	21.8	43	30.8	14.9	49	6.4

FIGURE II. 1


MEDITERRANEAN
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Mansura
Port. Said
BEHEIRA
GHARBIA
Tanta
Zagazig
SHARKIA
ISMAILIA
MENUFIA
Shebin El Kom
Banha
Ismailia
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Barrage
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L. Qarun
Qena
FAYUM
Fayum
QENA
Sids
Beni-Suef
BENI SUEF
Matoane
EGYPT
Boundaries of governorates.
Boundaries of Cultivated area
Capitals of governorates
Agricultural research Station
MINIA
Minia
ASWAN
Mellawi
Aswan Dam
High Dam
Aswan
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slightly over half lived in rural areas.* Population growth is estimated at between 2 and 3 percent per year depending on which set of statistics is used. Population has been shifting rather rapidly from rural to urban areas, as a result of which the proportion in rural areas was reduced from 76 percent in 1937 to 55 percent in 1974. A further reduction to about 46 percent by 1985 is projected. Cairo has been growing at a rate of 4.5 to 5.0 percent per year, about one-third due to immigration. Between 1966-1975, 70 percent of all net migration from other governorates was to Cairo, and 15 percent to Alexandria. With the reopening of the Suez Canal, a shift of population to that area is under way.

Careful projections suggest that population by 1985 will be in a 43-50 million range and by 2000 will range from 60 to 70 million or more. After that, projections differ greatly. Some analysts project a slowing in the growth rate to a peak of around 90 million by 2050. Others assume a rise to 140 million by 2030, and an acceleration thereafter.

The population of Egypt is a young population. Table II. 2 makes this clear -- 43 percent of the population is in the 0 to 14 year age group and another 41 percent in the 15 to 44 year age group. This and accompanying factors signify that the labor force includes a high proportion of children. Those under age 15 represent about 23 percent of the labor force and those under 20 represent about 23 percent. The average family size was 5.3 persons in the 1966 census.

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* As noted earlier, current estimates place population at about 40,000,000.

TABLE II. 2

PERCENTAGE DISTRIBUTION OF POPULATION BY AGE GROUPS

1966 Population Census

Age Group	Percent
0 - 14 years	42.7
15 - 44 years	40.5
45 - 64 years	13.3
65 and over	3.5
Total	100.0

Source: Central Agency for Public Mobilization and Statistics, "The Increase of Population in the United Arab Republic and Its Impact on Development", September 1969, p. 51.

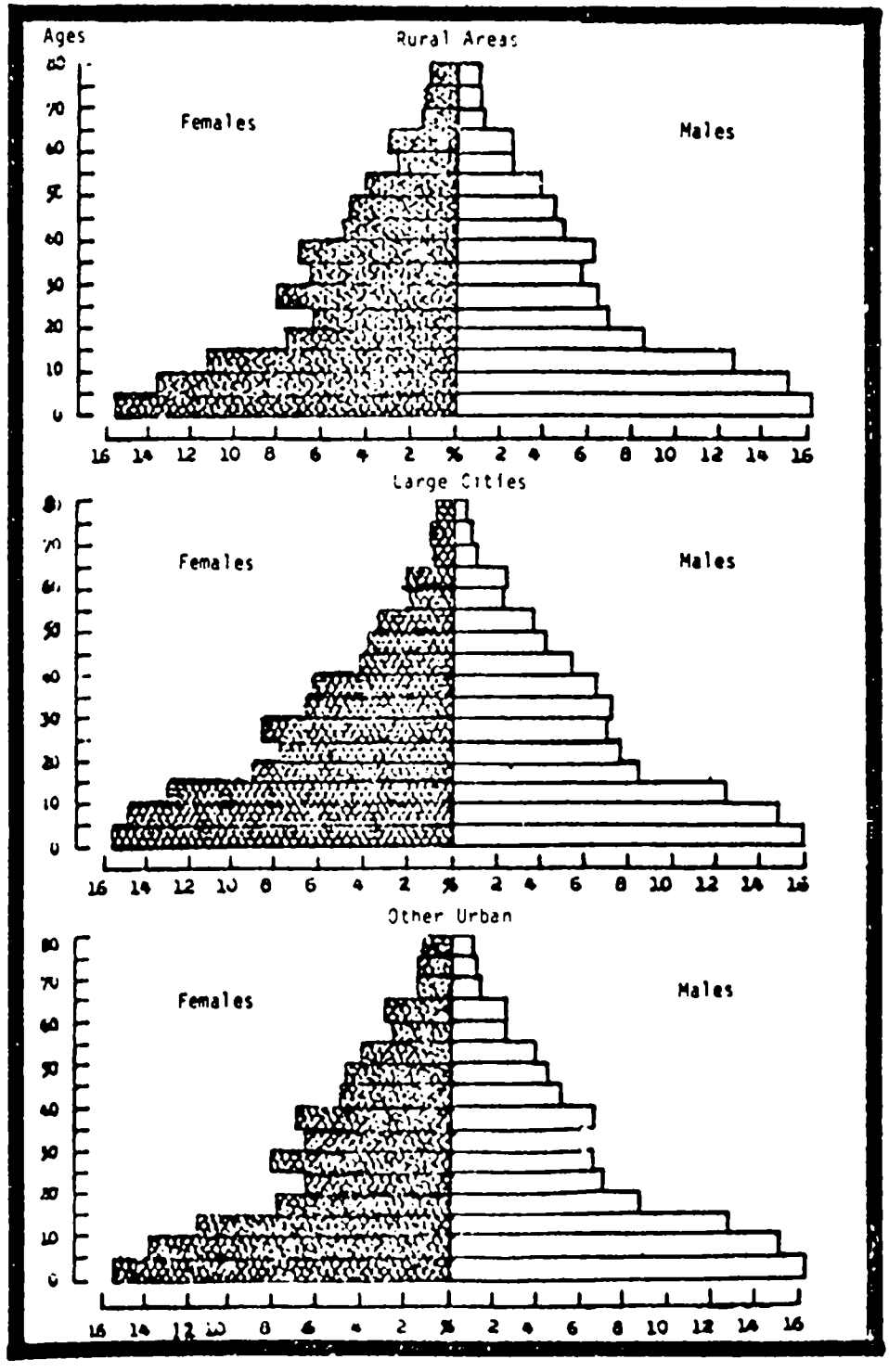
Population pyramids showing age breakdowns by sex and by rural areas, large cities, and other urban areas are detailed in Figure II. 2.

Population is highly concentrated in Egypt. Almost two-thirds of the people live in Lower Egypt (including Cairo), one-third in Upper Egypt, and about 1 percent in the desert areas outside the Nile Valley and Delta. In the inhabited non-desert area of the Nile Valley and Delta, the average population density is over 1,000 persons per sq. km. This heavy concentration of people and the increased immigration phenomenon from rural to urban areas carries with it many difficult social problems.

Growth in population is particularly critical because of the small area available for crop production. The present ratio of people to agricultural land is about six people per feddan based on land used for crops, and about three per feddan in terms of crops grown, one of the highest in the world. Even if cropping intensity were to increase from the present level of 1.9 crops per year to 2.1 by 1985, and reclaimed lands were to contribute an additional 10 percent to total output, the increased food requirements for the 30 percent population

FIGURE II. 2

POPULATION PYRAMIDS, 1966



increase projected for 1985 would be substantially greater than can be expected from this amount of horizontal expansion. Thus, increased yields represent the best prospect for maintaining or improving present per capita production levels.

Administrative Governorates

Administratively, Egypt is divided into 25 governorates, of which 4 are urban governorates (Cairo, Alexandria, Port Said, and Suez), 4 are desert and frontier governorates of little agricultural value at present (Sinai, Red Sea, Matruh, and the New Valley) and the remaining 17 are the main agricultural governorates (9 in Lower Egypt, 4 in Middle Egypt, and 4 in Upper Egypt). The agricultural governorates are divided into a number of districts or counties called "markaz".

Employment

Egypt's civilian labor force, estimated at 9.8 million in 1974, has been growing in recent years somewhat faster than population. Civilian employment has only grown at 2.0 percent annually, however, resulting in an unemployment rate of about 10 percent (Table II. 3).

While some government and union officials have expressed the view that a labor shortage exists in Egypt, localized and seasonal unemployment and under-employment are evident, the latter especially in Government services and in agriculture. Providing government employment to all university graduates has

TABLE II. 3

LABOR FORCE AND EMPLOYMENT, 1960-1974

Item	1960	1965	1970	1973	1974
Labor force (million)	6.7	7.9	8.9	9.6	9.8
Number of workers (million)	6.0	7.4	8.2	8.9	9.0
Employment (percent)	90.0	94.0	93.0	93.0	92.0

TABLE II. 4

NUMBER OF WORKING DAYS IN AGRICULTURE, 1974-1976

In Thousands

	1974		1975		1976	
Month	Man	Boy	Man	Boy	Man	Boy
January	17,600	10,000	15,700	9,900	16,500	10,100
February	27,300	12,000	27,000	11,800	27,500	12,100
March	24,300	8,900	23,400	8,200	23,800	8,300
April	43,000	9,100	42,300	8,800	42,100	8,900
May	55,000	16,400	53,900	16,400	54,400	16,700
June	64,700	41,700	62,300	41,700	62,200	41,700
July	25,100	43,100	22,600	42,700	23,100	40,800
August	23,600	11,400	22,800	10,000	23,400	9,800
September	37,100	41,700	32,600	41,700	30,300	41,700
October	34,800	13,400	34,400	13,100	33,600	13,100
November	21,300	12,200	21,200	12,400	20,900	12,900
December	22,800	11,800	22,700	11,900	22,100	12,400
Total	396,400	231,800	380,900	228,600	379,800	228,600

Source: Ministry of Agriculture, Agricultural Economics Research Institute

created disguised unemployment in the government sector, estimated to be as high as 30 percent.* Underemployment in agriculture results in part from sharp seasonal fluctuations in labor demand because of the fixed cropping pattern. Working days for men in 1974 reached 64.7 million and for boys 41.7 million in June, but fell to 17.6 and 10.0 million, respectively, in January (Table II. 4). Similar figures for 1976 indicated the number of working days was 62.2 million for men and for boys 41.7 million in June, but only 16.5 and 10.1 million, respectively, in January. The impact of continued rapid population growth in rural areas increases the pressure on the land. This is typified by what is happening in the "reform land" areas near Alexandria. Divided into parcels of 3 to 4 feddans during the land reform period 1955-1967, each parcel supported a family of six just over twenty years ago, but now the same parcels support three nucleus families or an extended family of 20. The government estimates that about one fourth of those actively engaged in agriculture are disguisedly unemployed for most of the year.**

The contradiction between a perceived labor shortage and an evident labor surplus results from a number of anomalies in Egypt's manpower structure. Thus, a shortage of perhaps 350,000 skilled workers is said to exist, while there is widespread underemployment in liberal professions and in the government's administrative and social services. Thousands of skilled Egyptians seek employment outside the country where jobs are available and wages higher. Officials of the Arab Federation of Workers in Agriculture indicated that as many as 500,000

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* Ministry of Planning, Government of Egypt.

** Ibid.

Egyptian farmers have gone to Libya to work in the construction and other trade industries, another 200,000 to Lebanon, 80,000 to Jordan, and fewer numbers to other countries. About 5,000 farmers have gone to Sudan and Iraq to work on farms in those countries. In some instances, unskilled labor is also thought to be scarce. This results from adverse wage differentials, legal and institutional impediments to labor movement, and the concentration of employment centers in a limited number of localities.

Looking further at labor requirements for agriculture, data furnished by the Ministry of Agriculture were examined. Labor requirements per feddan per month for major crops other than vegetables and for selected fruits reached a peak in May or June in all the major producing areas except in the Mid-Egypt and El Fayoum areas where the peak was reached in September (Tables II.5 and II.6). Lows occurred in November or January. Looking at the seasonal variation pattern, ratios indicate that labor demands were about 4.5 times greater in June than for the three monthly average demands for January, November, and December. These ratios may help to explain the controversy over whether there is a surplus or shortage of farm labor. Apparently, some shortages exist in peak months; surpluses occur in the other months.

The pattern of employment generation has changed little since 1960. Large investments in capital-intensive industry from the sixties to the mid-seventies generated only 20 percent of the total increase in employment. Agriculture, on the other hand, continued to absorb most of the employment, resulting in less than 8 percent decline in agricultural employment during that time. Consequently, growth in agricultural labor productivity has declined. The average annual increase of output per worker in agriculture was 2.1 percent during 1960-66 but fell to 0.5 percent during 1966-71.

TABLE II. 5

LABOR REQUIREMENTS FOR SELECTED CROPS ON OLD LANDS BY MAJOR CROPPING SEASONS 1972-74 Average

Crop	In Million Man - Days
Winter Crops	
Clover	46.8
Other field crops	46.0
Vegetables	11.2
Total	104.0
Summer Crops	
Field crops	141.5
Vegetables	24.6
Total	166.1
Nili Crops	
Field crops	11.5
Vegetables	14.0
Total	25.5
Longer-term crops	
Cotton	130.3
Sugarcane	22.4
Fruits	39.2
Total	191.9

Source: Ministry of Agriculture, Agricultural Economics Research Institute

TABLE II. 6

LABOR REQUIREMENTS ON OLD LANDS BY MONTH

Month	Million Man - days*	Seasonal Variability**
January	12.37	.77
February	23.62	1.48
March	25.67	1.61
April	41.42	2.59
May	58.67	3.67
June	72.32	4.52
July	43.47	2.72
August	26.79	1.68
September***	52.10	3.26
October	45.93	2.88
November	16.65	1.04
December	18.89	1.18
Total	437.89	---

* Labor need to produce vegetables is omitted. Requirements for vegetables are estimated at 49.8 million man-days.

** A rough measure of seasonal variability was obtained by computing the ratio between the average for the three low month January, November, and December, with all months.

*** Peaks in labor requirements for all major agricultural production areas occurred in May or June except in the Mid-Egypt and El Fayoum areas where the peak occurred in September.

Source: Ministry of Agriculture, Agricultural Economics and Research Institute

Agricultural Production Crop

Cultivated Area

For Egypt as a whole, about 5.7 million feddans of old lands were in cultivation in recent years and some 0.5 million feddans of new lands were producing crops. Since water is available all year round and agriculture is fully irrigated, continuous cropping is the general rule throughout the cultivated area of the country. Consequently, the total cropped area at the present time as a result of cropping intensity is over 11 million feddans (Table II. 7). However, to appreciate the scarcity of farm land in Egypt, it is worth noting that in 1976 the state of Illinois alone planted more than 12 million acres (i.e., 11.5 million feddans) in corn.

Cropping Seasons

The agricultural year starts with the planting of the winter crops and ends with the harvesting of the summer crops. By tradition, the first of November is usually considered the beginning of the agricultural year. Historically, the year was divided into three more or less distinct cropping seasons: winter, summer, and nili. The last of these, nili, has lost its distinctive significance in the last decade as noted below.

Winter crops include the winter cereals, wheat and barley; the winter legumes, Egyptian clover or berseem, broadbeans, lentils, fenugreek, chickpeas, and lupine; winter onion; flax; and winter vegetables. Their planting usually starts in October and continues in November and December. Harvesting usually starts in April and continues in May and June.

Summer crops include: cotton; the summer cereals, rice, maize, and sorghum; sugarcane; summer onion; groundnuts; sesame; kenaf; and summer vegetables. They

TABLE II. 7

AREA OF MAJOR CROPS BY FIVE YEAR PERIODS

1960-74 AND FOR 1975, 1976, and 1977.

In Thousand Feddans

Crop	1960-64	1965-69	1970-74	1975	1976*	1977*
Berseem	2,444	2,630	2,801	2,812	2,757	2,855
Cotton	1,751	1,694	1,551	1,346	1,248	1,423
Maize	1,727	1,510	1,593	1,830	1,891	1,765
Wheat	1,387	1,268	1,302	1,394	1,396	1,207
Rice	791	1,028	1,093	1,047	1,074	1,037
Sorghum	469	507	493	489	475	408
Broadbeans	365	349	283	246	260	292
Barley	128	110	81	100	104	95
Sugarcane	122	145	197	218	242	250
Lentils	77	65	64	58	64	48
Fenugreek	55	38	28	32	29	21
Groundnuts	46	47	35	32	32	36
Sesame	45	32	37	33	31	40
Onions**	44	45	33	27	31	37
Flax	27	30	33	54	47	58
Vegetables	547	668	761	895	930	911
Fruits	147	208	255	285	313	--
Other Crops***	147	163	213	241	--	--
Total Cropped Area	10,319	10,537	10,853	11,139	---	---

* Preliminary

** Winter onion only

*** Other crops include chick peas, lupines, kenaf, aromatic and medicinal plants, other forage crops, and miscellaneous crops

Source: Ministry of Agriculture, Agricultural Economics Research Institute

are usually planted from March to June and harvested from August to November. Although sugarcane is a perennial crop, it is usually included with summer crops. It is planted in January and February and harvesting starts in December.

Nili crops were named after the Nile flood season and include maize, sorghum, rice and vegetables. They were planted in July and August and harvested in October and November. Prior to construction of the High Dam, the available summer water stored at the original Aswan Dam was not sufficient to meet the needs of all

summer crops. The planting of the bulk of the maize crop, in particular, was therefore delayed to the nili season after the arrival of the new flood. With the completion in 1965 of the first phase of the High Dam for irrigation purposes, maize was shifted from the nili season to the summer season.

Table II. 7 gives the production areas of the main crops as 5-year averages during the 1960-74 period and annual averages for 1975, 1976, and 1977. Tables II. 8 and II. 9 show the production areas for vegetable and fruit crops, respectively, for the 1970-74 period and annual averages for 1975 and 1976.

Cropping Intensity

Two crops per year are produced on most of Egypt's crop land. The cropping ratio on the old lands for the 1972-74 cropping seasons averaged 1.89, which represents a relatively high cropping intensity. It has been estimated, however, that a cropping ratio of 2.1 is judged to be feasible by 1985 (Table II. 10). This could probably be brought about by further development of shorter-season or earlier-maturing varieties to permit three crops in some areas. Also, mechanization of seedbed preparation and semimechanization of harvesting and threshing operations would be needed to shorten the turnaround time between crops. Egypt has the resource capability among its agricultural scientists to develop the crop varieties and improved production and harvesting techniques required to reach the higher estimated cropping ratios.

Crop Yields

The improvement in crop yields as seen in Table II. 11 has been generally sustained since the 1960's. However, for most crops, yield gains ranged from very modest to negligible and for sugarcane was negative. Maize and wheat yield

TABLE II. 8

AREA OF INDIVIDUAL VEGETABLE CROPS
FOR THE 1970-74 PERIOD AND FOR 1975 and 1976

Crop	In 1,000 Feddans 1970-74	1975	1976	In Percentage Cash Value 1976
Tomatoes	259	325	308	38.6
Potatoes	86	98	128	19.1
Watermelon	97	16	14	0.9
Marrow	44	46	49	4.9
Cucumber	38	37	35	5.1
Eggplant	23	25	25	2.4
Cabbage	30	34	34	2.2
Green pepper	17	18	20	2.0
Okra	12	11	10	1.2
Common beans*	26	24	27	2.1
Garlic	10	11	12	1.6
Melons	20	111	122	10.2
Peas*	16	18	22	1.1
Cowpeas*	13	35	39	1.9
Cauliflower	8	8	9	0.6
Other Vegetables**	62	78	76	5.4
Vegetable Seed	--	--	--	0.7
Total	761	895	930	100.0
Cash Value, LE (000)	157,508	246,292	319,703	----

* Includes values for the fresh green and dry seed crops.
** Includes some 25 other crops.

Source: Ministry of Agriculture, Agricultural Economics Research Institute.

TABLE II. 9

AREA OF INDIVIDUAL FRUIT CROPS
FOR THE 1970-74 PERIOD AND FOR 1975 and 1976

Crop	In 1,000 Feddans 1970-74	1975	1976	In Percentage Cash Value 1976
Oranges	122	136	152	24.6
Dates*	--	--	--	22.2
Grapes	35	42	46	18.4
Mangoes	24	23	25	8.2
Bananas	11	12	12	9.2
Mandarins	14	15	15	2.1
Guavas	11	13	12	3.7
Limes	9	10	11	1.9
Pears	4	6	7	1.7
Prickly pears	2	2	2	0.9
Figs	7	7	7	0.9
Apricots	4	5	5	0.7
Peaches	2	2	2	0.6
Pomegranates	3	3	3	1.0
Apples	2	4	4	0.8
Other Fruits**	6	5	9	3.1
Total	256	285	312	100.0
Cash Value, LE (000)	60,718	96,361	121,776	-------

* There is no estimate of the date palm area, as palms are commonly scattered in the fields and around villages. Total number of female date palms is estimated at about 5.3 million trees.

** Includes other citrus trees, prunes, olives, almonds, pecans, and others

Source: Ministry of Agriculture, Agricultural Economics Research Institute.

TABLE II. 10

CROP AREAS BY SEASON, LAND AREA, AND CROPPING RATIOS, OLD LANDS
1972-74 AVERAGE AND 1985 PROPOSED LAND AREA

In Thousand Feddans

Item	1972-74 Avg. Old Lands	1985 Proposed Land Area
Permanent Crops*	462	580
Cotton	1,535	1,700
Annual Crops		
Winter**	4,830	5,020
Summer	3,298	3,320
Nili	597	1,130
Total	10,722	11,750
Land Area	5,667	5,600
Cropping Ratio	1.89	2.10

* Orchards, vineyards, sugarcane, excluding dates.
** Including catch-crop clover.

Source: Ministry of Agriculture, Agricultural Economics Research Institute and U. S. Department of Agriculture, Foreign Agricultural Economic Report No. 120, Washington, D. C., June 1976.

TABLE II. 11

YIELD OF MAJOR CROPS BY FIVE-YEAR PERIODS
1960-74 AND FOR 1975, 1976, AND 1977

In Kilograms per Feddan

Crop	1960-64	1965-69	1970-74	1975	1976*	1977*
Cotton	749	793	878	784	839	772
Maize	1,056	1,503	1,557	1,519	1,611	1,660
Wheat	1,086	1,075	1,319	1,459	1,404	1,410
Rice, paddy	2,223	2,102	2,221	2,314	2,398	--
Sorghum	1,431	1,674	1,719	1,585	1,597	1,585
Broadbeans	752	849	989	952	979	920
Barley	1,108	1,012	1,102	1,187	1,185	1,169
Onions(winter)	6,847	7,298	8,126	8,592	--	--
Lentils	621	599	776	676	593	--
Fenugreek	692	683	729	750	--	--
Lupine	673	648	636	655	--	--
Chickpeas	687	677	734	729	--	--
Sugarcane(ton/fd)	39	39	37	36	35	--
Berseem			-not available-			

* Preliminary
Source: Ministry of Agriculture, Agricultural Economic Research Institute

showed the most perceptible progress. Spreading water logging and salinity is a major problem inhibiting yield increases. The adoption of improved seeds is also a critical factor.

Substantial increases in present yields are believed to be technically feasible if the inhibiting factors are alleviated. Projections of yield increases for 1985 were made by an Egyptian-U. S. Agricultural Sector Assessment Team in 1976 and are reported in Table II. 12. The greatest increases in yields are projected for vegetables and fruits. The yield of maize was assumed to increase by 33 percent and for wheat, 25 percent.

Yield Comparisons

How do agricultural yields in Egypt compare with other countries? In a comparison with other national averages, Egyptian yields appear generally high by world standards. However, this overlooks the fact that Egypt has exceptional growing conditions. Further, Egyptian yields are on land that is essentially 100% irrigated while national averages for other countries include substantial amounts of farm areas not fully irrigated. If only irrigated yields are compared, Egyptian yields would have to be considered rather low, taking into account soil potential, temperatures, sunshine and water quality.

When yields are compared with other areas where conditions are similar, Egypt appears to have substantial room for improvement (Table II. 13 and Table II. 14). Table II. 13 compares yields in Egypt with those in California. Egyptian yields are relatively high for wheat, barley, sorghum, and higher for beans and alfalfa/berseem. But for cotton, rice, potatoes, maize, tomatoes and a number of other fruits and vegetables, they are far lower. The California yields shown are statewide averages and include areas not irrigated; moreover, crops in California are

TABLE II. 12

CROP YIELDS OF SELECTED MAJOR CROPS
FOR 1972-74 AND PROJECTED 1985 YIELDS

In Metric Tons per Feddan

Crop	1972-74 Yield	Projected Yield, 1985	Percent Increase
Cotton, lint	0.30	0.30	20
Wheat	1.40	1.75	25
Maize	1.50	2.00	33
Rice, paddy	2.20	2.64	20
Sorghum	1.70	2.04	20
Sugarcane	36	45	25
Catch-crop Clover	12	15	25
Full-term Clover	24	30	25
Sweet Sorghum Fodder	---	18	--
Maize Green Fodder	---	18	--
Barley	1.14	1.37	20
Lentils	0.80	0.96	20
Horsebeans	0.98	1.18	20
Fenugreek	0.74	0.89	20
Flax, seed	0.49	0.59	20
Flax, straw	2.50	3.00	20
Onions	8.86	10.63	20
Vegetables	7.20	10.80	50
Fruits	7.10	9.94	40

Source: U. S. Department of Agriculture, Foreign Agricultural Economic Report No. 120, Washington, D. C., June 1976.

not grown under the same intensive conditions that are possible in Egypt. The rapid rise in wheat yields in Egypt in recent years, when the crop received added fertilizer supplies, suggests that, with proper management, yields of cereals in Egypt could exceed those of California.

Table II. 14 compares Egyptian yields with those in selected other countries. In this comparison, while Egyptian yields are generally high for cotton and cereals, those for fruits and vegetables fall below the output per hectare in some other countries. There are a number of areas of countries where cereal yields are above those of Egypt. This again points to the possibility of yield improvements in Egypt.

TABLE II. 13

COMPARATIVE YIELDS IN EGYPT AND CALIFORNIA
FOR SELECTED CROPS, 1972.

In Kilograms per Feddan

Crop	Egypt*	California**
Rice	2,189	2,540
Wheat	1,304	1,304
Beans	989	710
Potatoes	7,510	14,833
Cotton, unginned	917	673-1,360***
Maize	1,579	2,540-3,000****
Barley	1,169	1,197
Sorghum	1,719	1,829
Alfalfa/Berseem (dried and baled basis)	5,630*****	5,400
Tomatoes - processing	---	23,000
- fresh	5,700	10,000
Carrots	8,600	15,700
Onions	8,600	15,500
Watermelons	---	8,800
Oranges	6,300	7,600
Grapes	4,300	4,600

* Fully irrigated
** State-wide average yields, irrigated and unirrigated
*** 673 extra long staples; 1,360 short staples
**** 3,000 irrigated
***** One-quarter of reported cut berseem yield

Source: Ministry of Agriculture (Egypt), Agricultural Economics Research Institute and California Department of Agriculture.

TABLE II. 14

COMPARATIVE YIELDS OF SELECTED CROPS
IN SELECTED COUNTRIES, 1972

In Kilograms per Hectare

Crop	Egypt*	Japan	Lebanon	Spain
Cotton, seed	2,186	--	--	1,688
Wheat	3,102	2,309	1,092	1,272
Rice	5,334	5,847	--	5,576
Maize	3,747	2,900	1,030	3,597
Vegetables				
Tomatoes	16,000	41,549	13,333	29,232
Broadbeans	2,558	1,222.	1,000	964
Carrots	18,571	41,813	18,182	16,667
Dry Beans	1,739	1,565	1,333	1,537
Cucumbers	13,750	34,305	11,923	21,212
Onions (dry)	20,435	34,375	15,000	24,972

* Discrepancy due to different sources of data

Source: FAO Production Yearbook.

Livestock

The livestock industry in Egypt is not an independent enterprise but part of a mixed farming system. Shortages of forages and other feedstuffs are particularly acute during the summer months and are the basic constraints limiting animal production.

The number of farm animals for selected years is indicated in Table II. 15. There has been an 18 percent increase in the number of cows and buffaloes from 1960 to 1976. In 1976, there were 2.1 million head of cows and 2.2 million buffalo. Sheep number about 1.9 million head and goats, 1.3 million. The population of camels has declined steadily and in 1976 numbered 101 thousand. The number of donkeys was estimated to be 1.4 to 1.5 million head in 1976. The number of chickens in 1976 was estimated at 26.4 million. The total number of animals used for power (cows, buffaloes, camels, horses, mules and donkeys) approaches 8 million.

TABLE II. 15

NUMBER OF LIVESTOCK
SELECTED YEARS, 1960-1976.

In Thousands

Type of Livestock	1960	1966	1970	1974	1975	1976
Cows	1,867	1,608	2,115	2,119	2,102	2,079
Buffaloes	1,781	1,855	2,009	2,170	2,204	2,236
Sheep	2,220	1,855	2,006	1,965	1,926	1,878
Goats	1,583	787	1,155	1,293	1,321	1,349
Camels	184	175	127	109	105	101
Pigs	22	11	15	15	15	15
Horses	47	n.a.	35	32*	n.a.	n.a.
Mules	10	n.a.	6	5*	n.a.	n.a.
Donkeys	1,010	n.a.	1,362	1,400*	n.a.	n.a.

* 1973 values
n.a. = not available

Source: Ministry of Agriculture, Agricultural Economics Research Institute

Quantity and Value of Agricultural Production

The production of major crops and livestock products is detailed in Table II. 16. Five crops account for over 80 percent of the value of crop production and over 40 percent of the total value of agricultural production (Table II. 17). These crops are cotton, berseem, maize, wheat and rice. The data indicate that some important structural changes have occurred. Most significant is that the relative value of cotton at the farm level from 1970 to 1976 has been falling, thus continuing the trend that started in the 1960's. In 1976, cotton amounted to 20 percent of the value of field crops and just over 10 percent of the value of total agricultural production. This trend is important since over 50 percent of Egypt's agricultural exports are made up of cotton. Meanwhile, berseem, which accounted for only 9 percent of the value of field crops in 1960, now accounts for almost one-fourth of the value of crop production, a greater share than cotton. An increased demand for livestock products since 1970 is undoubtedly the major explanation for the expanded clover area. The change to crops to feed livestock was primarily helped by the policy under which a large part of livestock products move through the private sector at prices close to international levels.

Table II. 18 provides more detail about what has happened structurally to the sub-sectors making up total agricultural production. Between 1960 and 1974, the share of the value of field crops fell from 64 percent for the 1960-64 period to 57 percent for the 1970-74 period. The declining trend continued to 52 percent in 1976. During the 1960-76 time period, shares of vegetable and livestock production rose significantly. In 1976, livestock products comprised 28 percent of the total value of agricultural production.

TABLE II. 16

PRODUCTION OF MAJOR CROPS AND LIVESTOCK PRODUCTS
BY FOUR-YEAR PERIODS 1960-74 AND FOR 1975, 1976, 1977

In Thousand Metric Tons

Product	1960-64	1965-69	1970-74	1975*	1976*	1977*
Crops						
Cotton, unginned	1,294	1,337	1,363	1,204	1,248	1,255
Maize	1,783	2,269	2,460	2,781	3,047	2,724
Wheat	1,504	1,363	1,716	2,033	1,960	1,697
Rice, paddy	1,784	2,178	2,435	2,423	2,300	2,270
Sorghum	652	853	847	775	757	647
Broadbeans	282	299	90	234	254	270
Barley	142	112	7,305	118	123	111
Sugarcane	4,722	5,635	50	7,902	8,446	--
Lentils	48	40	20	39	38	24
Fenugreek	39	26	6	24	20	14
Lupine	12	8	6	5	--	--
Chickpeas	8	6	553	4	--	--
Onions	568	594	5,385	572	--	--
Vegetables	3,924	4,885	860	5,815	6,186	--
Citrus Fruit	375	645	361	856	756	--
Dates	414	328	495	415	417	--
Other Fruit	330	376		---	--	--
Livestock Products						
Meat	245	267	294	305	310	--
Milk	1,406	1,517	1,640	1,718	1,749	--
Poultry	77	91	101	113	115	--
Eggs	35	47	54	60	63	--

* Preliminary

Source: Ministry of Agriculture, Agricultural Economics Research Institute.

TABLE II. 17

RELATIVE IMPORTANCE OF MAJOR FIELD CROPS
IN TERMS OF CASH VALUE, 1970-74 AND 1975 AND 1976.

	Percent of Crop Production			Percent of Total Agricultural Production		
Crop	1970-74	1975	1976	1970-74	1975	1976
Cotton	23.8	17.7	20.3	13.7	9.6	10.4
Berseem	23.0	22.9	23.4	13.3	12.4	12.1
Maize	14.3	14.9	14.7	8.2	8.1	7.6
Wheat	12.1	14.1	11.2	6.9	7.7	5.8
Rice	10.0	10.2	10.6	5.7	5.5	5.5
Total	83.2	79.8	80.2	47.8	43.3	41.4

TABLE II. 18

STRUCTURE OF AGRICULTURAL PRODUCTION BY SUB-SECTORS, BY FIVE-YEAR PERIODS 1960-74 AND FOR 1975 AND 1976*.

In Percentage

Sub-Sector	1960-64	1965-69	1970-74	1975	1976
Field Crops	64.3	59.4	57.4	54.2	51.6
Vegetables	8.4	10.7	12.2	13.2	14.5
Fruits	4.7	4.5	4.7	5.1	5.5
Livestock Products	22.6	25.4	25.7	27.5	28.4
Total	100.0	100.0	100.0	100.0	100.0

* Calculated from Ministry of Agriculture data, valued at "farm-gate" prices.

TABLE II. 19

VALUE OF AGRICULTURAL OUTPUT AND VALUE ADDED AT CURRENT PRICES, 1960-74, 1975 AND 1976.

In Million LE

Item					
Plant Production	1960-64	1965-69	1970-74	1975	1976
Field Crops	396	529	744	1,013	1,133
Vegetables	52	95	158	246	320
Fruits	29	40	61	96	122
Sub-Total	477	664	963	1,355	1,575
Animal Production					
Livestock meat	59	101	154	235	284
Dairy	52	80	115	165	210
Poultry & Eggs	26	43	60	108	124
Wool	1	1	2	3	3
Honey	1	1	2	4	4
Sub-Total	139	226	333	515	625
Total	616	890	1,296	1,870	2,200
Cost of Inputs	155	214	343	488	542
Value Added	461	676	953	1,382	1,658

Source: Ministry of Agriculture, Agricultural Economics Research Institute

TABLE II. 20

VALUE OF AGRICULTURAL PRODUCTION, COSTS OF INPUTS, AND VALUE ADDED IN CURRENT PRICES, BY FIVE-YEAR PERIODS AND FOR 1975 AND 1976.

In Million LE

Item	1960-64	1965-69	1970-74	1975	1976
Value of Products					
Plant Production	477	664	963	1,355	1,575
Animal Production	139	226	333	515	625
Total	616	890	1,296	1,870	2,200
Cost of Inputs					
Seeds	22	28	34	53	64
Chemical Fertilizer	32	40	49	63	64
Fuel	5	7	9	11	12
Green Feeds	55	84	168	229	263
Straw	12	19	25	43	39
Concentrates	14	16	18	28	37
Insecticides	9	12	19	32	32
Depreciation	5	6	9	10	10
Others	1	2	12	19	21
Total	155	214	343	488	542
Value Added	461	676	953	1,382	1,658

Source: Ministry of Agriculture, Agricultural Economics Research Institute.

The value of all plant and animal production, the cost of inputs, and the value added are shown in Tables II. 19 and II. 20. Field crops continue to be the dominant component of Egyptian agriculture. At current prices, the value of field crops averaged LE 396 million during the 1960-64 period, LE 774 million in the 1970-74 period, and LE 1,133 million in 1976. In 1976, this represented 72 percent of the value of plant production and 52 percent of the total value of agricultural production.

Agriculture's Role in International Trade

Agricultural products account for most of Egypt's exports. Consequently, international trade and balance of payments are directly linked to the performance of agriculture. Processed and unprocessed agricultural commodities accounted for 87 percent of total commodity exports in 1965 and 1970 (Table II.21). By 1975, this dropped to 76 percent and fell sharply to 63 percent in 1976 and 1977. The recent sharp decline is primarily due to declining cotton production which is the major export crop.

Agricultural imports, not counting paper and wood products, accounted for over one-fourth of Egypt's total commodity imports during the 1970-1976 period, declining to 20 percent in 1977 (Table II. 22). The value of food imports has more than tripled during the last ten years.

Stagnation in cotton production at around 1.4 million tons (unginned) since 1970 combined with increasing local processing, has resulted in a levelling off and subsequent decline in the volume of cotton exports. From 1970 to 1977, reductions in the quantity of cotton exported was more than offset in terms of foreign exchange earnings by the worldwide rise in cotton prices. Should there be a weakening of the world demand for Egyptian cotton, the value of agricultural exports would fall sharply.

Wheat and flour have customarily accounted for about 45 percent of agricultural imports. The population's need for grain since 1975 has forced the import level to 2.5 to 3.0 million tons. It has been estimated that Egypt's wheat imports in 1979 may reach 5.0 million tons, a quantity that would make Egypt the world's leading wheat importing country.*

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* Egyptian Mail, Saturday, July 1, 1978.

TABLE II. 21

QUANTITY AND VALUE OF MAJOR AGRICULTURAL EXPORTS,
1965, 1970, 1975, 1976 AND 1977

(Value in LE Millions)

Product, Unit	1965 Quan.	1965 Val.	1970 Quan.	1970 Val.	1975 Quan.	1975 Val.	1976 Quan.	1976 Val.	1977 Quan.	1977 Val.
Cotton, M. kantars	6.5	146.2	5.7	147.9	3.7	201.1	3.3	154.8	2.9	182.3
Rice, Thou. tons	330.9	19.8	654.4	34.1	99.9	23.8	190.7	29.4	191.3	20.7
Oranges, "	3.4	--	162.2	6.8	209.2	18.5	168.7	18.9	169.7	21.4
Onions, "	159.2	5.6	90.8	5.6	73.6	8.9	71.2	10.2	87.8	11.1
Potatoes, "	44.1	1.2	90.3	3.7	47.6	3.2	157.7	17.2	166.1	16.4
Garlic, "	3.7	0.4	15.4	2.2	15.1	2.4	11.6	2.2	22.4	4.6
Others* --	--	4.5	--	5.3	--	3.9	--	3.5	--	7.2
Sub-Total	--	177.7	--	205.6	--	261.8	--	236.2	--	263.7
Cotton yar, Thou. tons	41.2	31.1	43.4	35.6	32.0	63.0	36.6	57.4	31.8	68.6
Cotton textile, "	14.5	11.7	22.7	18.1	13.9	16.2	14.4	20.1	14.8	24.5
Clothes, "	--	--	4.0	6.2	6.9	30.6	5.4	20.2	5.6	18.4
Sugar, "	14.8	0.6	82.4	3.3	40.4	14.2	39.3	10.0	58.4	10.2
Alcohol, M. liters	--	--	10.1	2.6	13.4	7.0	7.4	3.5	10.1	6.9
Other goods**	--	6.3	--	15.9	--	24.8	--	28.2	--	30.1
Sub-Total	--	49.7	--	82.2	--	155.8	--	139.6	--	158.7
Total Raw&Mfgd goods	--	227.4	--	237.8	--	417.6	--	375.8	--	422.4
Total Value of Exports		261.3		331.0		547.8		595.4		668.4
Percentage of total goods/ total value of exports		87.0		86.9		76.2		63.1		63.2

* Others include melons, groundnuts, fresh tomatoes, and miscellaneous items.
** Other goods include flax fiber, aromatic and medicinal plants and miscellaneous goods.

Source: Central Agency for Public Mobilisation and Statistics

TABLE II. 22

QUANTITY AND VALUE OF SELECTED AGRICULTURAL IMPORTS, 1965, 1970, 1975, 1976, AND 1977

Quantity in Thousands of Ton, Value in LE Millions

Product	Year 1965 Quan.	1965 Val.	1970 Quan.	1970 Val.	1975 Quan.	1975 Val.	1976 Quan.	1976 Val.	1977 Quan.	1977 Val.
Wheat	1,230.0	39.0	850.7	20.6	2,680.6	213.0	2,357.7	153.6	2,419.0	128.6
Wheat flour	610.3	22.6	274.8	7.9	521.4	46.5	404.1	36.4	615.2	49.4
Frozen & Dried Meat	12.7	3.1	5.6	1.3	11.2	4.5	35.6	13.5	46.8	22.9
Raw Wool	2.6	1.9	8.4	4.9	7.0	6.3	7.0	7.2	10.4	15.7
Vegetable Products*	38.5	5.0	99.6	13.0	160.2	17.2	148.1	16.7	85.1	11.5
Animal Grease & Oil	51.5	4.9	45.4	3.6	134.1	22.8	164.5	28.4	155.2	26.1
Tea	28.7	13.1	29.8	10.4	23.7	12.6	24.9	14.7	26.2	26.3
Tobacco	14.6	8.1	13.9	7.4	26.0	20.5	23.0	24.7	29.0	33.8
Cane sugar, refined	n.a.	n.a.	n.a.	n.a.	133.2	32.1	164.7	23.8	157.6	16.8
Maize	n.a.	n.a.	n.a.	n.a.	417.6	27.1	458.9	30.8	590.9	30.0
Others**	--	17.5	--	17.3	--	15.8	--	18.2	--	19.7
Total	--	115.2	--	86.4		418.4	--	368.0	--	380.8
Total Value of Imports		405.9		342.0		1,539.3		1,489.9		1,884.3
Percentage of Total/ Total Value of Imports		28.4		25.3		27.2		24.7		20.2

* Vegetable Products include sesame, dried beans, and lentils.
** Others include potatoes for seed, coffee, and miscellaneous items.

Source: Central Agency for Public Mobilisation and Statistics

The increased value of exports in 1970-1977 was due primarily to higher cost prices. Similarly, the increase in imports in recent years reflects almost entirely an increase in international prices particularly of food. The sharp increase in foreign exchange expenditures for food severely limits Egypt's capacity to import capital goods. Inadequate imports of intermediate goods accentuates the underutilization of productive capacity both in agriculture and industry.

Despite severe shortages of foreign exchange, Egypt imported the following proportions (quantity) of main foods consumed in recent years:

	Percent		Percent
Wheat	40	Lamb	2
Maize	2	Poultry	6
Lentils	11	Fish	4
Sesame	35	Milk	4
Beef	22	Cotton seed oil	54

Compared with these imports, Egypt exports a sizeable fraction of its proportion of other foods:

	Percent		Percent
Rice	15	Onions	25
Refined sugar	9	Citrus	22
Peanuts	45	Other fresh and Processed vegetables	21

Summary

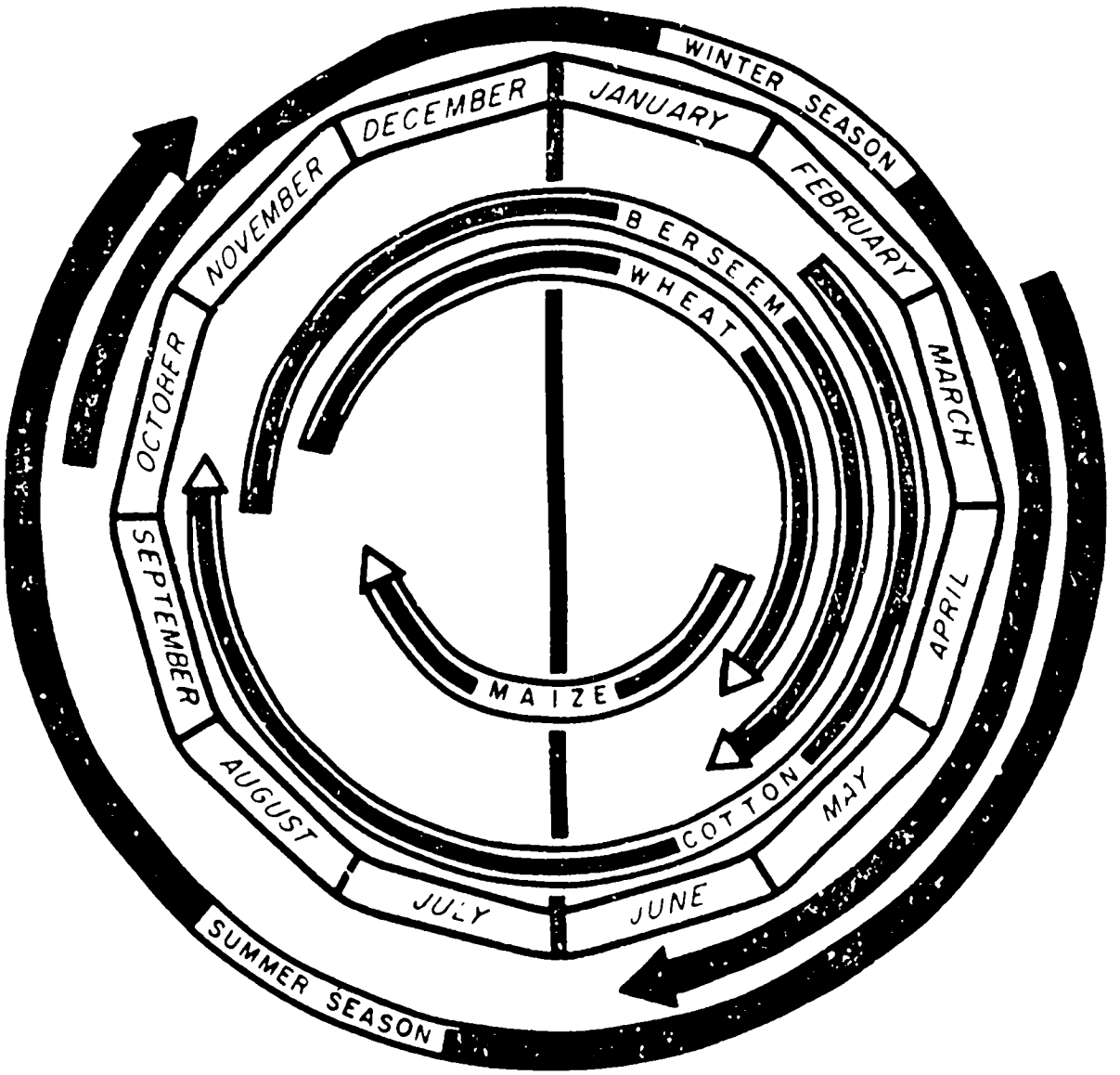
Unlike temperate zone, unirrigated agriculture, multiple cropping is the rule in Egypt. Theoretically, the soil could be occupied by a growing or maturing crop 365 days a year. The limited land base demands that full utilization of land take place. With abundant sunshine and a reliable, year-round water supply, the basic constraint at the farm is the ability to get tasks accomplished (whether

plowing, planting, harvesting, etc.) in a timely manner. Delays in completing the harvest of one crop results in delayed planting and reduced yield in a subsequent crop. Further, because of the nature of year-round production and a complex rotation scheme, it usually is not possible to examine the impact of a decision with regard to a single crop. For example, the decision to increase the cotton area (i.e., a summer crop) means that catch crop berseem (a winter crop) will also be increased. When specific trade-offs are evaluated in the report, their interconnections are clearly identified. The reader can gain an initial insight into the nature of land use in Egypt by examining Figure II. 1. Clearly, a complex pattern of land use requires special care in analysis and places a premium on planning and timeliness of operations for farmers.

The remaining sections of this report deal with a further evaluation of mechanization needs in Egypt, with the mechanization program developed by the Study Team, the economic evaluation of the program and a timetable for implementation.

FIGURE II. 1

THE CROP YEAR FOR A TYPICAL EGYPTIAN FARM IN THE CORN BELT



CHAPTER III

CURRENT SITUATION

Introduction

Many situational factors condition the current climate for mechanization of Egyptian agriculture. The present analysis identifies those factors that are of special significance. Each is discussed in more detail in later portions of this report, as are other aspects of the current situation particularly relevant to the Study Team's recommended near-term mechanization program.

Farm Labor Balance

Pushed by spiraling farm wage rates and seasonal labor shortages, Egyptian farmers small and large look to mechanization to overcome their crop production bottlenecks. Wage rates tripled between late 1973 and mid-1978 after having remained virtually unchanged throughout most of the preceding decade (Fig. III. 1). This apparently continuing sharp upward trend far outstripped the rise in prices received by farmers and the Rural Consumers Price Index (Table III. 1). As the wage rate increases signify, the demand for seasonal workers has pressed ever harder upon available supplies until now there are periodic shortages during peak seasons (Fig. III. 2). In these circumstances it is hardly surprising that the overwhelming majority of those interviewed in the survey of farmer's attitudes toward mechanization, conducted as part of the present study expressed themselves to be strongly in favor of further mechanization (Chap. VIII). Three quarters of

those respondents complained about the shortage of labor with the smallest farmers those cultivating less than 3 feddans and apparently the hardest hit by the scarcity of seasonal.

TABLE III. 1

INCREASES IN FARM WAGE RATES, PRODUCT PRICES AND RURAL COST OF LIVING, 1968 - 78

Period	Man-day Wage Rate*		Rural Consumers' Price Index[1]	Index of farm-gate prices received[2]	
	Actual	Index		Cotton	Maize
1968-71	25.3	100	100	100	100
1973	28.5	113	111	106	137
1974	35.1	139	128	128	154
1975	46.5	184	142	139	136
1976	61.6	244	160	179	152
1977	76.0	300	175	190	174
Jan.-June 1978	88.0	348	202(March)	-	-
July-Sept. 1978	90.0	356	-	-	-

1/ Source: Central Agency for Public Mobilization & Statistics

2/ Source: Agricultural Economics Research Institute, Ministry of Agriculture

That farmers and those who work closely with farmers believe Egyptian agriculture is today plagued with seasonal labor "shortages" was further evidenced by the Study Team's field contacts in the summer of 1978. Farmers, co-op managers, bankers, businessmen or whoever else they met complained of labor shortages and pointed to delays in wheat harvest or/and other peak season operations as evidence of the consequences to crop production of labor scarcity. The Arab Federation of Agricultural Workers which supplies contract workers for canal clearing and New Lands operations cites various examples of contracts it was unable to fill during 1978. Although not in itself conclusive evidence of cause and effect, it seems reasonable to infer that the strikingly lower cropping intensity on farms with more

FIGURE III. 1

FARM WAGE RATES AND RURAL CONSUMERS' PRICE INDEXES
AND FARM GATE PRICES
1973 - September 1978

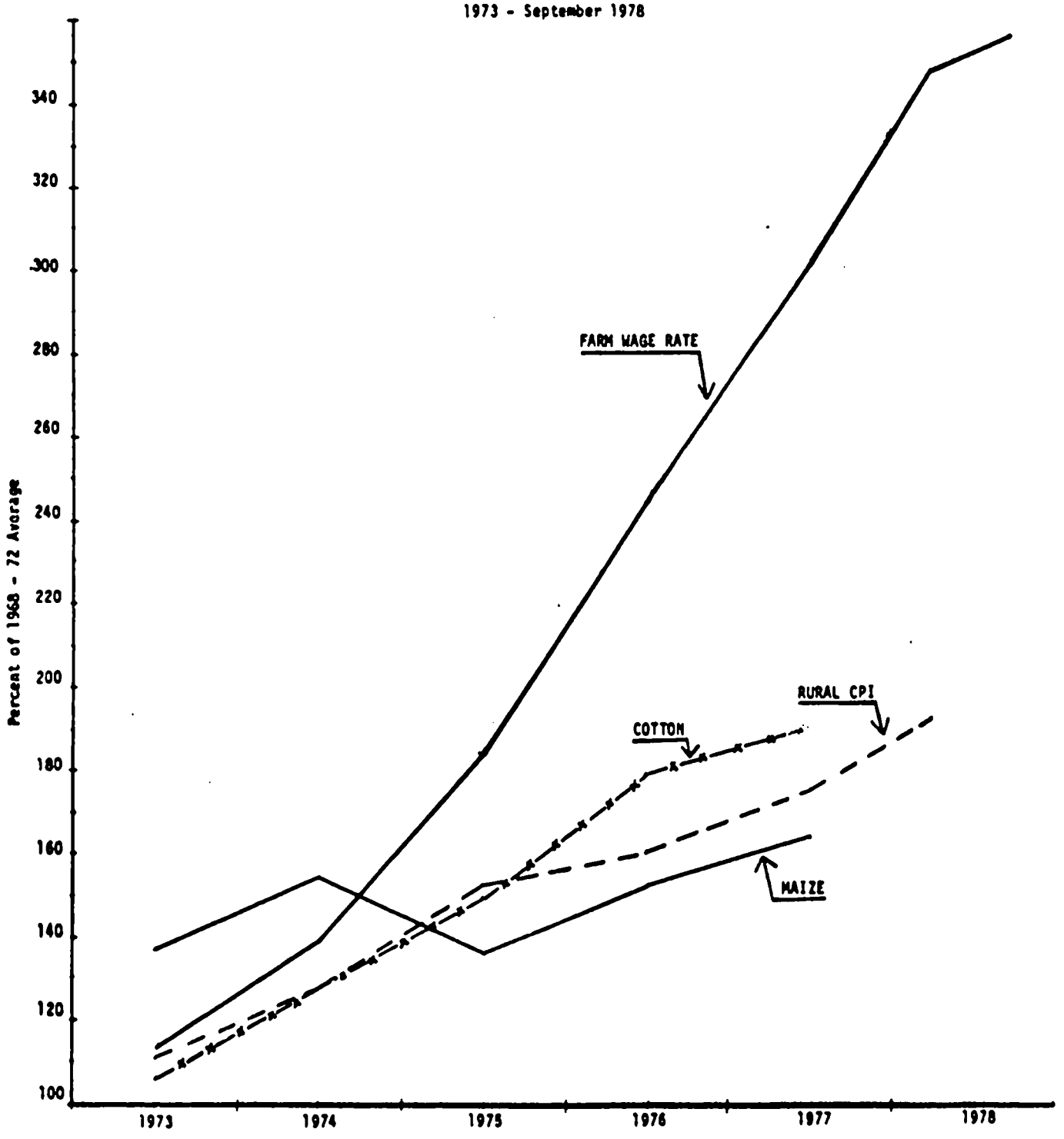
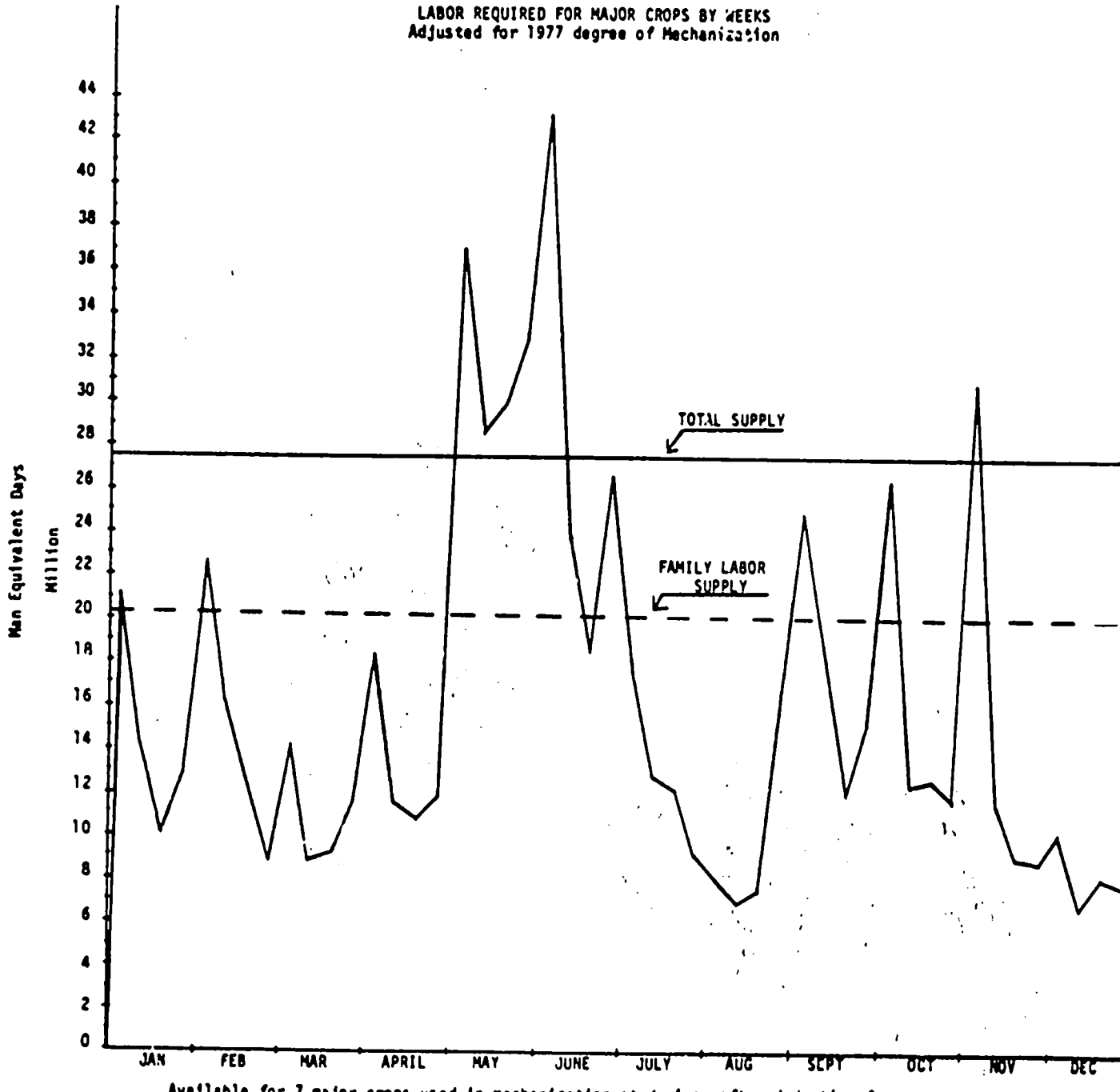


FIGURE III. 2

LABOR REQUIRED FOR MAJOR CROPS BY WEEKS
Adjusted for 1977 degree of Mechanization



Available for 7 major crops used in mechanization study i.e. after deduction for other field crops, vegetables and non-crop activities such as animal keeping.

than 20 feddans of cultivated area is related to the supply of farm labor and custom tractor services.

Although is it hard to understand why without more information about the circumstances of each farm unit than is now available, results of the Farm Management Survey carried out as part of the present study indicate that even very small farmers use a surprisingly high percentage of hired workers. This is markedly the case with two highly labor-intensive cotton production operations: manual pest control and harvesting, both of which typically are performed by gangs of children, youth and women, which in Egypt are called the "boy labor" work force. Pest control, hand picking of leaf worm egg masses, almost has to be done on a mass production basis. Besides tradition, what prompts farmers, with only one-half or even one feddan of cotton, to hire their picking done in a few hours rather than using family labor over a longer time span is less than obvious. In any event, it would be wrong to assume that scarcity of workers and rising farm wage rates affect only the big farmers.

As evidenced by Figure III. 2, Egypt's farm labor requirements are highly seasonal. This inevitably leads to periods of high labor demands during the summer and fall peak seasons and gross underemployment of the farm labor force during the rest of the year. Agronomic realism together with cotton acreage quotas designed to optimize national export earnings hold Egyptian farmers rather tightly to a traditional crop rotation system. Consequently there is limited scope for them, individually or collectively, to adjust acreage among crops to even out labor requirements over the 12-month growing season. Wheat and berseem are the only feasible large-scale winter crops; cotton cannot follow wheat without severe loss in yield. Consequently the only real choice, outside the rice-growing area of the Delta and the sugar cane region of Upper Egypt, is between cotton and maize

as a summer crop. Delta rice growers have the added option of rice vs. cotton or maize but economic advantage prompts them to keep about one third of their land in rice. In Upper and Middle Egypt, grain sorgum and beans are widely grown as food crops instead of maize, but afford little more opportunity for spreading labor requirements than do the crop combinations typical of Lower Egypt. As sugar cane is a perennial, kept for 2-5 ratoon cuttings after establishment, the only practicable alternatives open to farmers in the cane-growing area is growing or not growing sugar cane.

Principally responsible for the increasing scarcity of farm workers and the sharply escalating wage rates is the rapid rise since 1973 in the number of Egyptian workers who have moved to higher paying employment in construction work abroad, mainly in the Gulf States and Lybia. How much of this movement has been directly from farm work to foreign employment and how much to filling in behind non-farm workers who took employment outside Egypt is not known. Whichever the course, external migration coupled with increased non-farm employment opportunities within the country clearly have made a significant dent in the Egyptian farm labor supply. Just how much the farm labor force has been reduced during the past five to six years is not precisely known. The 1976 Census reported 1,425,000 Egyptians (including dependents) living abroad. As construction workers usually go abroad without dependents, it seems likely that this total may include well over one million adult males, although estimates vary. For example, based on the decline in membership, the Arab Federation of Agricultural Workers, whose members primarily include individuals engaged directly or indirectly in agriculture, estimates that between 750,000 and 1.5 million agricultural workers went abroad or into domestic non-farm employment between late 1973 and mid-1978. Other sources place the overall reduction in farm workers between 400,000 and 1 million. An MIT study in

preparation estimates the total flow abroad between 1966 and 1976 averaged about 135,000 per year. Including internal migration, the Study Team estimates that an average of 230,000 persons per year left Egyptian farms between 1966 and 1976.

National Policies

Differing significantly in the ways they condition the current climate for farm mechanization are four national policies of particular significance to mechanization program planning: food security, farm product and input pricing, import regulation and the use of cooperatives as instruments of government intervention. Overall, Egypt is struggling determinedly toward an open economy with as yet mixed success. One recent commentator on recent developments in Egyptian agriculture summarized the country's journey from its experiment with socialism in the 1960s to the present in these terms:

> "The market is re-emerging in Egypt as a kind of idol ... it appears that with the mixed results of the first five-year plan (1960-1965), the scrapping of the second five-year plan, the external payments crises and the June War of 1967, the economy as a whole ground to a halt. A kind of strategic drift set in that has prevailed until today. How Egypt intends to exploit maximally all its resources has been debated and analyzed and various interests, domestic and foreign, have offered advice and recommendations. But despite Sadat's advocacy of the economic open door policy, the new direction has not been translated into a coherent set of programs and policies. This drift, or laisser aller, has made itself felt among administrators and administratees with inevitably deleterious effects upon production in all sectors."*

However accurate or inaccurate this interpretation may be, Egyptian policy with respect to agriculture in general is in a state of transition. How far this transition has progressed and the direction(s) in which it is proceeding are critical factors in assessing mechanization strategy alternatives.

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* "Egypt's Agriculture: Administered Prices and State Intervention" by John Waterbury in "Common Ground" vol 4 No. 2 (1978).

Food Security

"Food Security" stands today as a priority national goal and policy intended to give maximum impetus to increasing farm production. The current interest among policy makers and planners in speeding the pace of agricultural mechnization stems in large part from high concern over the rapidly growing pressure of population among severely limited land resources. Relief from that long-standing problem provided by completion of the High Dam at Aswan in 1965 has now been exhausted. For a variety of physical and economic reasons, crop yields have stagnated over the past several years. Bringing the New Lands into efficient production has proven to be more drawn out and considerably more expensive than was anticipated. Fed by rising consumer demand and higher world prices as well as a growing and more urbanized population, the total cost of imports of agricultural products has tripled since the early 1970s. Thus the 1978-82 Five Year Plan understandably makes "Food Security" the centerpiece of national strategy for the agricultural sector.*

In the Plan, mechanization is looked to as one of the principal means for furthering food security objectives. Mechanization is seen mainly as a means of avoiding further deterioration in the rate of increase in agricultural production by offsetting the effects of labor shortage and rapidly rising wage rates engendered by the heavy external migration of Egyptian workers. Beyond describing the "labor shortage" problem and pointing to mechanization as a means of ameliorating it, the Plan gives little indication of how mechanization is expected to accomplish this task. Subsequently, however, the Ministry of Agriculture has defined specific objectives of agricultural mechanization and charted broad approaches to achieving them. Even so, there is yet neither a coherent set of policies and programs which translates these objectives into implementable activities nor a mechanism for

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* The Five-Year Plan, 1978-82; Vol. 4 "The General Strategy for Agriculture, Irrigation,and Food Security," Arab Ministry of Planning, Cairo (August, 1977).

making them effective at various administrative levels.

Further reducing the effective farm labor force in recent years has been the shrinking proportion of women and children who participate in farming operations. In the 1961 Census of Agriculture, the most recent farm labor force enumeration available, farm operators' wives and children under 18 years of age comprised 45 percent of all family workers. Data from the 1978 Farm Management Survey indicate that today only a fraction of such family members regularly engage in farm work. While there are no comparable data available on "temporary hired workers," it seems reasonable to expect that the same economic and social forces likewise have lowered participation among the women and children in that component of the overall farm labor force.

Remittances by farm workers going abroad and into "temporary" non-farm employment domestically has no doubt played a significant part in reducing participation rates over the past five years. Such remittances are estimated to have totaled $1.2 billion in 1977, making expatriate workers Egypt's biggest single source of foreign exchange.

In terms of purchasing power, the average daily wage rate for hired farm workers nearly doubled between 1973 and 1978. And, though still quite low for the bulk of Egyptian rural families, farm income has improved considerably since 1973. In such circumstances, it is characteristic in Egypt for women and children to progressively withdraw from farm work.

Product and Input Pricing

Farm product and input pricing policies exert a strong and pervasive influence on the crops grown and the income received from the farmers' production efforts.

Consequently these policies go far towards determining the farmers' ability to mechanize their farming operations. In general, Egypt's system of administered prices, procurement quotas on export crops and heavily subsidized farm production input prices has for years effectively taxed crop production on the Old Lands to provide export earnings and domestic revenues for expanding industrialization and development of the New Lands. In practical terms, this has meant lower net returns from controlled crops than would be indicated by their international market value. Commenting in 1975 upon the effect of then-current farm product prices, the Under-Secretary for Economics and Statistics stated in part:

> "It should be noted that there is a continuous increase in prices up to 1974 in all major commodities, yet taking into consideration all existing economic factors, (including) increase in international prices, it can be stated that the farmer did not receive an equitable price for his crop especially cotton, broad beans, lentils, rice and sugar cane".*

In addition to fixed prices, government until recently also levied procurement quotas on all major crops. This had the effect of both defining the crops a farmer practicably could grown and his access to the generally more profitable free market.

Since 1975, farm product proces have been adjusted upward from time to time due to what Hindy earlier had referred to as:

> "... some problems ... due to low fixed prices for the farmers. This has shown itself in the resentment of farmers to expand the area of cotton and rice. Relatively low prices of beans, lentils and sesame have shown their effect in the continuous decrease in area and production in recent years. The increase in sugar cane did not keep pace with the Plan."**

More importantly there has been some relaxation in procurement regulations and (unofficially) in the strictness with which quotas are enforced. Waterbury claims

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* "A Short Note on the Agricultural Prices and Subsidies in the Arab Republic of Egypt", Mohamed K. Hindy, May 1975.

** Ibid.

that even in 1974-75, rice farmers generally disregarded procurement quotas and sold more than three quarters of their rice on the open market with a consequent decrease in the quantity available for export.* Crops currently under administered pricing and procurement quotas are indicated in Table III. 2. Note that cotton

TABLE III. 2

PROCUREMENT QUOTA RATES APPLICABLE TO SPECIFIED CROPS FOR 1978 CROP YEAR[1]

Cotton	:	whole yield.
Rice	:	1.5 ton/fedd. for all counties except Abu el Matamir and Kafr Sadd for quota is 1 ton/fedd.
Sugarcane	:	depends upon sugar industry operation capacity.
Wheat	:	no quota for white varieties (a very recent change in regulations), and a 4.5-7 ardab 1 fedd. for brown varieties based on counties variations of average feddan yields.
Onions	:	6 ton/fedd. for Fayoum, 4 ton/fedd. for Almenia, 7 ton/fedd. for Asuit and Kena, and 8 ton/fedd. for Sohag.
Horsebeans	:	2 - 2.5 ardab/fedd. based on average yield per feddan variations.
Peanuts	:	4.5 - 8 ardab/fedd. based on average yield per feddan variations.
Lentils	:	2 ardab/fedd.

1/ Source: Files of Institute of Agricultural Economics Research and Statistics, Ministry of Agriculture.

is the only crop subject to total-production procurement. This policy can be effectively applied as there is no domestic market for locally-produced cotton. Thus, through acreage quotas, procurement quotas and administered prices the

* Waterbury, op. cit.

government essentially determines farmers' income from roughly one third of all cultivated land.* And, notwithstanding incremental increases in its procurement price over the past several years, the average price received by farmers for cotton is still less than half its export value reduced to a farm-gate equivalent. As further mechanization of farming operations inevitably is a function its profitability, it is not too much to expect that as the farm-gate price of cotton goes so too will the pace of mechanization go.

On the production input side government intervention is no less pervasive and influential than on that of product pricing and procurement. In 1975, Hindy summarized then-current government policy with respect to direct subsidies as follows:

> "The Government subsidizes the farmer in three main areas. First, the farmers are provided with better variety and improved seeds at a price below cost. Second, the Government shares the cost of controlling cotton leaf worm and the boll worm infesting the cotton crop. Third, the Government is fixing the price of fertilizers bought by the farmers at the same level the farmer had to pay since 1960 up to the present time even after the recent increase in international prices in 1973-75".**

As indicated by Table III. 3, subsidies on imported nitrogenous fertilizers were reduced sharply in 1977. That locally-produced nitrogenous and phosphorous fertilizer prices were raised at the same time suggests the change was aimed at encouraging local production rather than reducing fertilizer usage. Since 1975, imported livestock feed ingredients, mainly maize, have also been subsidized to offset the rise in international market prices that began in 1976.

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* It should not be inferred that every farmer finds returns from one third of his crop land so controlled in any given year. The 1978 Farm Management Survey found only 56 percent of all farmers interviewed growing any cotton. And, contrary to Waterbury's assumption that middle-sized land owners find ways around the cotton production regulations more frequently than do small ones, cotton comprised 17 percent of all crops grown on farms with over 5 feddans of cultivated lands compared with 14 percent on those will less than 2 feddans.

** Hindy, op. cit.

TABLE III. 3

SUBSIDIES ON SPECIFIED CROP PRODUCTION INPUTS[1]
TOTAL COST AND AS PERCENT OF LOCAL VALUE

Year	Fertilizers				Cotton Pest Control	
	Nitrogenous		P_2O_5			
	Imported	Locally Produced	Total	Locally Produced	Cost per Feddan[2]	State Share
	LE	Percent	LE	LE	LE	Percent
1974	94	5	99	23	26.2	50
1975	131	7	139	26	32.0	59
1976	53	4	57	18	32.0	59
1977[3]	73	8	15	23	NA	NA

1 Local values of fertilizers based on local producer prices of LE 2.150 per 100 kg for nitrogenous fertilizer with 15.5%N and LE 1.550 per 100 kg of phosphorous fertilizer with 15% P_2O_5. All phosphorous fertilizers are locally produced.

2 Since 1974 cost to farmers has been held constant at LE 13.1 per feddan.

3 Preliminary estimate.

Source: Derived from a report by the Undersecretary for Economics and Statistics Affairs, Ministry of Agriculture.

In addition to direct subsidies, the prices farmers pay for several other input items are subsidized indirectly to varying degrees (Table III. 4). In-kind crop-season production loans are made by the Agricultural Credit Bank at 4 percent as contrasted with the 10 percent or higher interest charged for intermediate and longer-term agricultural credits. Until mid-1978, tractors could be imported from several Eastern-bloc bilateral agreement countries at the official rate of exchange. When such imports were put on the "incentive" exchange rate, the effect

TABLE III. 4

DIRECT AND INDIRECT SUBSIDIES ON PRODUCTION INPUTS FOR SPECIFIED MAJOR CROPS, 1975

Crop	Direct Subsidy	Customs[1] Exemption	Exchange Rate	Total	
				Per Feddan	Per unit of product
	LE per feddan			LE	LE
Cotton[2]	20.53	6.23	22.40	49.16	8.94
Wheat	1.25	1.31	4.88	7.44	.79
Maize	1.30	1.40	5.20	7.90	.72
Sugar cane	3.04	2.80	10.40	16.20	.45
Rice	.82	.70	2.60	4.12	1.93

1 Customs taxes for fertilizer or pest control chemicals are 27 percent of import price. Additional costs borne by government for management and transportation come to 21 percent of the import price of fertilizers and 40 percent per pest control chemicals.

2 Includes following per feddan totals for pest control chemicals: direct subsidies LE 19.00, customs exemption LE 5.00 and exchange rate differential LE 17.80.

Source: Derived from data supplied by Institute for Agricultural Economics Research and Statistics, MOA.

was to nearly double the cost to Egyptian farmers of Yugoslav or Czech tractors. Now, only imports from two bilateral countries, Russia and East Germany, remain on the "official" exchange rate.

As noted earlier, tractors imported by the cooperatives are exempt from customs duties as are motors for irrigation pumps imported from India and a few other countries. Interestingly enough, all imported spare parts for farm machinery regardless of source are subject to custom duties. Those for pest

control equipment, however, may be imported at the official rate of exchange of Pt39 to the dollar rather than the "incentive" rate which is approximately Pt70 to the dollar.

Needless to say, the preceding paragraphs do not fully reveal all the ways in which government intervention influences farmers' production decisions. While not all of these interventions directly affect farmers' ability to invest in additional mechanization, presence of the system of administered prices and production quotas in and of itself necessarily dampens their enthusiasm for technological innovation. Government currently appears to be moving toward a free market agricultural economy. Under the best of circumstances, however, that process will be prolonged and steps taken toward that end are likely to be unsettling in the near term.

Open-Door Policy

With its widespread relaxation of controls over imports, the "Open-Door Policy" of 1973 already has significantly increased the pace of agricultural mechanization. By its philosophy with respect to government intervention in general, this policy has profound implications for future mechanization strategy. In particular, it implies that private enterprise is to be encouraged to take up much of the decision-making burden previously placed upon the government bureaucracy.

Evidence of the effectiveness of this policy in achieving its intended results are easily found in the farm mechanization field. After resting on a low-level plateau for several years, tractor imports tripled from 1974 to 1977. Egyptian entrepreneurs and foreign tractor and implement companies alike are vying for what they believe to be a rapidly expanding market. Although yet largely at the planning stage, interests of foreign manufacturers in joint ventures with Egyptian

firms to produce, market and/or service agricultural equipment is prompting Egyptian enterprises, both public and private, alone or in concert with foreign manufacturers and dealers, to search out ways of increasing their own effectiveness in meeting the needs of rural Egypt.

By strengthening a rising trend toward privately operated custom tractor services, the Open-Door Policy is reducing the need for government intervention through the cooperatives to supply such services. In some localities, private custom operators already are giving the co-ops strong competition. The co-ops are either striving to improve their services to meet that competition or, with their over-age equipment, abandoning the field to private entrepreneurs. However, the total number of tractors is still too small for this situation to become widespread. In the prevailing sellers' market the availability of co-op custom services appears to stabilize custom hire rates, some say at a level lower than is necessary to encourage advantageous expansion of private custom services. Many co-ops reportedly charge rates insufficient to cover costs including reasonable depreciation.

While responsible Government leaders worry about the large number of co-op tractors that have been allowed to become inoperable, the generally low quality of maintenance and low utilization of those which are serviceable, there is today no coherent Government policy with respect to the role of co-op-owned custom tractor services in the changed circumstances favoring private enterprise. In fact, the co-ops appear to have become victims of benign neglect. Over time, national interests might best be served by those cooperatives that cannot compete on a businesslike basis with private suppliers relinquishing custom work. In the meantime co-ops collectively own roughly one-fifth of Egypt's farm tractors, a national as

well as a co-op asset. And, as previously indicated, they can play a rate-stabilizing role in a tractor-short economy. Consequently, government posture vis-a-vis co-op-supplied custom services is one of the unsettled policy questions with which mechanization planning must deal as a matter of considerable urgency.

In addition to the custom-hire tractor field, Egypt's determined shift toward a market economy has particular significance with respect to three other areas of farm mechanization. The about-to-be-concluded Massey Ferguson/NASCO private sector joint venture for domestic production of farm tractors signals Government preference for private development of the farm machinery industry. On another front, MOA planning with respect to upgrading farm machinery repair and service facilities has focused explicitly on ways and means of achieving that end through private initiative. The third aspect alluded to concerns land leveling for more efficient irrigation. One deterrent to the Soil Amelioration Organization's taking a more aggressive approach in meeting this self-evident need is the amount of time and effort entailed. In discussions with Study Team members, officials of that organization viewed encouragement of private custom operators as the most advantageous way of treating the one million or so feddans of land that are sorely in need of precision leveling. It is doubtful that prior to 1973 the SAO would have considered being a catalyst to private initiative, much less an ardent champion of its playing precisely that role in the years ahead.

Considering its comparative recency, it is perhaps not surprising that the spirit of the Open-Door Policy pervading Cairo loses much of its strength on the way through the bureaucracy to the local community. This may be what Waterbury referred to as "the drift (which) has made itself felt among administrators and administratees with inevitably deleterious effects upon production in all sectors."*

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* Waterbury, op. cit., p.34

In the farm mechanization area at least, the problem appears more an inadequate means of communication and an as yet only loosely formulated and poorly articulated strategy than lack of vision and determination on the part of responsible leadership. These constraints as well as the philosophy of decontrol which they render more or less ineffective are realities which mechanization planning cannot disregard.

Regulations

Whatever policies a national government pursues, it is the body of regulations and rules concerning day-to-day administration that mainly determines how those policies are given practical effect. To expedite the reduction of government intervention in farm mechanization, a number of Egypt's significant regulations have been relaxed or removed informally during the past eighteen months. Discontinuing the licensing of tractor imports and removal of the 20-feddan requirement for purchase are cases in point. The difficulty with such informal changes in regulations is that the revisions are not applied uniformly. Thus, for example, the Agricultural Credit Bank ostensibly still makes ownership of 20-feddans of land a precondition to loan for tractor purchase. Leaving the application of regulations to the discretion of various administrative entities inevitably leads to real or imagined favoritism with obvious consequences to public regard for government. More importantly, differential application of regulations creates uncertainty, the bane of investment decision-making.

"Regulations" are brought into the present discussion only to stress the necessity for mechanization program planners to look beyond broad policies in estimating how any proposed innovation would likely fare in the prevailing

Egyptian administrative environment. A few case illustrations beyond that of the 20-feddan criterion for tractor loans already cited will adequately serve that purpose. One of particular significance to the development of dealer-associated service facilities is the narrow margin which Government allows private dealers handling NASCO-assembled tractors. That margin gives dealers no incentive for localizing either their outlets or their after-sales service capabilities.

Perhaps the most deleterious set of regulations affecting machinery maintenance is that which the co-op system applies to the repair of their tractors. In concept, the related procedures are laudable as they are ostensibly designed to give local co-ops ready access to spare parts and minimize opportunity for profiteering by their managers. In practice, however, the control aspect seems to dominate. As a result, the time and red tape involved in obtaining parts is said to discourage many local co-ops from making repairs that would keep their machines in operation. At a minimum, down-time reportedly is excessive. Much the same outcome results from NASCO's administrative practice of selling spare parts only to purchasers of their tractors. This reportedly is intended to minimize the black-marketing of parts. Desirable as that objective may be, NASCO's method of furthering it deprives owners of other tractors needing repair of access to the best organized source of tractor parts currently in existence.

Also worth mentioning in this context are two regulations/practices that restrict tractor sales. One is quite recent, having been promulgated in August 1978; it shuts, at least temporarily, the "open door" so far as private import of assembled farm tractors in the 45-65 hp range is concerned. This regulation is intended principally to relieve the substantial backlog of prior imports remaining unsold in dealers hands and to stabilize a market flooded by speculative imports following relaxation of controls in 1973. Not coincidentially, the

reference regulation reinstitutes import controls on the particular size of tractor the new Massey Ferguson/NASCO plant will start producing in 1981. The interim controls on importation will facilitate that local industry's entering the Egyptian tractor market. As they can be lifted at MOA discretion, either before or after the Massey Ferguson/NASCO plant begins production and are stated to apply for only three years, these could enable the selective admission of a few foreign-manufactured lines to keep the now-endemic proliferation of spare parts requirements within bounds while providing the economy the benefit of competition in farm tractors. Under present mechanization program leadership there is no reason to doubt that the discretionary feature of the 1978 import regulation will be so applied, while maintaining adequate pressure of supplies upon effective demand and enabling local manufacture to become established. Nonetheless, the risk exists that import controls might be employed again to hold down the number of farm tractors below the level required for optimal mechanization. In that event, a national mechanization program based on the assumption of higher tractor density would necessarily fall short of realizing expectations.

The second set of rules now limiting tractor purchases concerns the supply of loan funds made available by the Central Bank to the agricultural credit system. As early as October 1978, field contacts made by Study Team members indicated that Village Banks generally had exhausted their allocations for the remainder of the year and had backlogs of applications for tractor loans awaiting new funds after the first of the year.* Officials of the Principal Bank for Development and Agriculture estimated that with LE20 million additional loan funds, they could make 2000 more tractor loans in 1979 than present prospective resources will permit. Warding off excessive inflation must continue to be a priority national concern. In that light, anticipating how the Central Bank will

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* See Chapter XXII

treat agricultural sector lending assumes high significance in planning for future farm mechanization.

Stage of Mechanization

In Egypt today, farm mechanization is limited largely to tractorization of primary tillage and the threshing of wheat and rice. Eighty percent of all farmers still depend upon animal-powered sakias or man-powered tambours for lifting irrigation water. Even primary tillage and threshing operations are far from fully mechanized. Although about 70 percent of all farmers use custom-hire tractors for some plowing, there are only enough operable tractors available to cover 40 percent of the total area plowed each year. Consequently, even farmers who use custom tractor service necessarily depend upon animal drawn baladi plows, drags and hand methods for seed bed preparation operations beyond initial plowing. Indications are that with the general shortage of draft power and high farm wage rates, some farmers are foregoing the typical second plowing and others are skimping on seed bed preparation. And some larger operators appear to forego planting of a second crop. Either of these means of economizing available power and labor obviously takes a toll of national farm production. It also follows that until substantially more tractors are available little progress can be expected toward yield-increasing mechanization of even additional tillage operations.

As for threshers, mechanization is similarly "partial" in both kind and degree. Over all, about half of all farm operators are reported to use tractor-powered drum threshers; another 10 - 40 percent, depending upon the kind of crop, use a tractor-drawn variant of the traditional animal-drawn norag. Drum threshers are used much more extensively for wheat and tractor-drawn sledges for rice. Reasons given are that rice threshes more easily and is much more

subject to being cracked by drum threshing; also, wheat straw has to be pulverized for cattle feed while rice straw is generally not fed to animals. These grain-threshing methods produce only partial mechanization since winnowing remains to be done by hand. Using tractors for threshing reduces the already short supply of tractor power available for plowing or other seed bed preparation operations. Although modification of the IRRI-type self-powered thresher-winnower to fit Egyptian farm conditions has been under way for four years, and a few prototypes were field tested on grain sorgum in the fall of 1978, no thresher-winnowers are in general usage.

In the Study Team's judgment, a combination of low tractor density and poor understanding of how best to utilize tractor power to increase production are chiefly responsible for the existing suboptimal mechanization of tillage operations.* Currently, Egypt has only one operable farm tractor for each 475 feddans of cropped area. This translates into roughly .20HP per feddan of cultivated land area, less than half the level already achieved by the more advanced developing countries. In many areas, notably Upper Egypt, current tractor density is well below the national average. A significant consequence of low tractor density is the farmers' apparent willingness to wait for custom tractor plowing even at the expense of getting their crops, particularly maize, planted late with resulting lowered yields. That custom tractor plowing is both cheaper and faster than preparing land entirely with animal-drawn equipment and hand labor no doubt weighs heavily in such decisions. So, too, is the general scarcity of labor and power during the summer peak period when harvest, land preparation, and crop cultivation all require attention at the same time.

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* For further discussion of tractor numbers and size considerations, replacing sakias with motor-driven pumpsets and mechanizing threshing operations, see Chapters X and XII.

With respect to water lifting, the slow rate at which motor-driven pumpsets are replacing the traditional sakias and tambours appears to result from a combination of organizational and economic constraints. Even at today's relatively high milk and meat prices, there is little economic incentive for the five to ten farmers using a sakia cooperatively to shift to a motor-driven pump. Economical use of even the smallest diesel motor size would require that two or three present "sakia rings" join forces in an irrigation unit of 30 to 45 feddans. Neither the Agricultural Extension Department nor any other unit of government presently is engaged in encouraging and assisting farmers to take such steps. Even those who might take the initiative on their own are discouraged by the terms on which the agricultural credit system makes intermediate-term loan funds available.

Machinery Management and Maintenance

Lack of repair facilities and a chronic shortage of spare parts for the many makes and models of tractors in Egypt take heavy toll of the already small and aging farm tractor stock. Moreoever, the low state of repair services severely limits the investment Egypt should make in additional machines unless the investments are accompanied by significant improvement in such facilities, spare parts availability and machinery management in general. Today, farm machinery repair facilities range from mediocre to non-existent.* More than a fifth of all tractors owned by cooperatives are inoperable; on State Farms developing the New Lands, more than half are reportedly out of service. While no data are available on down-time, widespread reports of long waits for repair parts suggests they are quite substantial.

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* Also see Chapters XIII and XIV on these subjects.

Summary

Following a decade of low-plateau imports of farm tractors and components for local assembly, since 1973 the number of tractors and custom services has expanded dramatically. Custom operators and farmer-users alike plunged into tractor farming with little experience to guide them. Even now the accounting base used by cooperatives for setting custom rates typically disregards depreciation, leaving no margin to cover the cost of replacements. Tractor operators achieve only about 45hp of performance from the commonly-used 60-65 hp machines. The Agricultural Extension Service has no program in machinery management; research on tillage methods and other aspects of mechanization is meager in volume and seriously deficient in depth. Machinery dealers appear as little concerned with providing prompt, efficient after-sales service as they are with facilitating farmers' purchases of new equipment. In total, the ancillary services and facilities that typically support progressive farm mechanization are presently incapable of meeting the needs of even the present number of machines much less the more complex requirements that further mechanization of Egyptian agriculture would entail.

That Egypt has reached its present degree of farm mechanization is due predominantly to the time-honored custom of shared use of equipment, draft animals, and human labor. Only through a system of joint use based on custom services could tractor power have become available to the majority of Egyptian typically small farmers. Recent surveys indicate that about as high a percentage of farms of only 1-2 feddans use tractors for plowing and threshing as do units of 10-20 feddans. Today only 23 percent of total tractor hours are used by private owners on their own farms. As few farms are large enough to fully utilize an economical-sized tractor, privately owned machines are bought mainly for custom operations.

This practice is so firmly established that Egyptian credit institutions make tractor loans on the strength of borrowers' prospective custom operations. This combination of circumstances has not only greatly increased the extent of tractorization but has enabled a very widespread sharing of the benefits of mechanization.

The spread and popularity of custom tractor services also has enabled many small and medium sized operators to become tractor owners. As their own small acreages require only a fraction of a tractor's time, custom work has almost become a separate occupation for many small farmers and, in turn, a major source of family income. Until 1977, to ensure that the limited number of tractors imported were fully utilized for agricultural purposes, only farmers who owned at least 20 feddans of land could obtain a license to import a tractor. This same philosophy and criterion was also generally applied by the Agricultural Credit Bank, other credit sources and dealers who imported tractors in bulk for sale to farmers. The freeing of imports by the Open-Door Policy of 1973 and recognition of the importance of custom services to agricultural production prompted abandonment in 1977 of both the licensing requirement and the 20-feddan criterion. That many small farm operators have taken advantage of this widened opportunity to buy tractors is evident from the number of one to three year old tractors owned by farmers with less than 5 feddans of cultivated land.

Joint use of sakias and other irrigation devices has been common practice in Egypt for generations. "Rights" to participate in the joint ownership and use of such equipment typically have been passed on from generation to generation. In fact the strong hold of tradition upon the size and composition of sakia-rings may well be the strongest single deterrent to modernizing irrigation water lifting.

Those using irrigation water from a given sakia typically are joint owners of the equipment. Where motor-driven pumps have come in, users typically "rent" the pumpset; that is, they pay the pumpset owner a user charge. There is no evidence, however, that farmers have any more aversion to custom-hire usage of water lifting equipment than they do in the case of tractors. In either instance they may complain about high custom rates, as did many of those interviewed in the survey of attitudes towards mechanization. Egyptian farmers readily accept the custom services system as a traditional and necessary way of gaining the benefits of farm mechanization.

CHAPTER IV

PRODUCTION POTENTIAL OF MECHANIZATION

Perspective

No nation ever attains maximum technological efficiency except perhaps in some specialized field such as space exploration. Economic, social, political, and institutional considerations condition what is achieved. Nonetheless, a long-range perspective as to what may be achieved primarily by technology may be useful for near-term mechanization program planning. Consequently, it seems appropriate to indicate how unconstrained technological improvement might improve Egypt's agriculture.

This vista reaches into the late 1980's. It assumes no change in existing land holding and land use patterns, relative farm product prices and the system that establishes them. These assumptions imply no judgements as to what the future should be or to the situation a decade from now. Available data and time preclude detailed assessment of mechanization-induced increases in production of all farm products. Such refinements would have to be treated in the context of an overall sector analysis.

Table IV. 1 summarizes general increases in production resulting from full, efficient use of agricultural production technology that could practicably be made available by the late 1980's.* In total, mechanization potentially could increase current farm production about 46 percent. What would achievement of

* The cost of "unconstrained" technological improvement and the practical necessity of dealing with a finite time span limit the production potential of mechanization. Consideration is therefore limited to presently known equipment. They similarly limit upgrading the milk and meat production of cows and buffaloes freed from draft work over a long period.

TABLE IV. 1

POTENTIAL IMPACT OF UNCONSTRAINED MECHANIZATION UPON EGYPTIAN AGRICULTURAL PRODUCTION[1]

Source	Increase in yield per feddan[2]	Increase in total farm production[3]
	Percent	
Better seedbed preparation	14	11
Timeliness of planting	13	10
Improved seed placement[4]	4	3
Reduced harvest losses	9	7
Subsoiling highly benefited lands[5]	8	6
Precision leveling of uneven field[6]	2	2
Increased cropping intensity[7]	5	3
Freeing draft animals	NA	6
Total	55	47

1 Assumes 1990 end point and no significant changes in 1977 cropping pattern and relative prices. In reality government probably would reduce cotton acreage quotas as yields increase and encourage farmers to grow more maize and wheat to reduce imports and supply feed for a growing livestock and poultry industry. With forage supplies enhanced as indicated in text, berseem acreage might not change much even with some increase in livestock numbers and quality of their diet. Such shifts in the overall cropping pattern would not appreciably affect the data shown in this table.

2 Weighted average of potential increases in yield of respective crops adjusted for fruits, vegetables and sugar cane assumed to be unaffected by the types of mechanization considered in the present study.

3 Component sources of production increase weighted by estimated 1977 value of production of respective crops and livestock products.

4 Assumes yield increases only on row crops.

5 Assumes application to only Class III and to lands which comprise roughly half of Egypt's total cultivated area.

6 Assumes application to only that 1.5 million feddans mostly in upper Egypt, on which yields are seriously affected by uneven fields.

7 Assumes 30 percent of total increase in acreage of crops grown would be in fruits and vegetables.

this production increase entail in terms of: types of equipment, support facilities and appropriate administrative philosophy and practice?

Equipment Package and Applications

Central to the farm mechanization system envisaged is a complement of 45 to 65 hp four-wheel tractors effectively used and maintained by operators who pursue opportunities to expand custom-service operations.* The basic tillage equipment package would include with the tractor, a chisel plow, a disk-spike-tooth-harrow combination, a two-row mounted planter for maize, cotton and other crops, a two-row crop cultivator, and a grain seed drill. With this equipment, a custom operator could complete all land preparation, small grain and row-crop seeding and cultivation operations on 100 feddans of land. This could be done in a timely manner so customers could get their crops in and properly tended by the dates research indicate would result in maximum yields. Full and effective mechanization could easily increase average cropping intensity from the present 190 percent to 200 percent over the next decade. As a result, total area of crops grown would rise to about 12.5 million feddans. Better seedbed preparation, timely planting, better seed placement, and machine cultivation of row crops would increase cotton production per feddan an estimated 63 percent, maize 75 percent, wheat and other small grains 35 percent, berseem clover 55 percent, and miscellaneous crops, excluding vegetables an average of 54 percent.

Mower-Binders, Threshers, Grain Dryers

In a fully mechanized Egyptian agriculture, all wheat, rice, and other small grains would be reaped with mainly custom-operated, self-propelled mower-binders

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* Under Egyptian farm conditions a 45 hp tractor is a more economical investment than the currently popular 65 hp unit (Chapter X).

capable of harvesting one feddan per hour. This contrasts with present hand harvesting of wheat or rice by sickle which requires six days per feddan. The cut grain would be immediately removed by tractor-drawn trailer to permit timely seedbed preparation for the maize crop to follow. This would save the 10-15 percent of grain now lost in transport by camel and wheat and rice now lost in field-drying to permit threshing by drum thresher, tractor-drawn sledge or animal-drawn morag. Small, high-capacity threshers like the ones now widely used in Europe would thresh and winnow 10-11 feddans a day. This machine would be custom-operated as drum-threshers and man-powered winnowers now are. It would be equipped with a straw cutter to make wheat straw usable as cattle feed. In the rice growing area, each village would have convenient access to grain drying equipment to reduce the moisture content of rice to storage level. This would permit grain threshing with much less field-drying than at present which in turn would reduce shatter losses and free the land for earlier planting of the next crop.

Water Lifting

By 1990, all irrigation water lifting would be by 7 and 7.5 hp diesel or electric motor powered pumpsets, the mix depending on the pace of rural electrification. Each pumpset would be owned jointly by farmer-users organized into "water-use associations", each including about 75-90 feddans of cultivated area. Ideally, the present irrigation system would be restructured around 7.5 hp stationary pump sets to make most efficient use of the mechanical pumping equipment.* However, problems of organization and redesigning of on-farm distribution systems would prob-

* See Chapter XII for comparative costs of lifting irrigation water with alternative types of equipment.

ably preclude reaching the ideal within a decade. Consequently, a practical maximum for the period under consideration would result in a mix of 6 hp portable pumpsets, which require little redesigning of on-farm water ways, and 7.5 hp stationary units serving larger, continguous irrigation areas.

Motorized irrigation of the 12.5 million feddans of crops grown would free some 2.5 million cows and buffaloes from the 150-160 days of draft work per animal per year now required to pull 400,000 sakias. This alone would increase farm production of milk and meat by 16-18 percent. It would also free some half a million small boys, women and older family members from the drudgery of keeping the sakia-pulling animals at work and 100,000 or so adult men from the laborious task of turning tambours.

Sub-Soiling

Private custom service sub-soiling operations would, in the late 1980's, have the capacity for covering all Class III and IV lands regularly at three year intervals, the optimum frequency. About three million feddans of these lands require periodic sub-soiling to produce adequate yields. Ideally, permanent field drainage systems would have been installed on one fourth of this area by the end of the decade. Periodic subsoiling of the remainder would increase Egypt's total crop production roughly 9 percent per year under the assumption of no change in cropping patterns.

Land-Leveling

Building on pilot, government-provided, precision land-leveling custom services begun in the late 1970's, private operators would have entered this field in volume by 1990. All one million feddans in upper Egypt sorely in need of it would have been effectively leveled, as would the half million feddans in other parts of the

country where a significant increase in yield would result from precision leveling. As land leveling must be done at the same time as seedbed preparation, private land leveling contractors would have purchased several thousand 65 hp tractors and scrapers for this purpose during the 1980's thus strengthening substantially the market base for a thriving farm machinery production industry.

Trailers

Tractor-drawn trailers would replace camels and donkeys for on-farm and farm-to-market transport. This practice would double demand for domestically manufactured trailers, increase annual tractor usage 10-15 percent and reduce overhead cost per tractor hour. In some areas, village-to-market roads would have been improved to permit trucks to drive directly to villages rather than to load cotton, grain and other products destined for central markets or to unload fertilizer and other commercial production inputs at intermediate points.

Repair Facilities

To keep the number of machines of various types visualized for maximum technological efficiency in full operation, there would be a complex of inter-connected, well-equipped repair facilities strategically located to minimize down-time of motorized and other equipment and staffed with well trained mechanics. These facilities would carry a spare parts inventory for all major makes and models of tractors and other equipment in their areas. By the end of the next decade, they would also have established client relationships with small component fabricators to produce spare parts not requiring specialized equipment to ensure an adequate flow of parts that can be made locally. Area Service Center managers' relationships with parts suppliers would enable them to monitor and enforce quality control through rejection of inferior merchandise. This would give customers confidence of always getting

dependable repair services. Each Area Service Center would have established dealership and after-sales service arrangements with two or three foreign and/or domestic manufacturers of tractors and other farm implements. It would also have arrangements with importers and manufacturers for a timely flow of spare parts and prompt filling of special orders.

What will have begun several years earlier as area repair facilities will have grown into one-stop farm machinery sales and service centers able to meet promptly all needs of equipment users, buyers, and sellers in their territories. They will also have become major employers of trained mechanics. Here young farm boys would gain apprenticeship training under master mechanics before going into business for themselves or taking advantage of urban or off-shore employment opportunities.

Extension Services, Research and Development

There would be active agricultural mechanization extension, research and development programs operated by the national government in a mutually advantageous relationship with the respective governorates, the major agricultural colleges and farm machinery manufacturers. The extension component would help farmers to learn the best use of machinery custom services to meet crop production needs in a timely fashion. It would also be the principal outreach facility for training machine operators, advising custom operators on equipment care and custom-operation management and a source of business opportunity and technical advice to small-shop spare parts fabricators. This branch of the Agricultural Extension Service would, in summary, have made the promotion of sound mechanization practices a priority.

The research and development program would identify opportunities to improve

mechanization technology and mobilize university and governmental research in agricultural engineering and related fields to capitalize on them. In its own facilities and/or through arrangements with machinery manufacturers, government would have established the capability to develop and test promising innovations growing out of ongoing research and to ready those that promise significant improvement for production by machinery manufacturers.

Machinery Manufacture

Assuming that the present Massey Ferguson/NASCO private sector joint venture plans materialize, Egypt will, by the mid 1980's, have the capacity to manufacture 6,000 farm tractors yearly, increasingly with locally-fabricated components. Such a volume would meet the country's internal demand and would make Egypt a major exporter of farm tractors. Thus, by 1990 the number of tractors required by a technologically efficient agriculture would all be supplied by domestic manufacture. To gain the benefits of competition, however, Egypt probably would also elect to allow the import of several makes of foreign-manufactured tractors. Such competition would help assure efficiency in Egypt's repair, service, parts supply and dealership operations.

Egypt would have taken similar steps to modernize its production of other types of farm machinery. This would provide capacity for domestic manufacture of the new types of implements required for full mechanization of agriculture. It would also have induced manufacturers to seek market development, to produce to meet potential demand and to stock major items at local dealers. Thus, Egypt would then have in place the capacity for domestic manufacture required for full farm mechanization and a system of dealerships to promote adoption of all types of equipment to increase farm production. Through the business and technical advisory

activities of the Agricultural Extension Service, numerous small fabricators would have expanded, improved quality of output, and would be able to meet all requirements in a timely manner.

Farm Credit

Maximizing technological efficiency in agriculture would increase commercialization of the "agricultural mechanization system". With more elements of that system brought into the money economy, the credit system would have grown significantly in size and breadth of participation. Otherwise, shortage of loanable funds at any level would preclude purchase of required machinery. Thus, the Central Bank would make certain adequate funds were available at all times to provincial, district, and village banks serving farmers and custom operators. The same would be true of other credit facilities serving other parts of the agricultural mechanization system.

To enable the Agricultural Credit Banks to meet enlarged credit management responsibilities, ways would have been found to transfer to some other appropriate entity the responsibilities for in-kind production input loans which village banks recently acquired from co-ops. Additionally, either the agricultural credit system, or other institutions such as the Nasr Social Bank and/or commercial credit institutions would have broadened their traditional roles to meet the credit needs of small implement manufacturers, machinery dealers and others. These ancillary elements would function at high capacity to make it possible for Egyptian farmers to obtain their technical efficiency.

Livestock Industry

Full mechanization of Egyptian agriculture would have a profound impact on the country's livestock industry. By freeing cows and buffaloes from draft work, mech-

anization would increase farm production of milk by a fourth and that of meat by 8-10 percent.* This would be one of the largest single contributions to farm output. The increase by 1990 would probably be substantially greater than these figures imply since by that time government efforts would have upgraded the baladi cow and the work buffalo to produce more milk and meat. The direction of those efforts, how vigorously they are pursued and how successful they may be, remain to be assessed. Herd improvement takes a long time. Nonetheless, under the opening assumption of price relationships holding for the period under consideration, Egyptian farmers will have freed cattle from draft work by mechanization and will have increased milk and meat output because this would be profitable.

Forage Crop Production

To gain the benefits of full mechanization, Egyptian farmers with Extension Service assistance would by the late 1980's have found solutions to today's chronic seasonal shortage of roughage. Without significantly altering existing cropping pattern or reducing maize grain production, availability of roughage during the critical early summer months would be increased by 60 percent by farmers planting 20 percent of their maize land to Napier (elephant) grass. Elephant grass yields up to a 120 tons per feddan in the April-November period when forage supplies are critically short. Elephant grass, a perennial, becomes dormant in the early fall and grows without reseeding the next summer. Berseem would be seeded over the dormant elephant grass with no loss in yield to provide a year-around forage supply.

With fall forage available, farmers would stop the common practice of first overplanting corn and later stripping the leaves from the immature stalks for cattle

* Total milk and meat would be increased somewhat less as only 80-85 percent of all cows and buffaloes are on farms.

feed. The latter practice reduces grain yield about 25 percent; the former yields little feed while significantly increasing peak season labor requirements. Reducing overall maize acreage by 20 percent to free land for elephant grass would consequently also increase maize production some five percent. From a mechanization standpoint, this minor change would facilitate mechanized cultivation of maize and virtually eliminate the need for the eight man days per feddan now required for hand hoeing during the busiest part of the crop year.

Egyptian farmers would also increase forage supplies as a result of the following: Mechanized seedbed preparation, mechanical harvesting and use of a high capacity thresher-winnower would reduce the time between crops. With all optimal planting dates met, 75-80 days would become available between maize harvest and berseem seeding. That period would be used for a fodder crop or for planting berseem earlier to get an extra cutting per year. Either would decrease the summer shortage of roughage and eliminate stripping leaves from regular maize for cattle feed.

Mechanical Harvesting

By the late 1980's, mechanical harvesting of berseem, a crop that occupies half of Egypt's cultivated area for five months of the year, will have been made possible. Berseem is now harvested day-by-day over a six-week period between cuttings. This practice is followed even on large farms which produce more berseem than is required for their own animals. Harvested this way, some berseem inevitably is cut before full nutritive value is reached and much is left standing well past its prime. By conservative estimate, fully 20 percent of the potential nutritive value of berseem is wasted by traditional harvesting practices. In addition, that operation cannot practicably be mechanized so long as traditional practice

is followed. In total, cutting berseem now accounts for about 30 million days of the labor now spent by women and children on crop production tasks. Lack of space and facilities for storing berseem cut as hay no doubt gave rise to the now-traditional practice and stand as major obstacles to mechanizing the harvesting of this crop. Capture of the nutritive value of the crop and facilitating carry-over from the summer season to overcome the acute roughage shortage are significant unmet challenges for farm mechanization research and development.

Management

The preceding speculation on what could be achieved through agricultural mechanization implicity assumed the necessary management would be forthcoming. Specific actions were set out with respect to building management quality at the farmer level over the years. But, to realize that objective would require expert planning and efficient execution at various levels of government to handle the complexities of foreign exchange, and imports ensuring adequate credit availability, establishing efficient repair and service facilites and other factors. Lack of effective over all program management, whether administered carefully or by private enterprise, is probably the predominant reason why mechanization and other national programs are observed to operate with varying degrees of efficiency. Thus, the choice of implementation philosophy and arrangements become critical to a new national program or amending one already in being. The degree to which the mechanization goals are realized will inevitably come down to a determined program to overcome weaknesses and to establish quality management.

SUMMARY

The preceding excursion into future possibilities sought to accomplish three principal purposes. The first was to indicate fairly concretely the potential contribution of agricultural mechanization to an increase in farm production if tehcnological efficiency were the only consideration. A second was to outline what the Study Team saw as major ancillary actions to be taken to make significant progress toward maximum technological efficiency in agricultural production. Third, this exposition has tried to make clear that, even under the ideal 1990 conditions hypothesized above, agricultural mechanization is not a panacea to Egypt's food security and export earnings problems. Judiciously planned and competently implemented, further mechanization has the technological potential for contributing to their resolution. Under the best of circumstances, though, mechanization will, by itself, not revolutionize Egyptian agriculture. The pattern of technological improvement realistically contemplated for the next decade will provide the basis for an evolutionary change in the level and quality of agricultural production that should stand Egypt in good stead for the longer run as well. The extent to which that potential is realized will depend primarily on how realistically national leadership creates the conditions and organizes the effort for mechanization to occur at an optimal pace.

CHAPTER V

LABOR AND POWER REQUIREMENTS FOR MAJOR EGYPTIAN CROPS

Method of Analysis

Data from many primary and secondary sources were merged to arrive at estimates of the amount and time distribution of labor and power required for different crop operations at Egypt's present stage of farm machanization. Chief among these were:

1. Experience-based estimates of requirements for non-mechanized production of cotton, wheat, rice, maize, berseem and sugar cane developed by Dr. Aly el Kishen, Professor of Agronomy, Alexandria University in consultation with Study Team members.

2. The Farm Management and Farm Machinery Surveys carried out as integral parts of the present study.

3. Ministry of Agriculture series on total man and boy labor inputs into Egyptian agriculture by year.

4. Labor requirements data from a variety of secondary sources including Egyptian research reports, unpublished masters and doctoral theses by Egyptian graduate students, World Bank studies of Egyptian agriculture and the 1976 Egyptian-American joint team report on "Major Constraints to Increasing Agricultural Productivity."*

Needless to say, merging and reconciling data from such varied sources inevitably involved judgmental decisions, a process invaluably aided by cross checks of preliminary Team conclusions with well-informed Egyptian professionals. In the end, data from the various sources proved sufficiently consistent to give the Study Team confidence that the requirements estimates set forth in the

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* Egyptian-US Agricultural Sector Assessment Team, Egypt: Major Constraints to Increasing Agricultural Productivity. Washington, U.S. Department of Agriculture, June 1976.

succeeding tables are reasonably close to reality. However, this experience convinced the Team that building an increasingly reliable basis for estimating labor and power requirements in the future deserves high priority on Egypt's farm machanization research agenda.

In passing, it is worth noting that the Farm Management Survey conducted as part of this over all study of Egyptian farm mechanization was designed to provide inter alia detailed data on labor and power requirements as well as on the size and composition of the farm labor force, off-farm employment and various other labor supply and demand characteristics. Unfortunately, the questionnaire proved too complex for respondents and enumerators alike. Consequently, although that survey yielded a wealth of original data on the dates farmers performed different cropping operations, the equipment used, labor supply and many other aspects of Egyptian farming operations by size and type of farm, the labor requirements information was not usable. As a result, it became necessary to rely primarily upon secondary source data for labor and power input requirements per feddan for non-mechanized and mechanized performance of the different crop operations.

The two-part large-scale Farm Machinery Survey has yielded good consistent data on the usage of tractors by the principal crop operations for which tractors are presently used. One half of these schedules provided such information in terms of hours of use by individual tractors together with the age, make and condition of each respective machine and whether it was privately owned or owned by the local cooperative. The other half provided information on the percentage of all farms in different size groups using tractors for particular operations. As evidenced by the tables appearing elsewhere in this report, the Farm Machinery Survey also has provided information on several other

significant aspects of the current state of Egyptian farm mechanization.

Where they addressed the same question, e.g. type of equipment used, the Farm Management Survey and both parts of the Farm Machinery Survey yield essentially the same indications of current practice. In some respects the findings from these surveys differ significantly from beliefs held by Egyptians concerned with farm mechanization policy and practice. As a case in point, they have long believed that about three-quarters of all land is plowed with tractors but the data also reveal they could not be doing more than 40 percent of all plowing with the number of operable tractors available.

Degree and Effect of Mechanization

Today only three farm operations are motorized to any appreciable extent:

Plowing	40%
Threshing	
Wheat	60%
Rice	50%
Irrigation	20%

The threshing figures overstate the extent to which this operation is mechanized because a high percentage of rice in particular is threshed by tractors pulling a version of the traditional animal-drawn norag over grain piled on a threshing floor. In all three farm functions above, survey data revealed no significant differences in machine usage among farms of different size. Such differences as did appear were geographic and generally related to variations in tractor density. There likewise was no indication of significant differences

among crops except in the case of wheat and rice threshing noted above and sugar cane which is irrigated with motor driven pumps to a far greater extent than other crops. Consequently, in the absence of convincing contrary evidence, the same percentage of mechanization was assumed to apply to all crops in the case of plowing and to all crops except sugar cane for irrigation water lifting. Mechanized threshing is limited to wheat and rice. Grain sorgum is typically threshed by hand, broadbeans, soy beans and others either by hand or animal-drawn equipment.

Table V. 1 compares labor requirements per feddan for each function under non-mechanized and fully mechanized conditions with those at Egypt's present degree of mechanization.

TABLE V. 1

LABOR REQUIRED PER FEDDAN AT
VARYING DEGREES OF MECHANIZATION

In days

Operation	Non-Mechanized		Present Practice		Fully Mechanized	
	Man	Boy	Man	Boy	Man	Boy
Seed bed Preparation[1]						
Plow	5.50	--	3.40	--	.13	--
Drag	1.00	--	1.00	--	--	--
Disk/harrow	--	--	--	--	.13	--
Ridge	1.00	--	1.00	--	.06	--
Ditch	4.00	--	4.00	--	--	--
Finish	1.00	--	1.00	--	--	--
Thresh & Winnow[2]						
Wheat	6.00	4.00	4.30	1.60	.09	--
Rice	4.00	8.00	2.25	2.00	.09	--
Irrigation[1]	8.00	10.80	7.20	8.40	.25	--

1 Data shown are for cotton as operations vary somewhat with kind of crop. For example, seedbed preparation for small grains or berseem does not involve ridging; cotton is irrigated 12 times; permanent berseem 14 times; wheat only 6 times.

2 Winnowing is done at present by hand regardless of the threshing method employe Under full mechanization, threshing and winnowing will be done by a simple machine.

Essentially, this table illustrates the dramatic decrease on labor requirements with increasing mechanization.

Level and Distribution of Labor Requirements

Tables V. 2a-g summarize Study Team estimates of the labor and power required per feddan at the present degree of mechanization for producing the respective field crops typically grown on Egyptian farms. These composite estimates were derived by combining non-mechanized requirements such as those shown in Table V.1 with those for production where plowing, threshing and irrigation are partially mechanized. The weights used for making these combinations are the "percent mechanized" figures indicated in the preceding section. The data on "miscellaneous crops" are meaningful only for arriving at aggregate labor or power requirements. That complex includes some 50 crops ranging from vegetables to grain sorgum and broadbeans. Consequently, the per feddan estimates for miscellaneous crops in general logically cannot be applied to obtain labor or power requirements for any individual component crop. This is true for the time distribution of requirements as well.

TABLE V. 2a

COTTON: LABOR AND POWER REQUIREMENTS PER FEDDAN
AT PRESENT DEGREE OF MECHANIZATION

Operation	Man Days	Boy Days	Animal Days	Machine Days
Land Preparation				
Plow	3.40	-	6.60	.10
Drag	1.00	-	2.00	--
Ridge	1.00	-	-	--
Ditch	1.00	-	-	--
Finish	4.00	-	-	--
Total	10.40	-	8.60	.10
Irrigation (12 times)	7.20	8.40	25.20	.30
Fertilizing (P_2O_5)	.50	.50	-	-
" (N)	1.00	-	-	-
Planting	.50	4.00	-	-
Weeding	-	12.00	-	-
Hoeing	14.00	-	-	-
Thinning	-	12.00	-	-
Manual pest control	2.00	30.00	-	-
Picking	10.00	30.00	-	-
Transport (from field)	1.00	2.00	.50	-
Pulling stalks	9.00	-	-	-
All Operations	55.60	98.90	34.30	-

TABLE V. 2b

RICE: LABOR AND POWER REQUIREMENTS PER FEDDAN
AT PRESENT DEGREE OF MECHANIZATION

Operation	Man Days	Boy Days	Animal Days	Machine Days
Nursery (total)	1.30	.55	1.65	-
Land Preparation				
Plow	1.60	-	3.60	.05
Puddle	2.00	-	2.00	-
Total	3.60	-	5.60	.05
Manure application	2.00	8.00	8.00	-
Irrigation	8.00	8.00	28.00	.20
Transplanting	11.00	20.00	-	-
Weed Control	.50	7.00	-	-
Fertilizer & draining	1.50	2.00	-	-
Harvesting	6.00	-	-	-
Transport (from field)	-	4.00	4.00	-
Threshing & winnowing	2.25	2.00	4.00	.55
All Operations	36.15	51.55	47.25	-

TABLE V. 2c

WHEAT: LABOR AND POWER REQUIREMENTS PER FEDDAN
AT PRESENT DEGREE OF MECHANIZATION

Operation	Man Days	Boy Days	Animal Days	Machine Days
Land Preparation				
Plow	3.40	-	6.60	.10
Drag	1.00	-	3.00	--
Ditch	1.00	-	-	--
Finish	4.00	-	-	--
Total	9.40	-	9.60	.10
Seeding	1.00	1.00	-	-
Irrigation (6 times)	3.60	4.20	12.60	.10
Fertilizing (N)	1.00	-	-	-
Weed control (chemical)	.50	1.00	-	-
Harvesting	6.00	-	-	-
Transport (from field)	-	4.00	4.00	-
Threshing & winnowing	4.35	1.60	3.20	.30
All Operations	25.85	11.80	29.40	-

TABLE V. 2d

MAIZE: LABOR AND POWER REQUIREMENTS PER FEDDAN
AT PRESENT DEGREE OF MECHANIZATION

Operation	Man days	Boy Days	Animal Days	Machine Days
Land Preparation				
Plow	3.40	-	6.60	.10
Drag	1.00	-	.60	--
Ridge	1.00	-	-	--
Ditch	1.00	-	-	--
Finish	4.00	-	-	--
Total	10.40	-	7.20	.10
Manure application	2.50	15.00	15.00	-
Irrigation (11 times)	6.50	7.70	23.10	.25
Planting	1.00	1.00	-	-
Hoeing	8.00	-	-	-
Weeding	-	10.00	-	-
Thinning	-	5.00	-	-
Topping	1.00	2.00	-	-
Harvesting & shelling	10.00	-	-	-
All Operations	39.50	43.70	45.30	-

TABLE V. 2e

BERSEEM: LABOR AND POWER REQUIREMENTS PER FEDDAN*
AT PRESENT DEGREE OF MECHANIZATION

Operation	Man Days	Boy Days	Animal Days	Machine Days
Land Preparation				
Plow	3.40	-	6.60	.10
Drag	1.50	-	3.00	--
Ditch	1.00	-	2.00	--
Finish	4.00	-	-	--
	9.90	-	11.60	.10
Irrigation				
Catch crop (9 times)	5.40	6.30	18.90	.20
Permanent (14 times)	8.40	9.80	29.40	.30
Fertilizing (P205)	1.00	1.00	-	-
Seeding	.50	-	-	-
Harvesting				
Catch crop (2 cuttings)	6.00	8.00	-	-
Permanent (4 cuttings)	12.00	16.00	-	-
All Operations				
Catch crop	34.80	15.30	30.50	-
Permanent	37.80	26.80	41.00	-

* 1977 acreage of catch crop and permanent berseem were almost identical.

TABLE V. 2f

MISCELLANEOUS CROPS: LABOR AND POWER REQUIREMENTS PER FEDDAN
AT PRESENT DEGREE OF MECHANIZATION

Operation	Man Days	Boy Days	Animal Days	Machine Days
Land Preparation				
Plow	3.40	-	6.60	.10
Drag	1.00	-	2.00	--
Ridge	1.00	-	-	--
Ditch	1.00	-	-	--
Finish	4.00	-	-	--
	10.40	-	8.60	.10
Fertilizing				
Manure	2.50	15.00	15.00	-
Nitrogen	1.00	-	-	-
P205	.50	.50	-	-
Planting	1.50	4.00	-	-
Thinning	-	6.00	-	-
Hoeing	12.00	-	-	-
Weeding	-	10.00	-	-
Pest Control	1.00	8.00	-	-
Irrigation	10.00	4.00	12.00	.60
Harvesting	8.00	12.00	-	-
Threshing & Winnowing	6.00	12.00	4.00	-
All Operations	52.90	71.50	39.60	-

TABLE V. 2g

SUGAR CANE: LABOR AND POWER REQUIREMENTS PER FEDDAN
AT PRESENT DEGREE OF MECHANIZATION

Operation	Man Days	Boy Days	Animal Days	Machine Days
Establishment				
Land Preparation				
Plow	2.5	-	-	.25
Ridge and Plant	15.00	12.00		
Ditch	1.00	-	2.00	-
Finish	4.00	-	-	-
	20.25	12.00	2.00	.25
Hoeing	18.00	-		-
Fertilizing (n)	1.00	-	-	-
Irrigation	5.00	-	-	4.50
Harvest	22.00	-	-	-
Transport & Loading	11.00	-	9.00	-
All Operations	77.25	12.00	11.00	-
Ratoon				
Plowing (inter row)	8.00	-	16.00	-
Ditch	1.00	-	2.00	-
Finishing	4.00	-	-	-
Hoeing	7.00	-	-	-
Fertilizing (n)	1.00	-	-	4.50
Irrigation	5.00	-	-	-
Harvest	22.00	-	-	-
Transport & Loading	11.00	-	9.00	-
All Operations	59.00	-	27.00	-

Timing of Crop Operations

Tables V. 3a-e indicate the time spans during which different crop operations typically are performed for cotton, rice, wheat, maize and berseem*. These data were derived from frequency distributions of the week (or weeks) during which farmers interviewed in the Farm Management Survey reported they actually performed the respective operations. Median and weighted averages of the reported dates correspond closely with typical performance dates obtained from other sources. Some operations such as irrigation and cotton and maize hoeing are repeated two or more times during a crop season; This accounts for their drawn-out performance spans and discernable points of concentration within them.

These tables clearly show the progress of operations from land preparation to harvesting or removal from the field for each crop as the season moves ahead. The close sequence in required farm functions for a given crop or among crops is realistically indicated by these data. For example, for cotton, land preparation, first fertilizing and planting are done within a limited time, essentially from the month of February through the first and second weeks of March. Each table clearly reveals the peak periods with a given type of function. This is illustrated by the concentration of pest control in rice at two to three-week intervals beginning with the second week of June.

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* Miscellaneous crops are omitted as the data for the category as a whole have no meaning with respect to individual component crops. Sugar cane is omitted as the number of sample farms was too small to yield reliable detailed estimates.

TABLE V. 3a

COTTON: DISTRIBUTION OF LABOR REQUIREMENTS
BY CROP OPERATION BY PERIOD OF PERFORMANCE*

Land Preparation		Fertilizing (P2O5)		Planting		Weeding		Irrigation		Picking		Pulling Stalks		Transport (from field)	
Period	%	Period	%	Period	%	Period	%	Period	%	Period	%	Period	%	Period	%
2-1	25.2	2-3	24.1	2-3	20.3	3-2	17.6	3-4	5.2	8-4	23.6	10-1	16.5	9-1	17.9
2-2	18.6	2-4	19.6	2-4	24.2	3-3	26.4	4-1	7.0	9-1	17.3	10-2	23.7	9-2	15.1
2-3	21.1	3-1	20.8	3-1	41.4	3-4	37.2	4-2	10.3	9-2	22.6	10-3	26.5	9-3	21.8
2-4	12.0	3-2	14.6	3-2	14.1	4-1	18.8	4-3	7.5	9-3	7.5	10-4	18.9	9-1	11.3
3-1	23.1	3-3	20.9					4-4	9.9	9-4	29.0	11-1	14.4	10-1	33.9
Total	100.0	Total	100.0	Total	100.0	Total	100.0	5-1	8.6						
								5-2	7.2						
								5-3	4.8						
								5-4	7.0						
								6-1	10.3						
								6-2	7.2						
								6-3	9.3						
								6-4	5.7						
Fertilizing (Nitrogen)		Hoeing		Thinning		Manual Pest Control									
3-4	18.6	3-2	1.7	3-1	9.1	4-3	1.4								
4-1	26.2	3-3	2.5	3-2	17.8	4-4	1.4								
4-2	38.7	3-4	12.8	3-3	19.4	5-1	8.9								
4-3	16.5	4-1	13.4	3-4	19.3	5-2	11.9								
		4-2	11.9	4-1	16.7	5-3	13.4								
		4-3	13.9	4-2	9.1	5-4	13.4								
		4-4	15.5	4-3	8.6	6-1	23.8								
		5-1	8.4			6-2	7.4								
		5-2	5.9			6-3	6.5								
		5-3	7.1			6-4	11.9								
		5-4	5.2												
		6-1	1.7												
Total	100.0	Total	100.0	Total	100.0	Total	100.0	Total	100.0	Total	100.0	Total	100.0	Total	100.0

* Period = month and week e.g. 2-1 = 1st week of February
Source: Derived from 1978 Farm Management Survey data

TABLE V. 3b

RICE: DISTRIBUTION OF LABOR REQUIREMENTS BY CROP OPERATION BY PERIOD OF PERFORMANCE*

Land Preparation		Manuring		Transplanting		Irrigation	
Period	%	Period	%	Period	%	Period	%
5-1	36.4	5-1	37.8	5-2	21.4	6-1	10.0
5-2	10.3	5-2	22.2	5-3	23.2	6-2/ 6-4	25.0
5-3	22.2	5-3	6.6	5-4	21.5	7-2	10.0
5-4	12.9	5-4	11.1	6-1	13.9	9-2/ 9-4	55.0
6-1	18.2	6-1	22.3	6-2	20.0		
Total	100.0	Total	100.0	Total	100.0	Total	100.0

Draining & Fertilizing		Pest Control		Harvesting		Thresh and Winnow	
7-1	50.0	6-1	6.4	10-1	43.5	10-1	10.9
7-2	50.0	6-2	17.3	10-2	17.2	10-2	23.8
		6-3	8.7	10-3	19.7	10-3	25.1
		6-4	21.8	10-4	3.9	10-4	26.2
		7-1	6.4	11-1	15.7	11-1	14.0
		7-2	8.9				
		7-3	10.9				
		7-4	6.4				
		8-1	2.2				
		8-2	4.4				
		803	4.4				
		8-4	2.2				
Total	100.0	Total	100.0	Total	100.0	Total	100.0

* Period = month and week e.g. 5-1 = 1st week of May

Source: Derived from 1978 Farm Management Survey data.

TABLE V. 3c

WHEAT: DISTRIBUTION OF LABOR REQUIREMENTS BY CROP OPERATION BY PERIOD OF PERFORMANCE*

Land Preparation		Seeding		Fertilizing (nitrogen)		Weed Control	
Period	%	Period	%	Period	%	Period	%
10-1	9.8	10-4	13.1	12-1	50.0	12-2	50.0
10-2	3.2	11-1	29.8	12-3	50.0	12-3	50.0
10-3	7.8	11-2	24.4				
10-4	5.4	11-3	12.9				
11-1	53.4	11-4	12.2				
11-2	10.6	12-1	7.6				
11-3	9.8						
Total	100.0	Total	100.0	Total	100.0	Total	100.0

Irrigation		Harvesting		Thresh and Winnow		Transport (from field)	
Period	%	Period	%	Period	%	Period	%
11-2	2.9	4-4	23.6	5-1	4.6	5-1	25.5
11-3	3.0	5-1	17.3	5-2	18.3	5-2	12.4
11-4	6.2	5-2	22.6	5-3	16.5	5-3	23.2
12-1	6.8	5-3	7.5	5-4	15.3	5-4	16.3
12-2	9.9	5-4	29.0	6-1	23.3	6-1	22.6
12-3	9.2			6-2	12.4		
12-4	14.6			6-3	9.6		
1-1	3.4						
1-2	3.9						
1-3	2.3						
1-4	3.0						
2-1	15.9						
2-2	2.8						
2-3	10.8						
2-4	1.3						
3-1	1.8						
3-2	2.2						
Total	100.0	Total	100.0	Total	100.0	Total	100.0

Irrigation		Harvesting		Thresh and Winnow		Transport	
Period	%	Period	%	Period	%	Period	%
11-2	2.9	4-4	23.6	5-1	4.6	5-1	25.5
11-3	3.0	5-1	17.3	5-2	18.3	5-2	12.4
11-4	6.2	5-2	22.6	5-3	16.5	5-3	23.2
12-1	6.8	5-3	7.5	5-4	15.3	5-4	16.3
12-2	9.9	5-4	29.0	6-1	23.3	6-1	22.6
12-3	9.2			6-2	12.4		
12-4	14.6			6-3	9.6		
1-1	3.4						
1-2	3.9						
1-3	2.3						
1-4	3.0						
2-1	15.9						
2-2	2.8						
2-3	10.8						
2-4	1.3						
3-1	1.8						
3-2	2.2						
Total	100.0	Total	100.0	Total	100.0	Total	100.0

* Period = month and week e.g. 10-1 = 1st week of October.

Source: Derived from 1978 Farm Management Survey data.

TABLE V. 3d

MAIZE: DISTRIBUTION OF LABOR REQUIREMENTS
BY CROP OPERATION BY PERIOD OF PERFORMANCE*

Manure Application		Land Preparation		Planting		Hoeing		Weeding		Thinning		Irrigation		Topping		Harvesting	
Period	%	Period	%	Period	%	Period	%	Period	%	Period	%	Period	%	Period	%	Period	%
4-1	15.7	4-1	6.5	5-1	15.1	5-3	2.5	5-3	2.5	5-1	4.2	5-3	2.4	8-3	33.4	8-1	4.6
4-2	9.4	4-2	1.6	5-2	20.8	5-4	8.4	5-4	10.3	5-2	4.2	5-4	4.8	8-4	33.3	8-2	7.1
4-3	5.8	4-3	4.2	5-3	17.1	6-1	10.2	6-1	10.3	5-3	5.7	6-1	4.8	9-1	33.3	8-3	7.5
4-4	5.3	4-4	3.2	5-4	12.3	6-2	10.7	6-2	5.1	5-4	16.5	6-2	6.5			8-4	7.5
5-1	30.9	5-1	33.7	6-1	16.2	6-3	14.9	6-3	12.9	6-1	14.2	6-3	6.9			9-1	31.6
5-2	6.2	5-2	9.4	6-2	18.5	6-4	14.3	6-4	23.2	6-2	13.9	6-4	9.6			9-2	10.0
5-3	5.3	5-3	7.5			7-1	14.7	7-1	5.1	6-3	9.3	7-1	9.9			9-3	12.5
5-4	6.2	5-4	4.2			7-2	9.3	7-2	5.1	6-4	15.1	7-2	9.2			9-4	4.2
6-1	15.2	6-1	15.7			7-3	10.9	7-3	10.3	7-1	9.8	7-3	7.8			10-1	15.0
		6-2	14.0			7-4	4.1	7-4	7.6	7-2	7.1	7-4	8.5				
								8-1	5.1			8-1	6.7				
								8-2	2.5			8-2	4.1				
												8-3	1.9				
												8-4	5.4				
												9-1	6.1				
												9-2	1.1				
												9-3	1.3				
												9-4	1.7				
												10-1	1.3				
Total	100.0	Total	100.0	Total	100.0	Total	100.0	Total	100.0	Total	100.00	Total	100.0	Total	100.0	Total	100.0

* Period = month and week e.g. 4-1 = 1st week in April

Source: Derived from 1978 Managerial Survey data

TABLE V. 3e

BERSEEM: DISTRIBUTION OF LABOR REQUIREMENTS
BY CROP OPERATION BY PERIOD OF PERFORMANCE*

Land Preparation		Seeding		Fertilizing (P205)		Irrigation		Harvesting	
Period	%	Period	%	Period	%	Period	%	Period	%
9-1	7.7	9-1	3.1	9-1	7.7	10-2	1.8	12-3	3.1
9-2	2.1	9-2	4.7	9-2	2.1	10-3	1.4	12-4	3.1
9-3	3.7	9-3	3.6	9-3	3.7	10-4	2.9	1-1	22.5
9-4	5.1	9-4	6.2	9-4	5.2	11-1	2.2	1-2	16.1
10-1	25.5	10-1	18.3	10-1	25.4	11-2	6.4	1-3	3.4
10-2	4.2	10-2	8.3	10-2	4.2	11-3	5.2	1-4	2.0
10-3	6.1	10-3	7.5	10-3	6.1	11-4	7.6	2-1	10.9
10-4	5.4	10-4	5.8	10-4	5.4	12-1	6.0	2-2	6.0
11-1	25.6	11-1	17.8	11-1	25.6	12-2	8.0	2-3	2.9
11-2	6.5	11-2	13.8	11-2	6.5	12-3	4.2	2-4	1.1
11-3	3.0	11-3	6.0	11-3	3.0	12-4	6.7	3-1	4.3
11-4	5.1	11-4	2.1	11-4	5.1	1-1	.9	3-2	6.0
		12-1	2.8			1-2	.7	3-3	2.9
						1-3	.5	3-4	1.4
						1-4	1.5	4-1	1.0
						2-1	9.6	4-2	6.1
						2-2	2.2	4-3	2.9
						2-3	8.5	4-4	1.4
						2-4	2.2	5-1	1.6
						3-1	7.2	5-2	1.3
						3-2	1.8		
						3-3	5.5		
						3-4	1.1		
						4-1	3.4		
						4-2	.6		
						4-3	1.9		
Total	100.0	Total	100.0	Total	100.0	Total	100.0	Total	100.0

* Period = month and week e.g. 9-1 = 1st week of September

Source: Derived from 1978 Farm Management Survey data.

Study of these data led the team to seek additional information about some farming practices. This effort was not always successful. For example, efforts to find correlates in the survey data to explain why maize planting is spread over so long a period proved unavailing. No significant differences were discernible among farms of different sizes. It was concluded that where maize follows wheat, land preparation for maize apparently awaits harvest of the wheat crop. And under any circumstance, preparing land for maize competes for labor and power not only with the threshing of wheat but also cotton cultivation, irrigation and various other farm tasks. In the final analysis, the Study Team found itself in league with conventional wisdom that Egyptian farmers plant their maize whenever they can get around to it. With both labor and power in short supply during the peak summer months, maize production suffers severely from delayed planting. Presumably, these same factors, together with poor farmer appreciation of the relationship between delayed planting and yields, account for the substantial percentages of other crops also being planted well beyond their optimal dates.

Conclusions

The data on labor, animal and tractor usage by function and on the timing of functions provided the Study Team with additional evidence used in developing its mechanization recommendations. Attention for potential mechanization has been focused on the particular operations that absorb exhorbitant amounts of time or labor and can be readily mechanized. Similarly, those cases where crop rotations were delayed through extended operations for prior functions, indicated areas requiring attention from a mechanization point of view.

The concentration of animal labor on irrigation bore out the Teams observations. Thus, the present time-frame and human, animal and machine effort were clearly identified as a basis for analysis from the standpoint of economics, agronomy and agricultural engineering. The results of that analysis are contained in other parts of this report.

The data in the group of tables that follows is self-explanatory. However, a few highlights may be noted as follows:

Labor and Animal Usage, Total

Man days: The heaviest users of man days are sugar cane, cotton and miscellaneous crops.

Boy days: Cotton and miscellaneous outranked other crops in use of boy labor.

Animal days: Rice, maize and berseem requirements were highest in this category.

Labor, Animal and Machine Usage, By Crop, By Function

Cotton: The highest number of man days were absorbed by land preparation, hoeing, picking, pulling stalks and irrigation; boy days showed highest utilization for picking, manual pest control, weeding and thinning; animal days were by far heaviest for irrigation; machine days were found in irrigation and, to a minor extent, in plowing.

Rice: The heaviest application of man days was for transplanting, irrigation and harvesting; for boy days, transplanting outranked all others; the greatest concentration of animal days was for irrigation.

Wheat: This crop absorbed the greatest number of man days for land preparation and harvesting; boy days were found most heavily in irrigation and transport; animal days were highest for irrigation and land preparation; parts of machine days were found in threshing and winnowing and in plowing.

Maize: Land preparation, harvesting and shelling, and hoeing led other functions in use of man days; manure spreading and weeding absorbed the highest number of boy days; irrigation and manure spreading led in use of animal days; machine irrigation was also used.

Berseem: Cutting harvests of berseem totalled the highest in man day and boy day usage although irrigation labor and, especially, animal days ranked high in total; some machine days were used for irrigation.

Miscellaneous crops: Functions that were heaviest in man days were hoeing, land preparation and irrigation; large quantities of boy days were absorbed in manure spreading, harvesting, threshing and winnowing and in weeding; animal days were concentrated most heavily in spreading manure, irrigation and land preparation; irrigation was also a function identified for machine usage.

Sugar Cane: Heavy quantities of man days were found for harvesting, land preparation, transport and loading; boy days were concentrated in ridging and planting; animal days were heaviest for transport and loading; machine irrigation was fairly heavy.

CHAPTER VI

EGYPT'S 1977 FARM LABOR BALANCE

Reference is made at various points in this Study Team report to "seasonal labor shortages" and their impact upon production costs, timeliness of crop operations, farmers' incentive to mechanize and certain other aspects of the overal farm mechanization picture. In particular, the social soundness of further mechanization of Egyptian agriculture turns heavily upon the relation between farm labor supply and demand. This chapter summarizes the bases employed in arriving at a systematic approximation of Egypt's 1977 Farm Labor Balance.

Estimating the demand side of the equation was relatively straight forward, given the data on labor requirements by crop and operation summarized in Chapter V. However, to arrive at logical approximations of the size and composition of the 1977 farm labor supply was a different matter. As will be seen in later discussion of that topic, many factors have altered the labor supply since the 1961 Census of Agriculture, the most recent farm labor force enumeration available. Consequently, any estimate of the size and composition of Egypt's current farm labor force depends heavily upon the assumptions made with respect to the significant variables.

Demand

Estimates of the aggregate demand for farm labor shown in Table VI. 1 required five sequential steps to be taken:

1. Derive total man equivalent requirements by weeks and

months from the:

a. total man and boy day requirements per feddan for each major field crop and cropping operation from Table V. 2 a-g,

b. time distribution of each cropping operation for each crop from Table V. 3 a-f,

c. Ministry of Agriculture data on the feddans of each major crop grown in 1977.

2. Establish the total labor required for fruit and vegetable production on the basis of the ratio of the 1977 acreage of such crops to total crops grown that year.

3. Establish total labor requirements of farming operations other than crop production mainly on the basis of a 1964-1965 study by the ARE Institute of National Planning in cooperation with the International Labor Office.*

4. Derive in the same manner estimates of labor required by farms with less than one feddan of cultivated land using:

   a. requirements per feddan, etc., as in Steps 1-3 above, taking into account the lower degree of mechanization of these "mini-farms" as evidenced by the Farm Machinery and Farm Management Surveys,

   b. cultivated area and cropping pattern data for farms of less than one feddan from the 1978 Farm Management Survey and the 1961 Census of Agriculture,

   c. an estimate of the current number of farms of less than one feddan based on the 1961 Census of Agriculture distribution of farms by size groups, adjusted somewhat on the basis of more recent indicators of the relative number of farms of this size.

5. Deduct the resulting total for each time period in Step 3 from the corresponding totals derived in Step 1 to arrive at an estimate of labor required during 1977 for field crops grown on farms whose operators are mainly engaged in farming.

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* Rural Employment Problems in the United Arab Republic, International Labor Office, Geneva, 1969.

To arrive at man-equivalent estimates, the Study Team followed established Egyptian practice of considering two "boy days" the equivalent of one "man day." Until recently when man-day wage rates began rising faster than those for boy-days this formula for arriving at man-equivalents had for years matched very closely the differential in wage rates actually paid for farm labor. That boy-day rates currently are about 45 percent of man-day rates probably reflects the selective migration for employment abroad and in urban areas that has occurred during the past five years.

Combining man and boy-day requirements into man-equivalent labor requirements implicitly assumes that, if needed, boy labor is substitutable for man labor within a reasonable range. Thus, a farmer would use family members for performing man labor tasks before employing hired labor and vice versa. Evidence from several sources supports the view that in practice there is considerable substitution between the two. The largest known discrepancies arise from across-the-board use of the simplifying assumption underlying the present calculations in cotton harvesting and the picking of cotton leaf worm egg masses. (Table VI. 2). Apparently following a tradition of long standing, even operators of very small farms hire groups of boys to pick their crop in a few hours with little participation by family members. The same is true of manual cotton pest control. There, however, the reason may lie in economies of scale rather than tradition. Because no similar bases were available for adjusting the data for other crop operations, these underestimates of hired labor requirements were disregarded as not critically affecting the analysis as a whole.

TABLE VI. 1

TOTAL LABOR REQUIREMENTS BY MONTH AND WEEK, 1977[1]

In Millions of Days

Month and Week	Man-equivalent Days[2]	Month and Week	Man-equivalent Days[2]
January	58.0	July	51.4
1	21.1	1	17.5
2	14.1	2	12.7
3	10.0	3	12.1
4	12.8	4	9.1
February	59.8	August	38.4
1	22.6	1	8.0
2	16.1	2	6.9
3	12.3	3	7.4
4	8.8	4	16.1
March	43.6	September	73.1
1	14.1	1	24.8
2	8.8	2	19.3
3	9.2	3	11.9
4	11.5	4	17.1
April	52.3	October	62.7
1	18.3	1	26.3
2	11.4	2	12.3
3	10.8	3	12.5
4	11.8	4	11.6
May	128.1	November	60.1
1	36.9	1	30.8
2	28.5	2	11.5
3	29.8	3	9.0
4	32.9	4	8.8
June	111.7	December	32.5
1	43.0	1	10.1
2	23.7	2	6.7
3	18.5	3	8.0
4	26.5	4	7.7

[1] Excludes farms with less than 1 feddan of cultivated land. See text for explanation. Although they comprise more than one-fourth of all holdings, such units comprise only 4 percent of Egypt's total cultivated area.

[2] Man-days + (Boy-days - 2). This short-cut formula widely used in Egypt yields essentially the same level of total man-equivalents as does applying estimated participation rates and man-equivalent values to the different age/sex components of the farm labor force.

TABLE VI. 2

TYPE OF WORKER EMPLOYED BY OPERATION, BY MAJOR CROP

In Percent

Operation and Type of Worker	Cotton	Wheat	Rice	Maize	Berseem
Land Preparation					
Paid men ÷ Total men	24	13	16	13	*
Paid boys ÷ Total boys	*	*	*	*	*
Total boyc ÷ Total workers	12	12	10	11	9
Planting					
Paid men ÷ Total men	52	15	58	27	*
Paid boys ÷ Total boys	48	*	78	32	*
Total boys ÷ Total workers	23	*	35	20	12
Hoeing					
Paid men ÷ Total men	56	NA	NA	56	NA
Paid boys ÷ Total boys	*	NA	NA	*	NA
Total boys ÷ Total workers	*	NA	NA	*	NA
Irrigation					
Paid men ÷ Total men	13	11	5	12	*
Paid boys ÷ Total boys	*	*	*	*	*
Total boys ÷ Total workers	23	17	21	17	17
Manual pest control					
Paid men ÷ Total men	3	NA	NA	NA	NA
Paid boys ÷ Total boys	68	NA	NA	NA	NA
Total boys ÷ Total workers	71	NA	NA	NA	NA
Harvesting					
Paid men ÷ Total men	29	57	67	42	*
Paid boys ÷ Total boys	97	25	60	25	*
Total boys ÷ Total workers	87	9	10	14	16

NA = Not applicable
* = negligible

Source: 1978 Farm Management Survey

The 1964-1965 INP/ILO study alluded to above found that indirect requirements comprised 45 percent of the total labor used on the farms covered by that survey:

Function	Percent of Total Labor Requirements
Processing farm products	4
Animal keeping	27
Management, marketing, et. al.	9
Non-agricultural operations	5
Total	45

Animal keeping and the processing of farm products generally are considered boy-day tasks. Taking that 31 percent at one-half man equivalent value and the other two functions to be full man-day requirements adds the equivalent of 30 percent of total crop production requirements. As these are regularly recurring activities, the annual total of indirect labor requirements is distributed equally over the 48 weeks into which the calendar year is divided for operational convenience.

After considering various altenatives and inspecting both the 1961 Census and Farm Management Survey from different perspectives, the Study Team concluded that treating families on units less than one feddan in size as part of the hired labor supply would more accurately protray Egypt's farm labor balance. In the 1961 Census, the 26 percent of all holdings represented by that size group had an average of roughly .45 feddans of total land area, which is essentially the same as cultivated area among units smaller than 10 feddans. The 1978 Farm Management Survey likewise found the families on units of less than one feddan to have slightly less than .50 feddans of cultivated area. In both instances, this group appeared

quite different with respect to most farming characteristics than the next largest size group comprising units of 1-2 feddans. Case by case inspection of the Farm Management Survey schedules indicates that operators of less than one feddan units are largely "patch farmers". They commonly grow only a food crop for family consumption and berseem to feed their cow.

Having decided to treat operators of units of less than one feddan as basically laborers who till a small piece of land as a sideline, it was necessary to remove their calculated labor requirements from the total to reflect more accurately the aggregate labor demand on bona fide farming units. These labor requirements likewise were taken into account in estimating the net labor supply represented by families on units of less than one feddan. A persuasive consideration in deciding upon this treatment of "mini-farms" is their large numbers, hence family labor supply, in relation to their crop land and, in turn, their contribution to Egypt's total farm labor demand. Leaving them in the base distorted the apparent family labor supply so to make the resulting comparisons with aggregate demand unrealistic. Logic argues that most families growing only one feddan of crops per year must have some supplemental source of income. Some may, in fact, be working regularly at non-farm jobs and tilling their small crop acreages in their spare time. If that number is substantial, the hired labor force estimate derived in the next section of this analysis will, of course, be too high. There are, however, no data available for determining either the extent or character of their other employment. So far as aggregate labor demand is concerned, it matters little whether requirements of the less than one feddan units are included or excluded. They comprise less than 4 percent of the national total.

Supply

Paucity of relevant data makes any estimate of the supply of labor currently available to Egyptian farmers largely a matter of judgement about the behavior and influence of key variables. Egyptian censuses provide an urban/rural breakdown of the total population as do published data for inter-censal years. However, no census distinguishes between the farm and rural non-farm components of the total rural population. Thus, even though the 1961 Census of Agriculture gives detailed information about the farm labor force, there are no comparable population data from which to derive participation rates.

The 1978 Farm Management Survey was designed in part to provide definitive indications on many aspects of both labor supply and labor requirements. Unfortunately, the results indicated that the questions asked about participation in farm work were so widely misunderstood by the respondents as to make that part of the survey data generally unreliable as a basis for estimating the farm labor supply. A further complexity arises from Egypt's censuses having a de jure base. In that type of census, persons away from their normal residences are counted as being at that residence. Thus, farm youths doing their compulsory military service or farm workers "temporarily" employed in cities or abroad remain a part of the rural population.

Given these circumstances, the steps taken to derive estimates of farm labor supply by type of worker used in this report were:

1. Estimate the 1977 farm population on the basis of the 1966 census, previous censuses, related data published by the ARE Central Agency for Public Mobilization and

Statistics and ancillary evidence from a variety of other sources*

2. Adjust that result for the number of farm people who since 1973 have taken up employment abroad and/or filled in behind those from cities and towns who have taken up employment abroad during the past five years.

3. Estimate the family labor supply on farms with one or more feddans of cultivated area using data from the Farm Management Survey, the 1961 Census of Agriculture, the previously referenced ILO and Cambridge publications and tangential evidence from a number of other sources.

4. Derive similar estimates of net labor supply represented by families tilling less than one feddan of cultivated area, i.e., the total man-equivalents those families represent minus the crop and livestock production labor requirements for that group of units.

5. Estimate the 1977 temporary and permanent hired labor force, as those categories were defined in the 1961 Census of Agriculture, from a reconciled difference between the population actually on farms from Step 2 above, the number represented by families operating farms of more than one feddan and those tilling less than one feddan.

6. Test the logical consistency of the resulting labor supply estimates with those of labor demand derived in the preceding section of this analysis and with the 1961 Census data adjusted for natural population growth, farm to non-farm migration, workers taking employment overseas since 1973 and the 400,000 landless laborer farmilies who became land owners through the Land Reform Acts of 1961 and 1969.

In actual practice, all six of the above steps were carried forward concurrently as a series of interdependent approximations based upon alternative assumptions. It is for this reason that the hired labor force is referred to in Step 5 as a "reconciled difference". All of the estimated changes from

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* Particularyly useful among the non-census sources was Development, Income Distribution and Social Change in Rural Egypt (1952-1970), Mahmoud Abdel-Fadid, University of Cambridge, Department of Applied Economics, Occasional Paper 45, Cambridge University Press, 1975. That publication gives estimates of the farm population for 1950, 1961, 1965 and 1970 broken down by "landholders"and "landless laborers".

available base points were, in fact, "reconciled" with one another throughout the farm labor supply estimation process. The end products of this process are summarized in Table VI. 3.

TABLE VI. 3

POPULATION AND LABOR FORCE, 1960-77
In Millions

	Population					Farm Workers (man-equivalent)
			Rural			
Year	Total[1]	Urban[1]	Total[1]	Non-Farm[2]	Farm[2]	
1960	25.8	9.6	16.2	3.2	13.0	4.8[3]
1966	30.1	12.0	18.1	3.9	14.2	--
1976[4]	38.0	16.7	21.3	5.4	15.9	--
1977	--	--	--	--	14.4[5]	4.4[5]

[1]Population Censuses for respective years.

[2]Estimates

[3]Estimate based on 1961 Census of Agriculture number of farm workers by type by age/sex groupings.

[4]Includes 1.5 million Egyptian nationals living abroad.

[5]Excludes an estimated 750,000 "temporary" migrants some of whom have gone abroad, others to temporary non-farm employment within Egypt.

Clarity would be enhanced little by elaborating further upon the details of the respective steps indicated. However, a word about two major assumptions may be useful. One concerns the "temporary migration" of farm workers overseas or into domestic non-farm employment; the other, the number of landless laborers who have gained owner-operator status since 1960. Based upon the migration data

developed in Chapter XXV, a total of 1.5 million farm workers and family members are assumed here to either have gone abroad since 1973 or to have filled in behind thos from towns and cities who have gone abroad. As a high proportion of such temporary migrants are adult males, the 1.5 million is taken to represent roughly 750,000 man-equivalents of labor. By reason of their differing attachments to the land and degrees of underemployment, it is reasonable to assume that the different categories of workers have responded differently to the attraction of alternative employment opportunities. Consequently, separate rates of temporary migration were adopted for families of farm operators, families on units of less than one feddan and families of hired workers. On that basis, the 750,000 man-equivalent total breaks down as follows: 150,000 from families farming more than one feddan of cultivated area, 300,000 from those on units of less than one feddan and 200,000 from among the temporary and hired labor force.

While the transformation of landless laborers into farm owner-operators through government land distribution programs did not in and of itself alter the apparent total supply of farm labor, it did significantly alter its composition. For the present analysis, 400,000 laborer families are assumed to have received land as a result of the 1961 and 1969 Land Reform Act. This represents roughly 40 percent of the total number of farm laborer families in 1961. As a result of accelerated temporary migration since 1973 and the earlier land distribution program, the total number of landless, hired farm workers is today probably no more than half that recorded by the 1961 Census of Agriculture.

No attempt has been made in the present analysis to distinguish between permanent and temporary hired farm workers. The 1961 Census recorded 599,000 permanent hired workers of all ages and both sexes. Some 40 percent of that total were on farms larger than 50 feddans in size. As few units of that size remain,

it seems reasonable to presume that the number of permanent hired laborers has shrunk at least that much. How other forces operating since 1961 have affected the remaining 240,000-odd permanent hired worker families one only can guess. The Study Team found no recent data on the subject.

Farm Labor Balance

Table VI. 4 brings together the labor requirements and labor supply estimates derived by the processes described in the two preceding sections. The labor supply is taken to total 4.40 million man-equivalent workers made up of the following: 3.25 million family members on farms larger than one feddan, 650,000 temporary and permanently hired workers as the 1961 Census of Agriculture defines that component of the farm labor force and 500,000 hired-worker equivalents available from families tilling units of less than one feddan after allowance for the time required by their own crop and livestock operations. Farm operators and their family members are assumed to be available to work 25 days each month.* On this basis, the family labor force is presumed to meet all farm labor requirements up to a total of 81.25 million days per month or 20.25 million days per week. Subtracting the family labor days available per week from the weekly requirements data in Table VI. 1 indicates hired labor needs during 12 weeks of the year falling in the seven months indicated by Column 2 of Table VI. 4.

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* The previously referenced INP/ILO study likewise used 25 days per month in estimating the degree of underemployment of Egyptian farm families. If anything, this figure is probably on the high side except during extreme peak periods of fairly short duration.

TABLE VI. 4

CALCULATED ALL-EGYPTIAN FARM LABOR BALANCE, 1977[1]

Month	Total Labor Required[2]	Hired Labor Required[3]	Employment Available per worker	
			Family[4]	Hired[5]
January	58.0	.9	17.6	.8
February	59.8	2.4	17.7	2.1
March	43.6	---	13.4	---
April	52.3	---	16.1	---
May	128.1	46.9	25.0	40.8[6]
June	111.7	32.6	24.3	28.3
July	51.4	---	15.8	---
August	38.4	---	11.8	---
September	73.1	4.6	21.1	4.0
October	62.7	6.1	17.4	5.3
November	60.1	10.6	15.2	9.2
December	32.5	---	10.0	---
Total	771.7	104.1	205.4	90.5

[1]All data are expressed in man-equivalent units.

[2]Sum of week total from Table VI. 1. Total exclude units of less than one feddan.

[3]Sum of weekly excesses of requirements over family labor supply assuming family labor works 25 days per month.

[4]Sum of total required minus hired by weeks divided by 3.25 million man-equivalent of family labor supply.

[5]Hired labor required divided by 1.15 million man-equivalents of hired labor supply.

[6]As there are only 31 days available for working, this excess implies farmers spread their labor requirements more than is assumed in these calculations.

By these calculations, Egyptian farm family workers are required for farm tasks for over 200 days per year; the average hired worker is employed for about 90 days per year. These calculations further imply that aggregate requirements exceeded the total supply available throughout May, early June and

early November, and pressed hard upon that total supply in several other months. It is impossible, of course, for the number of days worked actually to exceed the total work time available. The seeming anomaly in the present calculations probably arises from two sources. First, farm operators and their families work longer hours than the 50-hour week assumed in deriving both labor requirements and family labor supply during such peak periods. Second, faced with a physical shortage of labor, or even high wage rates for hired workers, farmers adjust the timing of their operations to the supply of labor, albeit at some loss in production. In this context it is worth noting that the distribution of labor requirements underlying Table VI. 4 reflect the dates on which farmers interviewed in the Farm Management Survey said they performed their respective cropping operations. And, as demonstrated by the analysis in Chapter X of this report, even those dates result in substantial yield of losses due to late planting.

While the present calculations may exaggerate somewhat the extent of labor shortages confronting Egyptian farmers these past two years, they do nonetheless lend credence to the widespread reports on labor shortage which Study Team members heard wherever they travelled in the summer and fall of 1978. The upward spiral of farm wage rates since 1972 likewise signifies growing pressure of demand on supply. It also should be noted that there are methodological reasons why the type of national aggregate labor balance calculations presented here inherently understate labor supply deficits. This is because aggregation by geographic area, time period, or size of farm innerently imply complete mobility of labor. This is to say that any national aggregate calculation presumes that family labor in a region is available whenever needed to meet labor needs. In practice, this does not happen. In Egypt, even the hired labor force appears not to move far from their place of residence for regular farm work.*

Even within a smaller geographic area, the aggregation of farming units into area averages similarly understates the requirements for hired labor. Although small farms in an area might have an apparent surplus of family labor, larger units in that area may at the same time require hired workers. Indications are that a meshing of the two occurs very little in actual practice. More typical apparently, is the situation where operators of large farms are heavily dependent on hired workers during much of the year, while families on smaller farms in the same area are more underemployed than they theoretically need to be. For this and the related reasons stated above, hired laborers in Egypt probably are employed nearer to 140-150 days per year on the average than the 90 days indicated by the calculations in Table VI. 4. Conversely, members of the average Egyptian farm operator family doubtlessly are not fully employed with farm work for anything like 205 days per year.

A closer approximation to reality would result from comparing two typical farms of significantly different size in the same type of farming area. Rice-growing farms in the Delta are well suited for this purpose as they are all in a particular geographic area and grow a combination of all the major crops produced in Egypt. Table VI. 5 shows the calculated labor balance for a 2-feddan and a 10-feddan farm of this type. The smaller unit represents roughly the upper

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* Reportedly, the only truly migratory laborers in Egypt comprise the cadre called "tahrils" who seasonally move from Upper Egypt to the Delta cleaning canals en route. A comparatively small number of landless laborers also are mobolized by the Arab Federation of Agricultural Workers and private labor contractors for performing particular crop operations such as fruit picking on State Farms develop the New Lands and other specialized large farm units.

TABLE VI. 5

LABOR BALANCE ON TYPICAL DELTA RICE BELT FARMS OF SPECIFIED SIZES, 1977[1]
In Number of Days and Weeks

Month	2 Feddans		10 Feddans	
	Excess of Requirements Over Family Labor Supply[2]		Excess of Requirements Over Family Labor Supply[2]	
	Weeks in Excess	Man Days in Excess	Weeks in Excess	Man Days in Excess
	Number			
January	--	--	--	--
February	--	--	3	27
March	--	--	2	17
April	--	--	4	52
May	2	19	4	270
June	--	--	4	44
July	--	--	2	20
August	--	--	--	--
September	1	8[3]	3	118[3]
October	--	--	3	84
November	--	--	1	18
December	--	--	--	--
Total	3	27	26	650

[1]Labor required per feddan for respective crops grown and operations taken from Tables V. 2a-e; Weeks in which different operations performed based on 1978 Farm Management Survey data. Cropping patterns are those indicated by the Farm Management Survey to be characteristics of rice-growing farms of the respective sizes.

[2]Potential family labor supply based on 1978 Farm Management Survey data and reflects the largest number of family members reported participating in any rice production operation (transplanting) and assumes availability for farm work 25 days in any month. Farms in both size groups averaged the same number of "family men" (2.20) but the 2-feddan units indicated slightly higher participation by "family boys" than the 10 feddan farms, i.e., 1.00 vs. .80 per farm.

[3]Understates amount of labor hired, as cotton picking typically is done with hired labor regardless of unit size and the amount of family labor available.

limit of "family size farms"; the larger one, the "big" farms that are still fairly numerous.*

Since they appear to require hired labor for only two weeks in early May and one week in September when cotton and maize harvests coincide, it might appear that 2-feddan rice farmers could be completely labor self-sufficient by changing the timing of operations. The difficulty with doing so, however, is that it delays planting even farther beyond optimal dates than the requirements data shown here assume. In this context, it should be noted that the timing of the different operations used here are adaptations of those employed earlier for arriving at a national labor balance. Whereas it is appropriate in the latter instance for operation dates to cover a range reflecting practices followed by different farmers, any individual farmer performs a particular operation within a definite period of time of reasonably short duration.

Operators of large rice-growing farms have little opportunity to adjust the timing of their operations during either the summer or fall peak seasons. If seasonal workers were available when needed, farmers presumably would do better by higher a larger number to perform all of their cropping operations at the times which would result in highest yields. They do not do so. This suggests that shortages of both labor and power limit the timeliness of farming operations. These same factors appear to lie behind the significantly lower cropping intensity on large farms. About the only adjustment in land use that rice belt farmers could make to relieve the extreme peak requirements during May would be to plant more berseem and less cotton. Government regulations aside,

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* See Chapter XXVI for further discussion of labor requirements and other characteristics of typical Egyptian farms by size and type.

that is not as attractive an option as might first appear, since land preparartion for berseem competes with rice harvest.

CHAPTER VII

POWER, MACHINERY USE AND FAMILY LABOR COSTS

Concepts

In the present study, farm-level costs of equipment, labor and animal-power serve mainly as indicators of what farmers and custom operators respectively are likely to do when confronted by particular mechanization decisions. This is to say that in deciding whether to pay a custom tractor operator to plow his fields, a farmer presumably considers the cost of doing it with his own cows. He also takes some account of the cost of using his family's labor for that operation and the alternative of hiring workers to do the work so he and/or his working family members can gain some free time or spend their efforts on other farming operations. As most Egyptian farmers are users of custom-hire tractors and associated implements rather than owners of the machines, it is the custom rate rather than the cost of owning and operating the equipment that influences such farmer decisions.

To the custom operator, on the other hand, the reverse is true. From his perspective, the costs of owning and operating the equipment to provide services to his neighbors are all important. Unless the custom users are willing to pay a rate that at least covers his out-of-pocket costs, the custom operator is better off leaving his machinery idle. And, in deciding whether or not to buy a tractor in the first place, the potential custom operator has to be concerned about the margin over the direct costs of machinery use he prospectively can earn from custom work, as that margin determines in large measure his ability to pay for the machine.

Of course, reality is not nearly so uncomplicated as the preceding might suggest. Many other factors inevitably go into mechanization decisions by farmers and custom operators alike. Nonetheless, the self-evident ones noted provide an adequate frame of reference for the purpose at hand. Basically, that purpose is to establish a basis for imputing a value to owner-used production inputs which will approximate that which owners of those resources attribute to them in deciding mechanization questions. Thus, the analytic problem is that of discerning a reasonable basis for establishing opportunity costs.

The history of farm cost accounting theory and practice in the United States is replete with debates about the merits and demerits of alternative methods of imputing the value of family labor and other owner-used means of production. Some doubtlessly will take issue with particulars of the Study Team's methods outlined below. Such differences of opinion are endemic to a situation of this kind where there are no absolutes. With tractors and associated equipment, the cost calculations can be experience-based and reasonably free of value judgements as the respective components go through the market place either directly or indirectly. In that instance, it matters little in terms of machinery costs per se whether a custom operator uses the equipment on his own fields or for custom services. While there is a large and active market for hired farm labor in Egypt, it provides limited opportunity for alternative employment of family workers during much of the year. Similarly, there is a small custom cow-rental market. It too, however, cannot be considered to provide realistic alternative use opportunities for all the work cattle used on Egyptian farms. Consequently, bases other than market prices must be used for approximating farmers' opportunity cost of using family labor and/or their own work cattle in comparison with that of mechanizing particular

operations.

Farm Machinery Costs

Estimated costs by components of using the different types of field equipment recommended in this report are summarized in Table VII. 1. For the most part, these estimates were derived from U.S. research and field experience with the same or comparable types of equipment adjusted for differences between U.S. and Egyptian conditions. The most significant adjustment was made in the hours of economic life to take account of the lower level of maintenance generally practiced in Egypt. This should improve substantially as the program recommended in this report takes effect.

Following are the bases used in arriving at the respective component estimates:

Column 1: New cost reflects 1977-78 farm level prices for tractors and chisel plows; Catholic Relief Service data for the 10 hp self-powered IRRI-type thresher-winnower; and estimated import prices for the other items.

Column 2: Economic life reflects U.S. experience adjusted for differences in quality of maintenance and hours of annual use.

Column 3: Annual use data for tractors and chisel plows are based on the 1978 Farm Machinery Survey described in Chapter I; those for all other items reflect characteristic Egyptian crop rotations/patterns and near-optimal time spans for the concerned operations.

Column 4: Field efficiency is adjusted downward in all cases in consideration of field size and prevailing practice which results in tractors being used well below their capacity. Some improvement in field efficiency can be expected from the recommended mechanization program.

Column 5: Feddans per hour is derived from machine size, rate of operation and field efficiency.

Column 6: Depreciation is calculated in the usual manner i.e., new cost divided by hours of economic life. Per hour costs are derived from total depreciation and hours of annual use.

Column 7: Interest is shown at the prevailing bank rate of 10.5 percent. Inclusion of an interest charge enables the resulting total cost estimates to reflect what a typical custom operator borrowing from a bank to purchase the equipment needs to take into account in setting his custom rates.

Column 8: Total ownership costs are merely the sum of Columns 6 and 7.

Column 9: Repairs are derived from a percentage of new cost divided by the estimated hours of annual use. Annual repair costs are estimated to total 100-120 percent of depreciation depending upon the complexity of the machine involved.

Column 10: Fuel cost per hour is based upon consumption of .2 liters per horse power per hour and the current diesel price of approximately LE .025 per liter.

Column 11: Oil cost per hour is taken to average 15 percent of the comparable fuel costs.

Column 12: Total operating cost per hour of machine use is the sum of Columns 9, 10, and 11.

Column 13: Total cost per feddan is derived from the sum of ownership and operating costs per hour for the respective machines and the hours required per feddan for the given operation from Column 5. Note that except in the case of the self-powered mower-binder and the 10 hp thresher-winnower, the cost per feddan estimates include both the ownership and operating cost of a tractor and driver. Thus, in all instances, the data in Column 13 provide a direct basis for judging the charge necessary to make performance of the respective operations economically viable. Similarly, comparing the data in Column 13 with the value of increased production from mechanized performance of particular cropping operations shown in Chapter X, provides and indication of the range over which the benefits reasonably might be shared between custom operators and farmers using their services.

TABLE VII. 1

ESTIMATED COSTS OF USING SPECIFIED
TYPES OF FARM MACHINERY UNDER TYPICAL EGYPTIAN CONDITIONS[1]

Ownership Costs

Item	New Cost (1)	Economic Life (2)	Annual Use (3)	Field Efficiency (4)	Feddans Per Hour (5)	Cost Per Hour: Depreciation (6)	Cost Per Hour: Interest (7)	Cost Per Hour: Total (8)
	LE	Hours	Hours	Percent	No.	LE	LE	LE
65 hp Tractor	5750	9000	900	-	-	.639	.335	.974
Chisel Plow	200	2000	200	75	1.0	.080	.053	.133
Disk/Spiketooth Harrow	750	2000	200	85	2.0	.300	.197	.497
Mower-binder	2300	2500	600	70	1.0	.690	.211	.901
Thresher-winnower:								
10 hp self-powered	1750	4000	800	-	.09 Wheat .06 Rice	.292	.115	.407
High capacity (2.5mt/hr)	4550	6000	400	-	1.1	.760	.570	1.330
4-row Planter	2300	800	100	60	1.25	1.150	1.208	2.358

Variable and Total Costs

Item	Operating Costs Per Hour: Repairs (9)	Fuel (10)	Oil (11)	Total (12)	Total Cost, Per Feddan[2] (13)
	LE	LE			
65 hp Tractor	.645	.225	.034	.904	-
Chisel Plow	.096	-	-	.096	2.188
Disk/Spiketooth Harrow	.360	-	-	.360	1.275
Mower-binder (self powered)	.690	.050	.013	.753	1.854
Thresher-winnower:					
10 hp self-powered	.292	.050	.008	.350	5.300 Wheat 3.785 Rice
High Capacity (2.5 mt/hr)	.760	-	-	.760	2.290
4-row Planter	1.150	-	-	1.150	4.373

[1] See text for bases of estimates. Comparable data for diesel and electric powered low lift pumps are shown in Chapter XII.

[2] Includes tractor and operator where applicable.

Animal Power

The cost of animal power has high significance to mechanization strategy planning from several different standpoints. Consequently, how that cost is reckoned could mean the difference between success or failure of any given strategy. At the minimum, overestimating the cost of animal power as Egyptian farmers perceive it would result in a much lower demand for custom services, hence lower new machinery purchases, than anticipated. Conversely, underestimating farmers' perceived cost of using their female cows and buffaloes for draft work could lead to inadequate preparation for supplying the number of machines that would be put into use if supplies were available when and where needed.

Alternative Concepts

In broad terms, there are two main ways of approaching the cost of animal labor. One is founded on "resource use" concepts; the other has its roots in behavioral theory. Egypt's Five Year Plan took essentially a resource-use approach in concluding that national interest would be served by mechanization to free cattle from draft work; in turn, this would prompt farmers to dispose of their work animals and thus be able to turn the land now used to grow berseem for cattle feed to the production of cash crops such as cotton, rice or vegetables. That mechanization is not likely to have those particular chain effects for a variety of reasons to be indicated later is no indictment of the resource-use concept of farm cost accounting. But the fact that the conclusion underlying the Plan's policy prescription appears to have missed reality by a wide margin illustrates the hazard of selecting a cost-estimating concept inappropriate to a given purpose.

More common usage of the resource-use approach is found in traditional farm cost accounting practices in the United States and many other countries. In many instances, that concept adequately serves the analytic purpose sought. However, where joint products, hence joint costs, are involved -- such as a cow used both for draft work and the production of milk and meat--the allocation process easily can become tautological. For instance, if the components of a cow's total production are used as a basis for allocating feed and other joint costs, the value of a cow's draft work becomes a part of that total value of production calculation. Since the cost of that draft work is what the analysis started out to discern, the resulting estimate is heavily influenced by the value attributed to the draft work. To be sure, that problem might be overcome by turning to the cow-rental market for guidance on the value users are willing to pay for animal power. The Farm Management Survey obtained data on cow-rental rates (Table VII. 2). Inspection of the individual schedules, however, revealed that for the most part, respondents reported what they thought cow-rental rates would be in their respective communities if one had to rent a cow for farm draft work. Those survey results, as well as information from other sources, strongly suggest that for Egypt as a whole the cow-rental market is quite small and largely special purpose.

Another factor limiting the usefulness of rental rates for imputing a value to owner-used draft animals is that a custom supplier of animal power also provides the plow or other implement used and a driver. Also, a cow owner renting out his animals ordinarily would expect to get some return over costs. It seems doubtful that such a custom operator would look upon returns on his investment and time spent in managing the rental operation in the same way as a farmer using his own animals would. In any event, renting out their own animals does not appear to be an opportunity open to most Egyptian farmers.

TABLE VII. 2

DAILY COST OF RENTED ANIMALS*

Piasters per day	Number Reporting
40	6
50	56
60	17
70	18
80	11
90	--
100	64
Over 100	9
Total	101

* Respondents not renting animals were asked to give their best estimate of the going rate in their village.

Source: 1978 Farm Management Survey

Considering these several circumstances, the Study Team concluded that a behavioral approach would provide the most appropriate basis for approximating the cost of draft work which a farmer takes into consideration in deciding whether or not to mechanize particular farming operations.* Basically, the approach adopted assumes that the opportunity cost of animal draft power to an owner-user is the value of milk and meat lost as a result of working the animals involved. The reasoning behind that conclusion will become clear from the succeeding discussion of factors influencing farmers' decisions about keeping cattle and using them for draft work respectively.

* For a quick review of the behavioral theory of decision-making, see Decision-Making: An Annotated Bibliography Supplement, 1958-63, Paul Wasserman and Fred S. Silander (New York, Cayuga Press, 1964); Administrative Behavior: A Study of Decision-Making Process in Administrative Organization, Herbert A. Simon (Mc Millan, New York. 1957 2nd edition); A Behavioral Theory of the Firm, Richard Cyert and James G. March (Prentice-Hall, Englewood Cliffs, N.J. 1963, pp. 99-ff)

Freed Cows

Virtually all animal draft work in Egypt is performed by adult female cows and buffaloes (for simplicity, in the present discussion "cows" are taken to mean both cows and buffaloes). At any given point in time, a cow-owning farmer has four options with respect to his animals: (1) work and not milk them (2) work and milk them (3) milk but not work them or (4) sell the animals. Only if the work took away all of the cow's milk and calf production would any farmer work his cows and not milk them. Similarly, a farmer who decides to sell his cows no longer has any of the other options with respect to those particular animals. It follows, therefore, that if he does not sell his cows, a farmer can decide day by day whether or not to work them--assuming, of course, he has some alternative means of getting his farm work done.

Implicitly, the previously noted Plan's cattle-reduction strategy assumed that it would be unprofitable for farmers to keep cows if they did not work them. In such a situation only the selling vs. working/milking options would be relevant in farmers' decisions about mechanization. Then the opportunity cost of using cows for draft work would be determined by the sales price and the returns the farmer could expect to obtain from shifting the proceeds from the sale of his cows to some other use. The rapid expansion in tractorization of Egyptian farming during the past several years undoubtedly has freed many cows from draft work. During that same period, however, cattle numbers have continued to increase at the rate of 1-2 percent per year. Some would say that this is because mechanization to date has freed cows from only part of their draft requirements, and that until land preparation, threshing and irrigation water-lifting all are mechanized Egyptian farmers will have to keep their animals even if their milk and meat production is insignificant. Others have expressed

the view that the seeming anomaly of an increase in cattle along with increased mechanization merely marks a period of transition. In that view, when they become more accustomed to mechanization, and custom services are both certain and timely, farmers who mechanize will reduce their cattle holdings.

The Study Team explored these various cattle-reduction theses in considerable detail both separately and in conjunction with the shift of berseem land to other crops, which advocates of reducing cattle numbers assume. That analysis showed that there are two cogent reasons why Egyptian farmers generally will keep their cows even when they are completely freed from draft work. One is economic, the other agronomic. At current product prices, cattle-keeping is a profitable enterprise despite the low milk yield and relatively small calf crop baladi cows and buffaloes produce, even when they are not used for draft work. On the agronomic side, cotton cannot follow wheat in the rotation without drastically lowering cotton yields. That keeping a non working baladi cow is profitable is evident from the following comparison of cost and returns from a typical animal:

1. Returns per Year	LE
Milk	155
Meat	100
Manure	10
Total	LE 265

2. Maintenance Costs*	LE
Feed	184
Death Loss	18
Insurance	2
Interest on investment	18
Maintenance Labor	16
Total	LE 238

3. Net Return per Year LE 27

* Includes allowance for feed, etc. for calf sold and replacement stock.

These calculations, the bases for which are developed in a later context, indicate that a farmer would realize LE 27 per head per year from a nonworking cow even if he valued the family labor spent taking care of the cow at the 1977 average boy-day wage rate and considered bank-rate interest a cost. Unless he had borrowed the money to buy the cow, a farmer probably would not consider interest on investment a cost. Similarly, unless taking care of the cow kept some members of his family from spending that time working off the farm at a comparable wage, a farmer probably would not count the maintenance labor a cost. Consequently, what a typical Egyptian farmer would consider the cow's contribution to his family's income is LE 27 + LE 18 + LE 16 = LE 61 per year.

The preceding calculations treat cattle-keeping and berseem-growing as separate enterprises. That says, in effect, the farmer sold his berseem at farm-gate prices and bought that required to feed his cow at that same price. In reality, most Egyptian farmers market their berseem through their cows and buffaloes. Again, assuming that the average cow requires the production from .85 feddans of berseem cut the average number of times, and leaving all other factors the same, a farmer currently realizes roughly LE 108 + LE 61 = LE 169 gross return from .85 feddans of berseem or nearly LE 200 per feddan. Leaving aside the changes in wheat and maize prices that necessarily would come with a widespread shift of land use from berseem/cotton to wheat/maize, LE 200 per feddan is 50 percent higher than the gross value of production per feddan of either wheat or maize at current farm prices and national average yields. Under such circumstances, few farmers are likely to sell their cows and buffaloes when mechanization frees them from farm draft work. From this it follows that the opportunity cost of animal labor is the value of milk and meat lost as a result of using the animal for draft work.

That under existing price relationships it pays a farmer to keep his female cattle for milk and meat production alone, significantly affects mechanization strategy planning. In particular, it permits mechanization of land preparation, harvest and threshing operations and irrigation water-lifting to proceed at different paces. It permits individual farmers to decide more or less day by day whether to perform a given operation mechanically or with animal power. To the extent that mechanization might otherwise be delayed by farmers' concern that custom hire equipment may not be available when needed, the ready availability of the animal-power alternative largely removes that deterrent. In like fashion, farmers' option of using animal-drawn equipment no doubt places a ceiling upon tractor custom rates. Other factors such as timeliness, reduced hired-labor requirements, et al. will prevent custom tractor rates from falling much below the level of animal power cost. Conversely, neither can they rise without limit regardless of the inadequacy of available tractor supplies.

Some may feel uneasy that by equating the opportunity cost of animal labor with the value of milk and meat lost due to working a female cow or buffalo, no account is taken of the feed and other costs necessary to maintain the animal in working condition. However, when considered from the perspective of a farmer, it is clear that only the milk and meat losses are relevant. He would keep the cow whether she worked or not. Consequently, the cost of working the cow is the additional milk and meat he could have had by not working her.

Milk and Meat Loss

Unfortunately, the data available on milk or meat loss due to working a cow or buffalo leave a great deal to be desired. In developing the present

estimates, several factors have been considered. These include the fact that baladi animals have historically been bred for their ability to work rather than for milk or meat production. Consequently, their milk yields are low even when they are not worked. Buffalo milk yields are higher than those of cows, and buffalo milk brings a higher price due to its high butterfat content. However, buffaloes have a longer breeding cycle than do cows, and their calves typically are sold as vealers whereas cow calves are kept to about 8 or 9 months of age.

The most complete data on non-working baladi cows and buffaloes the Study Team was able to locate are those summarized by Ragab and Asher in 1968 from Ministry of Agriculture and university herds. Their production data indicate yields per head well below those reported by some sources but appeared well in line with others. Consequently, the following Ragab-Asher data were used in determining the production of non-working animals:

	Baladi Cattle	Buffalo
Age at first calving	34 - 44 months	39 months
Daily milk yield	5.5 kg	6.4 kg
Fat %	4.6	6.5
First Lactation		
Milk	809	1360
Days	186	300
All lactations		
Milk	1140 kg	1820 kg
Days in lactation	210	320 - 340
Days dry	150	210
Days calving interval	410	500
Estimated calving percent/year	89	73

The above data were translated into estimates of the milk and meat loss by working female cows and buffaloes on the basis of World Bank mission reports and indications gleaned from a variety of other sources including field contacts

by Study Team members. Operationally, this involved the following assumptions:

Milk Loss:

1. Base production per year: cow 1140 kg, buffalo 1330 kg.
This takes accouht of buffaloes' longer calving interval and disregards the small effect of assuming that cows calve each year, rather than the reported 410 days.

2. Farm-gate price per kg in 1977: cow 13.6 pt, buffalo 15.4 pt.
These data are from the 1978 Farm Management Survey and represent reported prices received for milk sold, weighted by reported total production.

3. Milk loss due to working: 35 percent of annual production for both cows and buffaloes.

Most studies and informed opinion on the subject indicate milk loss in the area of 30-50 percent by animals working 180-200 days per year. It is widely believed in Cairo that only cows are used for field work, while buffaloes are confined to pulling sakias. However, inspection of the individual Farm Management Survey schedules suggest that on small farms, at least, farmers use whatever animals they have for either task. Otherwise, there would be far more renting of cows than either logic or available data indicate to be the case.

4. Value of Milk Loss per Head: cow LE 54, buffalo LE 72.
These figures are merely the products of the respective data from items 1-4 above.

Meat Loss:

1. Calf Crop: nonworking cow 89 percent, buffalo 73 percent; working cow 67 percent, buffalo 60 percent.

Following Ragab-Asher, these estimates assume that the nonworking baladi cow has a calf each fourteen months, whereas the working cow produces a calf each eighteen months; the nonworking buffalo calves each sixteen months compared to twenty months for the working buffalo.

2. Market Value of Calf: cow LE 100, buffalo LE 45.
Cow calves typically are marketed at 8-9 months, buffalo calves at 1-2 months of age. The present calculations assume that all calves are sold. In reality, a small fraction is retained as replacement stock.

3. Value of Meat Loss: cow LE 22, buffalo LE 6.
These estimates are derived from the respective calf crop reduction in (1) and market values per head in (2).

Loss per Day Worked:

1. Milk and Meat per Year: cow LE 76, buffalo LE 78.
The higher value of a cow's calf approximately offsets the higher value of a buffalo's milk production. As the number of working cows and buffaloes is approximately the same for Egypt as a whole, LE 77 is taken as the combined average loss per animal per year.

2. Days Worked per Year: combined average 190 days.

The animal labor requirements per feddan at Egypt's present stage of farm mechanization set out in Chapter V indicate a total requirement of some 190 work days per animal per year when all crop and non-crop operations are taken into account.

3. Value of Loss per Day Worked: LE .393

In all of the preceding steps, data are shown in round numbers for sake of reader convenience. The 39.3 pt figure shown here and used in various parts of the overall Study Team report was derived from unrounded numbers. In any event, this calculated value of loss per animal per day should be taken only as a rough indication of the order of magnitude of the opprotunity cost of animal labor. It could be anywhere from 25-60 pt per day depending upon the value assigned the different components. Over all, the above estimate should be on the conservative side. Some sources put both milk production and percentage reduction due to animals' working much higher than the levels used in the present analysis. Here, conservative values were used to avoid exaggerating the benefits likely to accrue from further farm mechanization.

The Study Team recognizes that the estimating process outlined above could be refined in a number of ways if there were reliable data on which to base the refinements. Given existing circumstances, greater sophistication in analytic technique would yield little more than enhanced conceptual and mathematical precision. The basic data available are so imprecise as to make refinement of calculations derived from them largely an exercise in futility. From its own experience with the data, the Study Team concluded that the estimated opportunity cost of animal labor derived in the manner described is close enough to reality to serve the broad purposes of mechanization strategy planning.

Labor Costs

As in the case of animal power, it is their perception of the value of labor saved that influences farmers' decisions with respect to mechanization. In this regard, opportunity for reducing hired labor costs is viewed quite differently from opportunity for reducing the amount of work required of the farm operator family. Savings of hired labor costs directly increase an operator family's incomes; savings of family labor may result only in that family's having more leisure time.

From the standpoint of the Egyptian economy as a whole, the value of any labor saved by mechanization--whether hired or family--depends upon the assumptions made with respect to alternative employment opportunities. Although non-farm employment opportunities have been growing rapidly in recent years, they still are relatively limited, especially for seasonal employment. Consequently, to stay on the conservative side with respect to the prospective benefits of further mechanization, the social internal rate of return calculations in Chapter XXIV accord no value to labor savings. This in effect says that by reducing overall farm labor requirements, mechanization is assumed, for that particular purpose, to generate no additional productive resources.

As labor savings do influence farmers' mechanization decisions, the succeeding discussion focuses specifically on that aspect of the opportunity cost of labor. In particular, it concentrates upon the opportunity cost of operator family labor. Hired laborers' perception of the opportunity cost of their labor affects farm operators' mechanization decisions only indirectly through wage rates.

Hired Labor Rates

Recent trends in Egyptian farm wage rates are discussed in Chapter III. Consequently, for the present purpose it is sufficient merely to note that the 1977 national average wage rate per man day was LE .76, that for boy workers, LE .355 pt per day. Rates naturally vary somewhat among regions and to some extent between seasons in the same area. The general patterns of these variations are seen in Table VII.3.

Family Labor

Arriving at a plausible estimate of farmers' perception of the opportunity cost of family labor requires two sets of assumptions. One concerns the impact of reduced total labor requirements upon those for hired workers. The second involves establishing a conceptual basis for valuing the savings of family labor resulting from mechanizing particular farm operations.

Hired Labor Requirements

As indicated in the Chapter VI discussion of Egypt's overall farm labor balance, the Study Team found no better basis for estimating the amount of hired labor used than simply taking the difference between total farm labor requirements and the estimated supply available from operator families. By this approach, any mechanization-generated reduction in total labor requirements during weeks in which total requirements exceed the aggregate family labor supply reduces hired labor requirements by that same amount. For the purpose at hand, two features of that approach bear stressing. One is the weekly matching of total requirements and family labor supply. This suggests that the opportunity cost of family labor may be different in peak periods than it is in slack ones. The second significant feature

TABLE VII.3

Average Daily Wage Paid for Specific Crop Operations
Farm Management Survey Data, 1978

Belt	Wheat Manuring		Maize Hoeing	Cotton Hoeing	Cotton Pest Control	Wheat Harvest	Cotton Harvest	Maize Manuring		
	Man	Boy	Man	Man	Boy	Man	Man	Boy	Man	Boy
1	.91	.39	.99	.96	.14	1.07	.88	.51	.99	.43
2	1.00	.44	1.03	1.02	.14	1.06	1.06	.40	1.06	.43
3	.86	.41	.93	1.00	.26	.98	.84	.49	.86	.35
4	1.05	.27	1.07	1.02	.14	1.07	1.00	.48	1.02	.45
5	.84	.25	.74	.74	.13	.93	1.00	.32	.73	.28
6	.70	.46	.80	.87	.14	.85	.90	.38	1.00	.45
7**	1.22	.50	1.21	1.26	.19	1.21	1.25	.48	1.25	-
Average	.95	.40	.97	.95	.15	1.03	.90	.42	1.00	.41
	Sept-Oct 1977		June-July 1978	March-May 1978	June-July 1978	May 1978	September 1977		Feb-March 1978	

Belt	Rice Harvest	Maize Harvest	Wheat Threshing	Rice Threshing	Wheat Winnowing		Sugarcane Harvest		
	Man	Man	Man	Boy	Man	Boy	Man	Boy	Man
1	1.12	1.05	1.00	.46	.96	.44	1.01	-	-
2	1.13	1.08	1.16	.44			1.64	-	-
3	1.10	.87	1.01	.43			1.46	-	-
4	1.18	1.09	1.10	-			1.75	-	-
5	.85	.96	.79	.50			2.32	-	-
6	-	.82	1.08	-			1.84	-	-
7	-	1.14	1.49	-			1.53	-	1.16
Average	1.11	1.01	1.11	.45	.96	.44	1.68	.49	1.16
	Oct 1977	Sept 1977	May-June 1978		October 1977		May-June 1978		Jan-Feb 1978

* Geographic areas generally in South to North pattern
** Sugarcane - growing area.

is the underlying assumption that family labor inputs will not be affected by reduction of total peak season requirements. Both of these assumptions come strongly into play in the succeeding derivation of the estimate of the opportunity cost of family labor.

Peak Periods

The calculations in Chapter VI indicate that at Egypt's present stage of mechanization, total farm labor requirements for the country as a whole exceed the apparent family labor supply during 12 weeks of the year. In those weeks there are, by the concepts underlying this analysis, opportunities for farm operators and/or members of their families to be employed on other farms as hired workers. Thus, from that perspective, the opportunity cost of family labor is the prevailing hired labor wage rate. This same conclusion is reached by approaching that opportunity cost from the standpoint of mechanization-generated labor savings. By definition, the average Egyptian farmer requires some hired labor during peak periods. Therefore, he has three options: (1) not mechanize and continue using the same amounts of family and hired labor respectively (2) reduce his family labor input by the amount of the mechanization-generated reduction in total labor requirement, hence continue using the same amount of hired labor as before or (3) maintain the family labor input and reduce hired labor costs. Only if Egyptian farmers place a high value on family leisure could they be expected to pursue the second course of action. To be sure, there are aspects of reported labor usage on Egyptian farms that are not explained by the availability of family workers in relation to over all labor requirements. Nonetheless, there is no evidence to suggest that farmers in general would "buy" family leisure at today's hired labor rates. Consequently, the more reasonable assumption is that when they have the opportunity, Egyptian farmers would rather reduce their hired labor than their family labor input.

Slack Periods

Egyptian farm labor requirements are so highly seasonal that, except for peak periods, total requirements fall well below the apparent supply of family workers. During such periods, family labor saved by mechanization can have a monetary value only if opportunity exists for off-farm employment of that labor. For the reasons noted earlier, there is nothing to suggest that sufficient seasonal employment oportunities are available to absorb a significant part of the total operator-family labor supply. In this national aggregate analysis, opportunity for working on other farms is foreclosed--as it was in the similar analysis in Chapter VI--by the assumption of complete mobility of all labor.

Under these circumstances, reducing total labor requirements during slack seasons would result in increased leisure for the operator family. As mechanization has its cost, for a farm operator to mechanize a given operation solely to reduce non-peak labor requirements, he would have to perceive this added leisure to be at least as valuable as the cost of the mechanization. Here again, there is nothing in the evidence that came to the Study Team's attention that suggests Egyptian farmers, in general, would seek increased family leisure at the expense of reduced income. Thus, it seems realistic to conclude that farmers view family labor as having no opportunity cost in slack period --at least, in the short run.

Estimated Opportunity Cost

Given the preceding circumstances, the Study Team adopted a two-part approach to the opportunity cost of family labor as it affects farmers' decisions with respect to mechanization. Man equivalents of labor saved during the peak periods were valued at the 1977 national average man-day wage rate. In 1977, the boy-day wage rate was a bit less than half the man-day rate, but this

makes little difference in the outcome.

As the ratio of hired to family labor increases with farm size, mechanization decisions by operators of larger than family-sized units can be expected to be much more sensitive to opportunities for reducing total labor requirements than are families on small farms. Not only do they employ the bulk of all hired labor used in Egyptian agriculture; they require hired workers in many more weeks of the year than the preceding national aggregate estimates imply. They also account for about half of Egypt's total farm production, hence offer the nation particular opportunities for reaping the output-increasing benefits which mechanization can bring. The implications of type and size of farm difference to estimation of opportunity cost of family labor are evident from the typical farm analyses in Chapter XXVI.

The underlying assumption of complete labor mobility has the effect of understating the importance which Egyptian farmers, in general are likely to attach to labor savings. The reason is that assuming complete mobility of labor reduces the number of weeks during which labor requirements exceed the family labor supply. In reality, the Egyptian farm labor force appears to be surprisingly immobile. Given the marked seasonality of total farm labor requirements, it is hard to say how much effect altering that assumption would have upon the number of weeks family labor should be considered to have an opportunity cost affecting operator's mechanization decisions. However, whatever effect it does have would be in the direction of making mechanization more attractive than the present national aggregate estimates suggest.

CHAPTER VIII

ATTITUDES OF FARMERS TOWARD MECHANIZATION

Introduction

Other parts of this report examine the question of increased mechanization of farming in Egypt from the standpoint of improving production, yields and benefits to the farmer and to the economy. Assuming they make the case for enlarging the extent of mechanization, basic questions arise as to whether Egyptian farmers favor machines. This chapter directs its attention to these underlying attitudes and to the characteristics of farmers who gave their views on this subject.

More specifically it addresses the following: What does the farmer think about mechanization? Is he positively disposed toward use of machinery? Is he aware of and knowledgeable about the availability of machines to perform specific functions and use of machines? What are his problems and how does he perceive that machines may help solve them? Is the farmer ready to adopt machines or will he resist them? Is the location or size of his farm a factor in his attitudes towards machines? Does he perceive a shortage of labor? If he wants machinery, what barriers does he see to obtain them? Does he believe that the co-ops or private owners supply tractor services adequate to serve his needs? Does he feel exploited by machine operators?

To answer such questions, a survey of farmers was devised and carried out in conjunction with personnel at Cairo University. A number of graduate students under the direction of Dr. Khairy Aboul Seoud were trained in the use of a questionnaire developed for survey purposes. These students administered the questionnaire in field interviews.

Methodology

The sampling for this study was based on the broad framework of a Ford Foundation-Ministry of Agriculture study that sampled some 800 farm families from 56 villages in all agronomic zones. Due to limitations of time, 158 families in 9 villages representing the dominant agricultural activity were selected for the present study. In each village, the total distribution of land holders was obtained from the co-op list and stratified to sample the appropriate percentage from each of six farm-size categories, as follows:

	N	%
Less than one feddan	52	33
One but less than 3 feddan	61	39
Three but less than 5 feddan	18	11
Five but less than 10 feddan	17	11
Ten but less than 25 feddan	8	5
Twenty feddan and over	2	1
	158	100

A preliminary questionnaire was constructed on the basis of objectives of the project, discussions with informed people regarding Egyptian agriculture and a review of existing literature. This was used to interview three farmers formally and several others informally, after which the schedule was revised, pre-tested on 13 farmers with various size holdings and revised again to put it in final form. During the developmental and pre-test phases, five Agricultural Extension graduate students were trained. Each student was involved in the pre-test and pre- and post-test sessions to familiarize them not only with the questionnaire, but also with the project as a whole.

Villages in various agronomic zones were selected to represent areas producing the major crops of the nations. The governorate, villages and crops represented are as follows:

Governorate	Dominant Crops	Villages
Qena	Cane	El Sabriat
Asyut	Cotton	El Zawia
Fayoum	Cotton	Zayiet El Kauatsa
Kalaubia	Fruit	Kafer El Gimal
Menoufia	Cotton	Tah Shaubra
Giza	Vegetables	Kafer Hakim
Kafer El Sheikh	Rice	El Khadmia
Damiat	Rice	El Abidia
Sharkhia	Cotton	Shubal Busta

Each of these villages is located in old lands. That is, no village is in the reclaimed lands or land reform areas. In each case, the village is of medium size, dominated by family farming and not too close to a large city, selected so as to avoid the undue influence a nearby city might have on cropping patterns.

Interviewers were instructed to tell the farmers that this was a scientific study being carried out by the University and that their responses were to be confidential.

A total of 158 usable questionnaires (approximately 17 from each village) were collected. Although the farmers interviewed were distributed to obtain as representative a picture of Egyptian farmer as possible, the number is small and therefore subject to statistical error. On the other hand, where total response to a particular question was overwhelmingly of a particular type, the aggregate data have greater statistical validity.

Survey Findings

General

The overall conclusion from this survey of 158 Egyptian farmers is that the overwhelming majority of them would like to mechanize. There are reasons for this attitude but there are also complications and constraints as to why these farmers

had not yet mechanized their farms. The following data and analyses are designed to help clarify some of the issues and problems besetting the Egyptian farmer.

Social Background Characteristics

Age: Thirteen percent of the farmers in this sample are between the age of 17 - 20, fifty-four percent between 35 and 55 and thirty-four percent are over 55 years of age.

Education: 58% are literate and 42% illiterate. Of the literates, forty-two percent have less than six years of education, thirty-nine percent from 6 - 12 years and eighteen percent 12 years and above.

Family: Average size of household is 6.9 people. This figure includes more than the nuclear family. Seventy-seven percent were nuclear families and 23% are of the extended family type. Seventy-five percent (119) are full time farmers. Only 7% (11) hired out as agricultural laborers while the remainder (18%) had other occupations such as merchant, teacher, government worker or Koran reader.

Farm Practices: Of all the farm practices performed by farmers, only 20% is carried out by machines. Another 19% is done with animals and fully 60% is performed by family or hired labor. Nevertheless, 77% of the farmers have their land plowed by machines, 17% by animals, and 6% by hand (See Table VIII. 1). These figures are somewhat deceptive in that the two villages in upper Egypt do much more plowing by animal than do the other seven villages. Over 90% of the farmers in the delta plow their land with tractors. Further inspection of the table reveals that Egyptian farmers are woefully undermechanized. Insect control is the only other practice that is mostly mechanized whereas irrigation, one of the most important aspects of Egyptain farming, is still being done predominately by animal

or human labor, and practically all of the transporting of crops is performed by animal and human labor. Literally all of the planting, weeding, fertilizing and harvesting is done by human labor, functions which can be readily performed by machines. Only plowing and insect control utilize machines to any great extent. Most machine operations are performed by private operators and the only area where the farmer uses his own machine to any extent is in irrigation and this amounts to a mere 15%.

TABLE VIII.1

TYPE OF MACHINE AND LABOR USED BY EGYPTIAN FARMERS FOR VARIOUS FARM PRACTICES

Farm Practices	LABOR			MACHINES			PERCENT		
	Family Labor	Hired Labor	Animal Labor	Owned	Rented Private	Rented Coop	Human Labor	Animal Labor	Machine Labor
Plowing	4	7	30	7	95	34	6 %	17 %	77 %
Discing	21	32	47	5	43	13	33	29	38
Manuring	73	66	53	1	2	0	71	27	2
Leveling	7	20	60	6	47	12	18	39	43
Furrowing	5	11	86	6	47	6	10	53	37
Ditching	91	73	22	1	2	1	86	12	2
Planting	110	95	0	0	0	0	100	0	0
Weeding	108	99	0	0	0	4	98	0	2
Thinning	107	80	0	0	0	0	100	0	0
Insect Control	16	22	0	4	24	71	27	0	73
Fertilizing	113	78	0	0	2	0	99	0	1
Irrigation	37	11	56	25	32	1	29	35	36
Harvesting	95	120	4	0	1	0	97	2	1
Transporting Crop	9	10	133	3	14	3	11	77	12
TOTAL	796	724	491	58	309	145	60.0%	19.4%	20.2%

Machine Ownership and Use of Machines

Of the 158 farmers, only 7 own tractors--all of them large; 31 own pumps, 5 own sprayers, and 4 own threshers. The majority of these are in the hands of the farmers who hold between 5 and 24 feddans (See Table VIII. 2). The important point to note in this table, however, is that 123 of 158 farmers own no machines at all.

Generally, whether a farmer owns his land or rents it does not seem to make much difference in the degree of mechanization* of the Egyptian farmer. The data in Table VIII. 3 does not show a discernible difference between those who own and those who rent.

However, the larger the farm holdings, the greater the proportion of farmers who are highly mechanized. As shown in Table VIII. 4, one can see that the farmers holding less than three feddans make up 80% of those who are low in mechanization and only 45% of those who are highly mechanized.

Farm Labor and Mechanization

A large proportion (72%) of the farmers complain about the shortage of labor. The farmer is hit the hardest during the harvesting season (53%), followed by the planting season (22%), but another 20% complain that the shortage occurs all year around. It appears that those with the smallest holdings (less than 3 feddans) feel the shortage more than those with larger holdings. Also those in the rice

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* A mechanization index was developed to determine a farmer's degree of mechanization. Weights were arbitrarily given to each farming practice according to the degree of importance to farming. Thus, plowing was given a weight of 5; discing a weight of 3; manuring 1; leveling 2; furrowing 2; planting 1; weeding 2; thinning 1; insect control 3; fertilizing 1; irrigation 4; harvesting 3; and transporting of crops 2. Total possible score any farmer could receive was 30. Analyses in cross tabulations were made by allocating each farmer in one of three categories of mechanization: low = less than 10; medium = 10 to 15; high = 15 and above.

TABLE VIII. 2

MACHINE OWNERSHIP BY SIZE OF FEDDAN HOLDINGS

Size of Holdings	Machine Ownership									
	None	Tractors				Pump	Sprayer	Thresher	Harvester	Total
		Large	Med	Small	2-Wheel					
Less than 1	51	0	0	0	0	1	0	1	0	
1 - 2.99	50	1	0	0	0	9	2	1	0	2
3 - 4.99	12	0	0	0	0	6	0	0	0	13
5 - 9.99	7	4	0	0	0	9	0	1	0	6
10 - 24.99	2	2	0	0	0	5	3	1	0	14
25 & over	1	0	0	0	0	1	0	0	0	11
Total	123	7	0	0	0	31	5	4	0	47

TABLE VIII. 3

DEGREE OF MECHANIZATION BY TYPE OF HOLDING

Type of Holding	Degree of Mechanization							
	LOW		MEDIUM		HIGH		TOTAL	
	N	%	N	%	N	%	N	%
Own	36	55	29	60	25	56	90	57
Rent	16	25	8	17	14	31	38	24
Own & Rent	13	20	11	3	6	13	30	19
TOTALS	65	100	48	100	45	100	158	100

TABLE VIII. 4

DEGREE OF MECHANIZATION BY SIZE OF HOLDINGS

Size of Holdings Feddans	Degree of Mechanization					
	LOW		MEDIUM		HIGH	
	N	%	N	%	N	%
Less than 1	27	42	17	35	8	18
1 - 2.99	25	38	24	50	12	27
3 - 4.99	5	08	3	06	10	22
5 - 9.99	5	08	3	06	9	20
10 - 24.99	2	03	1	02	5	11
25 & over	1	02	0	00	1	02
TOTAL	65	101	48	99	45	100

TABLE VIII. 5

DEGREE OF MECHANIZATION
BY THE AVAILABILITY OF FARM LABOR

Availability of Farm Labor	Degree of Mechanization							
	LOW		MEDIUM		HIGH		TOTAL	
	N	%	N	%	N	%	N	%
Yes	21	33	12	25	11	24	54	38
No	43	67	36	75	34	76	113	72
TOTAL	64	100	48	100	45	100	157	100

belt (Damiat and Kafr El Sheikh) had the greatest number of complaints about the unavailability of farm labor. Farmers least affected by labor shortage are those in the Giza governorate. Farmers think that reasons for the lack of availability of farm labor are, in order of their frequency; that they are too expensive, they are leaving the country, they are getting jobs outside agriculture, and that school takes children away from the farm. An important aspect of this problem is that those farmers who perceive a labor shortage are slightly more likely to be highly mechanized than those who do not perceive a labor shortage (Table VIII. 5). Thus,

as labor becomes increasingly scarce and expensive, farmers are turning to machines to get their work done. Another important consideration, from the point of view of the farmer, is that 123 (81%) of the farmers stated that hired labor was more expensive than either animal labor or machinery. Four (3%) thought animals were more expensive and 24 (16%) said machines were more expensive. Of those who thought machines were more expensive, the majority (14) are located in Kualuabin (fruit) and Giza (vegetables) provinces.

Problems of Farmers

When asked what were the most important problems with which they had to deal, farmers became quite voluble. The 158 farmers contributed a total of 379 responses which are categorized below:

Response	N	%
More fertilizer	92	24
More water for irrigation	87	23
Shortage of and high labor wages	50	13
Shortage of and high price of machines	47	12
Mismanagement of co-ops	37	10
Drainage problems	31	8
Miscellaneous	35	9
	379	99

The farmers in all governorates complained of the need for more fertilizer and, except for Damiat and Kualuabia, the need for more water. Apparently Damiat and Kualuabia are favorably located to barrage on the Nile and are therefore provided with speedy and ample access to water. The labor shortage problem has been discussed above but note the salience that machinery has for these farmers. More on this shortly. The farmers were occasionally bitter in their responses to the mismanagement of the co-ops, making frequent reference to shortage of supply, delay in deliveries of seed and fertilizer, arrogance of co-op officials and other

similar remarks indicating their dissatisfaction, not with the co-ops per se, but with management. In the miscellaneous category fell responses that could be related to mechanization. Several respondents complained of a lack of transportation, several more of the high cost of production, and others mentioned marketing problems, bad roads, the rotation system, low crop prices and so on.

When asked what they thought would be the best way to solve these problem, farmers had responses as follows:

Responses	N	%
More fertilizer	85	26
More water	85	26
More machines	76	23
Bettering drainage system	40	12
Miscellaneous	44	13
	330	100

As one would expect, the farmers indicated that the co-ops should provide more fertilizer, make the irrigation system better, etc., but the percentage who indicated that more machinery would help provide a solution to their problems is very instructive in that these were open ended questions. The farmer perceives machinery as a means of getting water in greater quantities in a shorter amount of time, and as a means of relieving him of the burden of relying on expensive hired labor, of transporting his crops, reducing the cost of production, and so on.

Knowledge about Machinery

When the farmers were asked if they thought that machinery was important to the Egyptian farmer, all 158 of them replied in the affirmative. Some of these attitudes are based on wishful thinking or some ideal notion about what machinery would do for them. However, as can be seen in Table VIII. 6, 109 farmers (69%) have considerable knowledge about the machinery they feel important to farming.

Note also that those farmers who are highly mechanized are also more knowledgeable.*

TABLE VIII. 6

DEGREE OF MECHANIZATION
BY KNOWLEDGE AND AWARENESS OF MACHINES

Knowledge Index	Degree of Mechanization							
	LOW		MEDIUM		HIGH		TOTAL	
	N	%	N	%	N	%	N	%
0 - 9	28	43	13	27	8	18	49	31
10 - 15	26	40	22	46	14	31	62	39
16 & above	11	17	13	27	23	51	47	30
TOTAL	65	100	48	100	45	100	158	100

The Economics of Machinery

After ascertaining the farmer's knowledge about machinery, a later question asked what machines he would be interested in buying. As shown in Table VIII. 7, a total of 124 (79%) indicated an interest in buying some kind of machine. Of these, 87 respondents (70%) indicated an interest in a water pump, 77 or 62% were interested in a large tractor, 47 (38%) showed interest in a thresher. There was also interest in a medium-size tractor (27), two-wheel tractors (24) and harvesters (23). When the categories are combined, the farmer's primary interest appears to be in tractors; water pumps are a close second. It is interesting to note that of those showing interest in large tractors, a very large proportion are represented

* A knowledge and awareness index was developed in which the farmer's knowledge was recorded in the following manner: They were asked if they had heard of, seen, knew the cost of, and knew where to buy each of nine machines. For each category they were awarded one point. Possible scores ranged from 0 to 36, actual range is 4 - 30.

TABLE VIII. 7

SIZE OF HOLDINGS BY TYPES OF MACHINES EGYPTIAN FARMERS ARE INTERESTED IN BUYING

Type of Machine	Size of Holdings: Less than one (N = 32)		1 - 2.99 (N = 52)		3 - 4.99 (N = 18)		5 - 9.99 (N = 17)		10 - 24.99 (N = 8)		25 & over (N = 2)		Totals (N = 124)	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Large Tractor	20	63*	29	56	9	50	13	77	6	75	1	50	77	62
Medium Tractor	5	16	14	27	5	31	1	6	2	25	0	0	27	21
Small Tractor	1	3	0	0	2	13	0	0	0	0	0	0	3	2
2-Wheel Tractor	5	16	9	17	3	19	6	35	1	13	0	0	24	19
Electric Pump	0	0	7	14	4	25	11	65	3	38	0	0	25	20
Motor Pump	19	59	30	58	3	19	6	35	4	50	0	0	62	50
Harvester	6	19	9	17	3	19	1	18	1	13	1	50	23	19
Thresher	11	34	19	37	4	25	8	47	4	50	1	50	47	38
Winnower	0	0	0	0	1	6	0	0	0	0	0	0	1	0
TOTALS	67	23**	117	41	33	11	48	17	21	7	3	1	289	

* As a percent of farmers in the category

* As a percent of total response

TABLE VIII. 8

SIZE OF HOLDINGS BY TYPE OF MACHINES FARMERS WOULD RECOMMEND FOR THE EGYPTIAN FARMER

Type of Machine**	Size of Holdings: Less than one (N = 52)		1 - 2.99 (N = 51)		3 - 4.99 (N = 18)		5 - 9.99 (N = 17)		10 - 24.99 (N = 8)		25 & over (N = 2)		Totals (N = 148)	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Large Tractor	41	79*	42	85	15	83	16	94	8	100	2	100	134	85
Medium Tractor	9	17	10	16	7	39	3	18	1	13	0	0	30	19
Small Tractor	0	0	5	9	1	6	3	18	1	13	0	0	10	6
2-Wheel Tractor	10	19	17	29	7	39	8	47	1	13	1	50	44	29
Electric Pump	5	10	14	23	10	56	4	22	1	13	0	0	34	22
Motor Pump	43	83	46	75	11	61	12	71	8	100	1	50	121	77
Harvester	9	17	16	26	5	28	5	29	1	13	1	50	37	23
Thresher	30	58	32	52	11	61	10	59	4	50	2	100	89	58
Winnower	1	2	1	2	0	0	3	18	1	13	0	0	6	4
TOTALS	148	29*	193	38	67	13	64	13	26	5	7	1	535	

* As a percent of farmers in the category

* As a percent of total response

** When there was some question about the meaning of large, medium or small tractors, the farmer was told the following: Large tractor = 45-65 horsepower; medium = 20-45 horsepower; small = 5-20 horsepower.

by those whose holdings are less than three feddans. The probable explanation for this lies in the fact that farmers with small land holdings expect to do custom work for others. Fully 91% of all farmers indicated that they felt they could earn more money if they owned machines. A not too incidental finding is that of the 124 farmers who showed an interest in buying machines, 83% indicated they would be interested in buying the machines in cooperation with other villagers.

Of those who indicated no interest in buying a machine (34 or 21%), the reasons given were that the machines were too expensive or impractical for their land. A few other respondents (9) indicated they would rather use family members for their work and fewer still (6) said they preferred hired labor. The bulk of these responses come from the governorates of Giza and Sharkia and the explanation is probably due to the presence of large numbers of private operators in those two areas. Moreover, 65% of those not interested in buying machines hold less than one feddan, 27% hold 1 - 2.99 feddans and the remainder are those who hold between 3 and 4.99 feddans.

It is apparent that the farmer in Egypt has considerable knowledge about and considerable appreciation of what machinery will do for him. When asked what kind of machine he would recommend for the Egyptian farmer, he responded with considerable enthusiasm. Eighty-five percent recommended a large tractor and the proportion doing so increased with size of holdings. As shown in Table VIII. 8, farmers recommended more than one type of tractor with the most frequent combination being a large tractor and a 2-wheel tractor. Beyond the farmers' love affair with the tractor, water pumps were next in line in importance. Fully 91% recommended some kind of water pump and a surprising proportion (56%) also recommended threshers. Such interest and concern about the utilization of farm machinery appear to be related to

certain structural and economic condition which are forcing farmers in this direction. We have already mentioned the shortage and lack of predictability of farm labor and the farmer's need to get larger quantities of water in a shorter period of time, but there are other reasons which we can infer.

The farmers believe that the government co-op machine service is a good idea (82%). In addition, the co-op has other benefits which are important to the farmer. When asked what the benefits were, the farmers responded with the following: Co-op provides

Response	N	%
Production requirements of seed fertilizer and seed	229	73
Provide machine service	35	11
Provide loans	23	7
Extension services	15	5
Other miscellaneous	13	4
	315	100

These responses were fairly consistent across all governorates. Note that only 35 mentioned machine service. The reasons for this became obvious when the farmers were asked about the liabilities of the co-ops. Here is how they responded:

Response	N	%
Shortage of fertilizers, seeds and insecticides	96	43
Mismanagement	49	22
Shortage of machines	46	20
Mistreatment	18	8
Other miscellaneous	17	8
	226	100

There is no doubt the farmer is dependent upon the co-ops and, given the structure and policies for distribution, he needs them for, among other things, financial reasons. The prices of those items needed for farm production are controlled and usually favor the farmer from an economic point of view. This

positive view is evident by the larger number of positive respondents (315) versus negative responses (226). However, among the negative responses, in addition to the shortage of machines, the category mismanagement includes such complaints as favoritism to the large farmer (including use of machines), managers not repairing machine breakdowns, and board members monopolizing machines--all of which preclude timely use of machines by the average farmer. Another reason why the farmer is interested in mechanizing is that he feels he is being exploited by the tractor and waterpump operators. Seventy-seven percent of the farmers are dissatisfied with machine operators. Their responses to ways in which they feel exploited are:

Responses	N	%
High cost	104	78
Not available	15	11
Unreliable	10	8
Other miscellaneous	4	3
	133	100

In contrast to the favorable response to the government operated machine service, only 65% believe that private machine service is a good idea. Larger proportions of dissatisfaction with private machine operators occur in the governorates of Kaluabia, Sharkia and Assuit.

Despite the fact that farmers feel somewhat exploited by private machine operators, they do not feel any threat to the ownership of the land. Only 6 farmers indicated that machine owners had tried to buy their land or put them in a position that would lead to them having to sell their land. Those who responded this way do not feel that the small farmer is the target of these efforts. Most of them indicated that their land was not expendable and they felt secure in their ownership.

Although the farmers would like to mechanize their farm operations, 80% indicate they cannot afford to buy a machine. In this instance, the pattern of poverty is prevalent in all governorates. The reasons given for this disability are:

Response	N	%
No money for down payment	96	53
Too hard to get credit	52	29
Cost of loans too high	14	7
High prices	6	3
Miscellaneous other	13	7
	181	99

When asked what they thought should be done to increase the number of farm machines in Egypt, they responded mostly in financial terms. Following are their responses:

Response	N	%
Reduce cost of machines	118	32
More cooperation between villagers (To buy machines)	64	17
Installment plan within their means	64	17
More money for their crops	45	12
Reduce cost of loans	42	11
Getting more machines in co-ops	25	7
Miscellaneous other	17	5
	375	101

Thus, one apparent way to increase machinery among Egyptian farmers would be by an infusion of more money into the system, by way of loans, or permitting the farmer to increase the price for his crops and supporting the increase in price.

Social Factors Associated with Mechanization

Obviously money is a very direct and important means by which mechanization can take place. However, there are social factors that can facilitate the process of mechanization.

We have already seen the mechanization is positively related to the degree of knowledge about machines. As can be seen in Table VIII. 9, knowledge about

machines is also related to the Traditionalism-Modernism score.* That is, those who are willing to try new ways of farming are also likely to have knowledge about farm machinery.

TABLE VIII. 9

TRADITIONAL-MODERNISM SCORES BY KNOWLEDGE OF MACHINES

Knowledge of Machines	Traditional-Modernism Score							
	LOW 5 - 8		MEDIUM 9 - 10		HIGH 11 - 16		TOTAL	
	N	%	N	%	N	%	N	%
Low								
Less than 10	19	31	12	24	13	28	44	28
10 - 15	29	47	15	30	14	30	58	37
16 & over	14	23	23	46	19	41	56	35
TOTAL	62	101	50	100	46	99	158	100

And, Table VIII. 10, shows that there is also an inverse relationship between age and tradition-modernism scores.

TABLE VIII. 10

TRADITIONAL-MODERNISM SCORES BY AGE

Age	Traditional-Modernism Score							
	LOW 5 - 8		MEDIUM 9 - 10		HIGH 11 - 16		TOTAL	
	N	%	N	%	N	%	N	%
Under 35	5	8	5	10	10	22	20	13
35 - 55	38	61	29	58	18	39	85	54
55 +	19	31	16	32	18	39	53	34
TOTAL	62	100	50	100	46	100	158	101

* Modernism score is derived by summing responses from four items (question number 6, 8, 69, 70 and 71). Higher scores represent the degree to which farmers are willing to try new ways and new techniques in farming.

A greater proportion of those 35 and under have higher modernism scores. The same, but not quite as strong a relationship, exists between education and modernism (Table VIII. 11) and between education and mechanization (Table VIII. 12).

TABLE VIII. 11

TRADITIONAL-MODERNISM SCORES BY EDUCATION

Education	Traditional-Modernism Score							
	LOW 5 - 8		MEDIUM 9 - 10		HIGH 11 - 16		TOTAL	
	N	%	N	%	N	%	N	%
Less than 6 years	16	49	13	43	10	36	39	43
6 - 12 years	14	42	10	33	11	39	35	39
12 years +	3	9	7	23	7	25	17	19
TOTAL	33	100	30	99	28	100	91	101

TABLE VIII. 12

DEGREE OF MECHANIZATION BY EDUCATION

Education	Mechanization Score							
	LOW		MEDIUM		HIGH		TOTAL	
	N	%	N	%	N	%	N	%
Less than 6 years	18	60	11	42	10	29	39	43
6 - 12 years	8	27	11	42	16	46	35	39
12 years +	4	13	4	15	9	25	17	19
TOTAL	30	100	26	99	35	100	91	100

Moreover, when comparing literate with non-literate (Tables VIII. 13 and VIII. 14), the differences are even more pronounced. A far higher proportion of those who are literate have high mechanization and modernism scores compared with those who are illiterate.

TABLE VIII. 13

DEGREE OF MECHANIZATION BY LITERACY

Literacy	Mechanization Scores							
	LOW		MEDIUM		HIGH		TOTAL	
	N	%	N	%	N	%	N	%
Illiterate	34	52	21	44	11	24	66	42
Literate	31	48	27	56	34	76	92	58
TOTAL	65	100	48	100	45	100	158	100

TABLE VIII. 14

TRADITIONAL-MODERNISM BY LITERACY

Literacy	Traditional-Modernism Scores							
	LOW		MEDIUM		HIGH		TOTAL	
	N	%	N	%	N	%	N	%
Illiterate	29	47	20	40	18	39	67	42
Literate	33	53	30	60	28	61	91	58
TOTAL	62	100	50	100	46	100	158	100

In addition, both mechanization scores and modernization scores are higher for nuclear families than they are for extended families (Tables VIII. 15 & VIII. 16).

In sum, there a number of social factors that are related to the mechanization process. Such factors as age, education, nuclear versus extended family type and knowledge about machines all appear to be related to the process of mechanization. And, while the correlations among them may be expected to be high, reflecting some

TABLE VIII. 15

DEGREE OF MECHANIZATION BY FAMILY TYPE

Type of Family	Mechanization Score							
	LOW		MEDIUM		HIGH		TOTAL	
	N	%	N	%	N	%	N	%
Nuclear	49	75.38	31	72.09	37	86.05	117	78
Extended	16	24.62	12	27.91	6	13.95	34	23
TOTAL	65	100.00	43	100.00	43	100.00	151	100.00

TABLE VIII. 16

TRADITIONAL-MODERNISM BY FAMILY TYPE

Family Type	Traditional-Modernism Score							
	LOW 5 - 8		MEDIUM 9 - 10		HIGH 11 - 16		TOTAL	
	N	%	N	%	N	%	N	%
Nuclear	47	58	37	77	33	81	117	78
Extended	15	42	11	23	8	20	34	23
TOTAL	62	100	48	100	41	101	151	101

recent changes in the Egyptian socio-economic structure, they are, nevertheless, factors to be taken into consideration in the efforts to mechanize the Egyptian farm. For example, increasing the educational levels of the present generation of children would probably affect all of the other social factors mentioned above.

This phenomenon is also reflected, in part, by the attitudes of farmers toward farming. Whereas practically all those questioned like farming, most (75%) do not think their sons will be farmers. Those with a traditional attitude toward farming are far more likely than farmers with modern attitudes to indicate that their sons will not become farmers. This probably reflects the arduousness of farming, mostly by animal and human labor, so that these farmers prefer their sons try occupations that are easier. This idea is reinforced from responses indi-

cating that modern, mechanized farmers are less likely to want to change occupation. The implication of this material is that education is important in exposing people to new ideas and change. Therefore it is important to keep people in school not only to eradicate illiteracy, but to free them from traditional practices that restrain their ability to raise their standards of living.

Benefits of Mechanization

The farmers were asked what they thought the benefits of mechanization would be and the largest proportion of responses related to raising their quality of life.

Response	N	%
Less drudgery	139	34
More leisure time	96	24
Education for children	57	14
Increase production	33	8
Increase income	24	6
Improve land	22	5
Get rid of laborers	14	4
Release animals from work	8	2
Miscellaneous	11	3
	404	100

As can be seen in the above responses, a farmer's expectations in respect to what farm machinery will do for him is quite great. Moreover, even though the question about personal goals and goals for his children were unrelated to mechanization per se, he tended to think in terms of machines. Therefore we see some element here of a response set in that the questionnaire items tended to be in regard to mechanization. However, Aryout[1] states that the Egyptian farmer thinks in terms of the immediate present and that he is tied to the here and now; and because of this, the Egyptian farmer appears to be illogical. Some elements reflecting this view do appear in his response to what his present goals are and one notes below that the

[1] Ayrout, Henry Habib. The Egyptian Peasant. Boston: Beacon Press, 1963.

responses do reflect the fellahin's attachment to his land.

Response	N	%
Increase land, production, income	105	33
Improve facilities of gov. co-ops	94	29
Acquisition of or use of machines	88	28
Raise children, build a house, etc.	22	7
Miscellaneous	10	3
	319	100

Thus, even though the response set seems relevant here, one wonders what other response the farmer could have made.

In regard to the farmer's goals for his children, a different picture emerges. Although some of the farmers show concern for an increased standard of living (20%), more land and machinery for their children (10%), fully 64% envision more and longer education for their children. The latter goal has important implications for farm labor. It has been estimated that 20% of labor inputs to Egyptian agriculture are by children between the ages of 6 and 12.[2] Should the aspirations of the farmer be realized by complying with compulsory education, the replacement of child labor will most likely be in the form of machines.

Farmer's Goals for Children over the next Five Years

Goals	N	%
Education	102	64
Increase standard of living - health	34	21
More land, more productivity	16	10
Getting married	6	4
Miscellaneous	2	1
	160	100

In addition, the farmer was asked if he thought that farm machinery would

2 Garret, Roger E. "Impressions with respect to Mechanization". USAID/Egypt unpublished manuscript.

help to achieve his present goals and those for his children; the response was a resounding yes. Fully 87 percent thought that machinery would help them achieve goals for themselves and for their children. Only 10% responded negatively to this question and another 3% did not respond. Thus, we obtain a picture in which machinery plays an important role for the farmer's goals and aspirations which include such benefits as less back-breaking work, more leisure, more education for his children and an increased income.

Potential Effects of Mechanization

Attempting to predict the impact of mechanization on the farmer and the social system of which the farmer is a part is not an easy task. The farmer does expect to reduce his dependence on agricultural labor and when asked what will happen to such labor when the Egyptian farmer mechanizes, his responses were rather diffuse. Many expressed the hope that laborers would get jobs elsewhere but many more seemed not to know. Their responses as categorized:

Response	N	%
Get jobs in non-agricultural work	73	36
Become machine operators	47	23
Other work with agricultural machines	34	17
No work	13	6
Miscellaneous	37	18
	204	100

Laborers were to get jobs in factories, government, countries outside of Egypt, and even the professions. Other work inside agriculture was to help clean out drainage ditches or work on poultry or fruit farms. The miscellaneous category included such responses as they could rent or buy land, nothing will happen to them, or that mechanization would decrease the cost of agricultural labor. This is not a clear picture but it is not likely that the farmer has given this pos-

sible outcome very much thought.

There has been some discussion in the literature and among agricultural officials, and there is a general expectation, that as mechanization increases the number of animals on the farm might decrease. In contrast, these data show that farmers with a high degree of mechanization also have larger numbers of animals.

TABLE VIII. 17

DEGREE OF MECHANIZATION BY
NUMBER OF ANIMALS OWNED

Number of Animals	Degree of Mechanization							
	LOW		MEDIUM		HIGH		TOTAL	
	N	%	N	%	N	%	N	%
1 - 2	33	56	22	55	15	35	70	49
3 and over	26	44	18	45	28	65	72	51
TOTAL	59	100	40	100	43	100	142	100

There is also a relationship between a strong interest in buying machines and a larger number of animals and a larger proportion of those who own a large number of animals have a higher knowledge index regarding machines. Whether animals will increase or decrease is still a hypothetical question, but Noel Vietmeyer[3] feels that people in many countries will not give up their water buffalo because they are too valuable a resource. He attempts to substantiate his remarks by claiming that there are some operations, such as in rice fields, where the buffalo is an esteemed member of the family and also provides milk and cheese. Only follow-up studies hold the answer to the question of whether the machines will replace the water buffalo.

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3 Vietmeyer, Noel D. "Why Not a Tractor that Provides Meat, Cheese, and Love". Smithsonian, December 1976, pp. 83-91.

General Social Implications of Mechanization

The survey, work by the Study Team in Egypt and the literature on mechanization provide some additional insights. The full impact of increased mechanization may not be known until an evaluation of the farmer and his social institutions can be made after the fact. Even then, other technical, economic and policy influences will have their impact so that it will be difficult to isolate the impact of mechanization alone. However, the limited mechanization of Egyptian farming has already begun to change the way the farmer conducts his business. The advent of private machine operators appears to have led to less reliance upon government cooperatives and to an increase in the signs of class consciousness. Farmers repeatedly made references to the "big shots", big people, poor people, and the like. Moreover, it is possible that private tractor operators may become a 'class' unto themselves. Harik[4] has reported the same phenomenon in an Egyptian village in the delta. Farmers referred to them as the 'rich' people. Consequently, one of the reasons small farmers are interested in buying machines is their perception that machine operators make a great deal of money--money that farmers could make if they had machines. One would expect greater social differentiation as machines make for greater specialization and a greater division of labor.[5]

Other social organization methods of getting work done is also likely to change with increased mechanization. Some types of mechanization may put children out of work and into school. As education and literacy increase, so too will the villagers' exposure to the nationwide communication system. Mass media are likely

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4 Harik, Iliya F. The Political Mobilization of Peasants. A Study of an Egyptian Community. Bloomington, Indiana: Indiana University Press, 1974.

5 Hopkins, Nicholas S. "Modern Agriculture and Political Centralization: A Case from Tunisia". Human Organization, 37:1, 1978, pp. 83-87.

to have a greater impact on those who are literate. What specific changes will ensue from this are unknown. However, one would expect that farming as a way of life may not appeal to those who have knowledge and awareness of the quality of life elsewhere, such as in the urban areas.

Hopkins[6] has found that when farm machines were introduced into Tunisia, there was not only a greater division of labor and role differentiation but also a need for more labor to complement and complete the rhythm of operations that the machine, in a sense, dictates. If these operations are coupled with an increase in use of machines for transport and in improved storage facilities, there will be a need for a larger number of laborers rather than a surplus as some are predicting. One would expect, however, that with increased specialization and interdependence introduced by machines, the farmer would also be forced to relinquish some of his present-day independence.

Another social institution which apparently has already changed a great deal is the informal means by which villagers have made decisions. In the past, farmers gathered at the waterwheel because the level of the water was not predictable and they had to be there to be sure to catch the water when the level became high enough to irrigate the land. This location became the site of informal planning, organization, and decision-making. However, since the advent of the high dam and improved and timely delivery of water, the need to be 'on the spot' to obtain water is no longer necessary. Consequently, meetings are more formal. They have also led to a greater degree of role differentiation and, simultaneously, some loss in efficiency of communication, lowering of feelings of unity and increased status discrepancies. One would expect this process to continue at an accelerated

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6 Hopkins, Nicholas S., Ibid.

pace if farmers in the future no longer reciprocate with neighbors in sharing labor as a regular farm practice. On the other hand, it may be that farmers, in their need to keep machinery in good shape, may gather at the maintenance shops and share repair tools and equipment with their neighbors.

Finally, much evidence from other studies of mechanization have indicated that mechanization has led to increased production, increased sales and income, reduced drudgery of work, increased level of living and increased per capita income.[7] The same can be expected for Egypt. However, there are some negative findings in that increased mechanization also tends to decrease the agriculture work force, decrease farm population, increase farm size, and result in increased hazards to health and safety. Structural differentiation in roles and in institutional organization also occur.[8] Such analyses as these have been based on U. S. agriculture and such rank comparisons with the U. S. or other countries are fatuous unless one concommitantly deals with the social fabric of the community in which mechanization takes place. Although the farming pattern may be the same, the values involved in the attachment to the land, the feelings of independence, and the village and kinship relations of the particular area undergoing the proposed change must also be considered and accommodated. Otherwise, the proposed change may founder on an unstable base.

Summary

Although only 7 of the 158 fa[illegible] owned tractors and 123 of the total owned

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7 Goss, Kevin F. and Richard D. Rodefeld. "Consequences of Mechanization in U.S. Agriculture 1935-1975". Paper read at the Rural Sociological Society Annual Meeting, Madison, Wisconsin, Sept. 1977.

8 Ibid.

no machines of any kind, the entire group concurred that machinery was important to the Egyptian farmer and the vast majority showed an interest in buying a water pump or large tractor. Interest was also shown in purchase of threshers, medium-size and two-wheel tractors and harvesters. However, 80% indicated they could not afford to buy a machine, because they had no down payment, found it too hard to get credit, the cost of loans were too high or some related reason. Farmers took the position resoundingly (87%) that machinery would help them active goals they had for themselves or for their children. They looked upon machines as a way to replace unavailable or high-cost labor and, in fact, believed that hired labor was more expensive than either animal labor or machines. Eighty-five percent of the respondents recommended large tractors. The farmers in the study did not feel any threat to the ownership of their land from machine owners.

In general, therefore, the social climate among farmers, as evidenced by the results of this study, indicates high recognition of the need for farm machines, broad acceptability of machines, particularly in light of the perceived lack of availability and high cost of hired labor, a pronounced preference for large tractors and pumps, and, in general, great optimism rather than pessimism as to the beneficial effects of machines.

Additional References:

1. Abdel-Fadil, Mahmoud. Development, Income Distribution and Social Change in Rural Egypt (1852-1970), London: Cambridge Univ. Press, 1975.

2. Abdou, Youseff M. Agricultural Mechanization in Underdeveloped Countries: Its Relation to Economic Development and Available Conditions in Egyptian Agriculture. Master Degree Thesis, Faculty of Agriculture, Alexandria University, Alexandria, 1973.

3. El Togby. Contemporary Egyptian Agriculture, 2nd edition, Cairo, Egypt, The Ford Foundation, 1976.

4. Gotch, Carl H. Agricultural Mechanization in Selected Middle Eastern Countries: Summary Observations. Unpublished report. USAID Contract No. NE-147-77-8, 1978.

5. Mayfield, James B. Local Institutions and Egyptian Rural Development. Special Series on Rural Local Government, Rural Development Committee, Cornell University, 1973.

6. Republic of Egypt, 1960 Agricultural Survey. Cairo: Ministry of Agriculture. Taken from Mayfield, James B.

7. Tadros, Helmi R. The Study and Evaluation of The Rehabilitation Process in the Newly Settled Communities in Land Reclaimation Areas.(Part 1). American University of Cairo, Social Research Center, 1975.

CHAPTER IX

YIELD EFFECTS OF WATER LOGGING AND SALINITY

Introduction

In the main, this Study Team report considers the effects of mechanization on crop production from the standpoint of national average yield, hence averages soil conditions. Water logging and salinity adversely affect yields in varying degrees on a large part of Egypt's prime cropland. Chapter XI deals specifically with the role of mechanization in coping with those problems. Other aspects of mechanization also interact with water logging and salinity both positively and negatively. On the one hand, it is less profitable to mechanize crop production on deteriorated lands as their base yields are lower. Conversely, changes in production practices such as improved tillage, more timely planting and improved irrigation practices may offset some of the adverse effects of poor drainage and salt accumulation.

Research has shown that yield reductions from salinity, alkanity and poor drainage result from the adverse effects of sodium on plants (calcium and/or magnesium deficiency), poor soil conditions which impede water infiltration and percolation, reduced water availability, and reduced aeration. Such soil conditions are problems in many parts of the world. As a result, they have been the subject of a great deal of research. Much of the basic and applied work in the United States is applicable to Egyptian conditions either directly or with appropriate adjustment for basic differences in soil conditions and crops grown. Succeeding sections highlight the findings from particularly relevant U.S. and Egyptian research on key relationships between

soil conditions and crop yields.

Relevant U.S. Research

Salinity and Alkalinity

Many soils of the western United States are similar to soils in Egypt in this regard. The United States Salinity Laboratory has published a handbook (1969) which deals with various aspects of soil salinity. Field crops, fruit, vegetable and forage crops are listed according to their salt tolerance. Salinity is determined by measuring the soil's electrical conductivity. The following table lists some of the important crops and the electrical conductivity at which a yield depression of 50 percent will occur.

TABLE IX. 1

ELECTRICAL CONDUCTIVITY ($EC_e \times 10^3$) VALUES OF THE SATURATION EXTRACT EXTRACT IN MILLIMHOS PER CENTIMETER AT 25° C ASSOCIATED DECREASE IN YIELD

Crop	Electrical Conductivity
Barley (grain)	16
Sugar beet	12 - 14*
Cotton	10
Wheat	9 - 10*
Rice	8
Corn	7 - 8*
Field beans	4
Sorghum	7 - 8*

* Judgement value; see U.S. Salinity Handbook for more detail.

It is apparent from this list that salinity does not affect all crops equally. It is also apparent from this information that on Egyptian soils (Table IX. 2) considerable yield reductions result due to saline and alkaline soils. Almost 50 percent of Egypt's soils are Class III and IV soils, with high exchangeable sodium content.

TABLE IX. 2

EGYPTIAN LAND CLASSIFICATION SYSTEM

Land Class	Electrical Conductivity mmhos/cm	Sodium Saturation Percentage	pH	Cultivated Land
I	<4	<15	<8.5	6.2
II	4 - 8	<15	<8.5	45.5
III	8 - 16	<15	<9.0	38.7
IV	*	*		9.6

Class IV land includes soils of the following types: (1) 90% or more sand; (2) Coarse $CaCO_3$ > 20%; (3) Heavy soils rich in soluble salts; (4) High water table; (5) Hardpan.

* Some data missing. (See Egypt: Major Constraints to Increase, Agricultural Productivity, pp. 82-83).

Research into the specific reasons for salinity or alkalinity yield relationships has been both extensive and wide-ranging. Bernstein and Pearson (1956), U.S. Salinity Laboratory, showed that excess soil sodium resulted in lower concentrations of calcium and magnesium in beans, beets, clover and alfalfa--on both loam and clay soils. Addition of a soil conditioner increased the yield only of beets, a very salt-tolerant plant. This indicated that the problem was primarily nutritional and could be corrected by addition of a calcium source such as gypsum. Change and Dregne (1955) worked with a non-

saline calcareous clay loam and added Na_2CO_3 (sodium carbonate) to produce a non-saline alkaline soil. Rising water tables in Egypt produce the same problem on both new and old lands. On these soils, cotton plant growth, seed cotton yield and alfalfa yield were reduced 55 percent, 38 percent, and 44 percent respectively when the exchangeable sodium percentage increased from 3 to 39.3 percent. Their research also showed that high sodium reduced the level of calcium in alfalfa.

Bower and Turk (1964) worked with naturally alkaline soils with high exchangeable soil sodium content. One soil was slightly saline and one moderately saline. The slightly saline soil, which had exchangeable sodium percentage (E.S.P.) of 46.2, produced almost no growth. Addition of calcium to the soil reduced the E.S.P. to 5.6 and growth was increased 20-fold. Addition of calcium and magnesium resulted in an E.S.P. of 8.0 and an increase in growth of 37-fold.

Addition of calcium to the other soil, a silt loam, showed essentially the same trend; increasing calcium amendments resulted in a decreasing E.S.P. and a large yield increase. Addition of hydrochloric acid (HCL), which had the effect of dissolving natural calcium but not reducing alkalinity, also resulted in a large yield increase, indicating that growth response was due to additional calcium and not to reducing alkalinity.

Addition of gypsum to Egyptian soils aids in reducing sodium and alkalinity, provides calcium and helps to improve the soil structure. The latter factor is quite important in Egypt where saline soils are leached with low salt water from the Nile. Research by Martin et al. (1964) showed that the hydraulic conductivity of water was reduced to almost zero when the E.S.P. was increased to above 20 in a clay loam soil. Hydraulic conductivity of soils with an E.S.P. of 0 to 10

was about 0.8 to 2.5 cm/hour. This shows the detrimental effect sodium has on soil structure and water movement. Most of the previous research cited on the subject of salinity-alkalinity-plant response relationships were cases where soils were manipulated in order to get an understanding of the system. Work by Fireman and Reeve (1949) took the opposite approach. They looked at naturally occurring saline and alkaline soils in Idaho where growth was poor and nearby soils of the same type where growth was good. These soils were then analyzed to learn why growth was good or poor. The irrigation water in the area was of excellent quality (70 ppm soluble salts), which is very similar to the Nile River (200 ppm soluble salts). Table IX. 3 presents data in some of the sites and remarks about growth. Site A had a high E.S.P. and would not support good crop growth unless reclaimed. Site N nearby had a good clover crop, but the E.S.P. was very low in comparison to Site A. Site K-1 and K-2 both had high E.S.P.; however K-2 had a high salt content (0.75%) which was 7.5 times higher than K-1. Sites D-2 and D-3 were only three feet apart; however, D-3 was bare whereas D-2 had a good stand of alfalfa. The major difference was E.S.P. in the soil profile. The Canon soils G-5 and G-4 were only 10 feet apart, yet one area (G-5) was bare. The bare spot was more saline, but primarily it had a high E.S.P. The permeability of water at this site was very low, less than 0.01 cm/hour compared with 1.9 cm/hour where sodium was lower and growth was good, indicating the poor soil structure and related water problems. Other sites A and E had poor water penetration as a result of excess sodium.

Soil Structure

In general, all the above soils were too high in soluble sodium and exchangeable sodium. These directly or indirectly affected water permeability and soil structure.

TABLE IX. 3

PH, SALT CONTENT, EXCHANGEABLE-SODIUM-PERCENTAGE, AND PERMEABILITY OF SOME PROBLEM SOILS FROM GEM COUNTY, IDAHO

Sampling Site	Series	Texture	Depth	pH*	Salt**	E.S.P.+	Permeability++	Remarks
			inches		%	%	cm./hr.	
A	Letha	fi. sa. loam	0-3	8.7	0.06	22	0.31	Virgin soil carrying good growth of desert vegetation.
			3-11	10.3	0.14	48	0.12	
			11-24	10.4	0.20	62	0.21	
N	Letha	fi. sa. loam	0-7	7.2	0.01	4	3.8	Good field of red clover with occasional bare spots.
			7-13	7.4	0.01	5	1.6	
			13-32	7.6	0.01	9	1.5	
K-1	Letha	fi. sa. loam	0-6	8.6	0.10	44		Fair field of corn with occasional bare spots.
			6-14	8.4	0.07	42		
			14-28	8.4	0.04	36		
K-2	Letha	fi. sa. loam	0-6	8.6	0.75	46		Bare spot in corn field 10 feet from above sample, high water table.
			6-12	8.8	0.20	64		
			12-24	8.9	0.12	82		
D-2	Reed	silt loam	0-6	8.2	0.06	18		In good alfalfa 1 foot from edge of bare spot.
			6-13	8.3	0.06	34		
			13-24	8.6	0.07	45		
D-3	Reed	silt loam	0-6	8.9	0.16	59		Three feet from above sample, in "bare" spot.
			6-12	8.6	0.11	58		
			12-30	8.4	0.07	39		
G-5	Canon	si. cl. loam	0-8	7.5	0.03	4	1.9	Good growth mixed wheat and alfalfa.
			8-16	7.8	0.03	6	1.4	
			16-28	7.7	0.02	7		
G-4	Canon	si. cl. loam	0-8	8.2	0.20	54	<0.01	Bare spot in field 10 feet from above sample.
			8-16	8.9	0.17	74	<0.01	
			16-28	8.9	0.15	82	0.07	
F	Moulton	fi. sa. loam	0-6	8.2	0.22	32	2.5	Poor pasture in first river bottom; high water table.
			6-12	8.5	0.08	40	0.67	
			12-24	7.6	0.02	7	4.00	
J	Wardwell	fi. sa. loam	0-2	6.7	0.04	5	9.00	Excellent perennial pasture kept fairly wet; water table at 22 inches
			2-11	7.4	0.02	18	0.56	
			11-15	7.8	0.03	36	0.02	
			15-22	8.4	0.03	41	0.40	
E	Power	si loam	0-7	6.5	0.01	7	0.1[illegible]	Bare spot in good alfalfa field; poor water penetration.
			7-14	7.2	0.04	17	0.0[illegible]	
			14-23	7.8	0.09	20	0.5[illegible]	

* pH of saturated paste.
** Percent salt, dry basis by chemical analysis of saturation exact.
\+ Exchangeable-sodium percentage based on exchange capacity.
++ Laboratory permeability of disturbed soil samples at conclusion of 6-inch irrigation or a week's run, whichever is less.

Rasmussen (1972) did work on similar soils which were saline and high in sodium. These problem soils had distinctive B_2 clay horizons which were low in soluble salts, but contained moderate to high levels of exchangeable sodium. The lower soil horizons usually contain both excessive exchangeable sodium and soluble salts. Some associated non-saline soils frequently have silica-calcium-carbonate-cemented hardpan layers and are underlaid with stratified layers that limit water infiltration and restrict water and root penetration.

In Rasmussen's research, treatments consisted of deep plowing 90 cm (35 inches); deep plowing plus gypsum at 18 and 36 metric tons/ha; and subsoiling. Deep plowing was done with a 1.2-m moldboard plow pulled by a 250 hp tractor. Subsoiling was done with the same tractor and a special subsoiling machine having a fluted, mole-like device behind each shank. A similar non-saline soil also was subsoiled and deep plowed. Yield data are reported in Table IX. 4.

TABLE IX. 4
SUMMARY OF CROP YIELDS AS INFLUENCED BY TILLAGE AND AMENDMENT TREATMENTS, 1960 and 1962.

Soil and Treatment	Grain Kg/ha 1960	Alfalfa Mt/ha 1962
Non-Saline		
Untreated check	3060	13.0
Subsoiled 70 cm depth	4280	13.6
Deep plowed 90 cm, no gypsum	5030	13.6
Saline		
Subsoiled 70 cm depth	1290	2.5
Gypsum 36 Mt/ha	1020	2.9
Deep plowed 90 cm	1590	7.1
Deep plowed 90 cm plus	5530	11.9
18 Mt/ha gypsum	5300	11.2
Deep plowed 90 cm plus 36 Mt/ha gypsum	4910	13.1
LSD 5% level	1140	1.34

Both subsoiling and deep plowing increased yields of grain (wheat and barley) on the non-saline soils with deep plowing being the highest. Alfalfa yield on this soil was not increased by tillage. In the saline soil, deep plosing alone appeared to be a sufficient treatment. Deep plowing in addition to gypsum application was significantly different from plowing alone. Total water intake on deep-plowed treatments increased 230 to 270% compared to the untreated saline soil. Deep plowing was effective on this soil because sufficient $CaCO_3$ (calcium carbonate) was present in the soil profile (B_{3ca} or C_{ca} horizon) to decrease both excess salinity and sodium. In addition, the increased water infiltration would aid in leaching out the excess salts. In a companion study, Rasmussen showed that these saline soils could be reclaimed by deep plowing alone within two cropping years. These data indicate that if sufficient soluble calcium is present in the profile, such as some of the reclaimed desert soils of Egypt, deep plowing alone may be sufficient to reclaim the land, provided sufficient irrigation is applied to leach the salts out of the rooting zone. Russell (1973) in his book Soil Conditions and Plant Growth speaks to the question of reclaiming saline and alkaline soils as follows:

> The principles underlying the reclamation of land rendered infertile by alkali are: first, to ensure that their drainage is adequate and that saline water is not seeping into them from higher ground; and, second, to replace some of the exchangeable sodium by calcium.[1] If the soil contains gypsum, draining the land and flooding it with water is probably all that is required, although if the soil is heavy, it may initially be sufficiently impermeable for the cropping to have to be chosen very carefully, But if the soil is low in gypsum, the primary trouble, which is either present, or which will develop unless precautions are taken, is the impermeability of the surface soil to water, and one great danger in reclamation that must be guarded against is increasing the impermeability of the soil during the reclamation. Soils containing much exchangeable sodium, or free sodium carbonate, will deflocculate and become quite impermeable to water if wetted

with pure water, or with rain, whereas if they contain much soluble salts, or the irrigation water has a high salinity, they may remain flocculated and permeable. Hence, the second great principle in reclaiming alkali soils is to maintain a fairly high salt content in the soil during the process of leaching out the exchangeable sodium, and in some areas high-salt waters are initially used to help get leaching started.[2] Provided the soil remains permeable, drainage, adding gypsum or sulphur, and flushing down the salts will remove exchangeable sodium without difficulty.

Many disused alkali soils are, however, almost impermeable to begin with, and the improvement in permeability is the primary problem.[3] Typically this is done by relacing the exchangeable sodium in the surface layer and so stabilising it. and then deepening this stabilised layer. Adding gypsum to the surface soil, or on some lighter soils working in farmyard manure or compost and then letting it wet and dry a few times will be enough to give a few inches of stable permeable soil. The soil may then be flooded, provided an adequate drainage system has been installed,

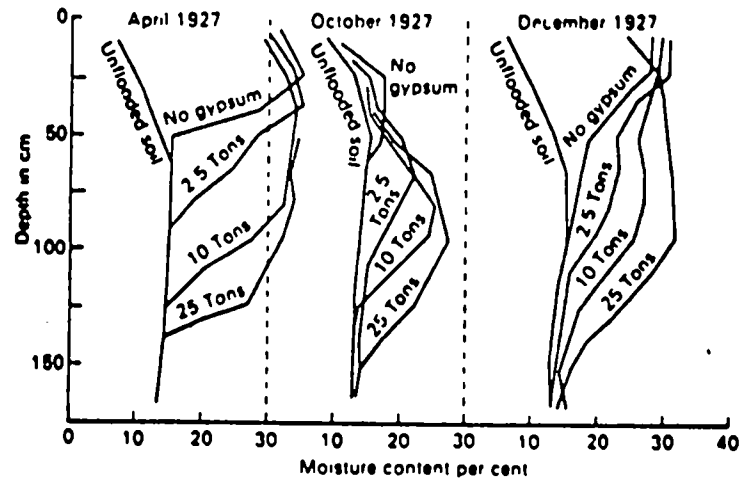

Fig. 27.3. Effect of gypsum on the permeability of soil. Percentage of moisture at different depths of unflooded soil (lefthand line) and of four flooded soils (righthand lines) treated with different quantities of gypsum (tons per hectare applied).

to allow the gypsum to wash down slowly into the subsoil, improving the permeability of every layer into which it penetrates, for rarely does a drained soil have a permeability of less than a few inches of water a month.[4] Figure 27.3 taken from some experiments of H. Greene on an impermeable Gezira clay, from the Sudan in which sodium constitutes 10 per cent of the exchangeable ions, shows this effect of gypsum of increasing the permeability of the subsoil.[5] The land was flooded in April, and shortly afterwards soil samples were taken for moisture content. The soil was left fallow and then flooded again in December and soil samples again taken. Without gypsum the water remained near the surface; with increasing dressings of gypsum it penetrated deeper and deeper into the soil. The drying out affected the first 60 cm equally whatever the gypsum treatment, but, as would be expected, much of the water that had penetrated below this depth remained in the subsoil. The permeability of the soil can also sometimes be increased by very deep ploughing,[6] particularly if some gypsum is ploughed in at the same time or if gypsum is present in the subsoil. This is probably most efficacious if the subsoil has a compacted layer, for deep ploughing can bring this layer up to the surface, break it up to some extent, and expose it to the weather so its structure can be mellowed by drying and wetting in the hot season.

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1. For illustrations of successful methods of reclamation, see W.P. Kelly, J. agric. Sci., 1934, 24,72; Hilgardia, 1934, 8, 149; Calif. Agric. Expt. Sta., Bull 619, 1973 (San Joaquin Valley California);"The Diagnosis and Improvement of Saline and Alkaline Soils";R.E. McKenzie and J.L. Bolton, Sci. Agric., 1947, 27, 193 (Val Marie, Saskatchewan); R. Aladzem, Bull. Un. Agric Egypte, 1947, 45, 47; R.S. Snyder et al., Idaho Agric. Sta., Bull. 233, 1940; W.L. Powers, Oregon Agric. Expt. Sta., Bull. 10, 1946.

2. For examples see R.C. Reeve and C.A. Bower, Soil Sci., 1960, 90, 139; Proc. Soil Sci., Soc. Amer., 1966, 30, 494; S. Muhammed et al., Soil Sci., 1969, 108, 249.

3. For an American bulletin on methods of doing this, see R.F. Reitemeier et al., U.S. Dept. Agric., Tech. Bull. 937, 1948.

4. W.L. Quayle (Wyoming Agric. Expt. Sta., Bull. 243, 1941) quotes examples of the value of flooding some Wyoming soils for two months before a crop is taken.

5. J. Agric. Sci., 1928, 18, 531. See also with O.W. Snow, J. Agric. Sci., 1939, 29, 1.

6. V.A. Kovda, Khim. Sotsial. Zemled, 1941, No. 4,31; I.N. Antipov-Karataev and A.A. Zaitzev, Dokuchaev Inst. Soils, 1946, Anth. 14.

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The second operation is to establish a crop on the land, either sown or of natural weeds, for the plant roots will continue the task of increasing the permeability of the subsoil, both by abstracting water from it, so causing cracks to develop which will let water down quickly, and also by respiring carbon dioxide there which will reduce the alkalinity somewhat. The choice of crop is, however, limited, for it must be able to withstand the prolonged waterlogging necessary for washing down as much sodium as possible into the deeper subsoil. Rice is an ideal crop, if other conditions are suitable, as it can be kept waterlogged throughout much of the season. Sweet clover (Melilotus Alba) and strawberry clover (T. fragiferum) are also suitable, so are many grasses, and under some conditions so is lucerne, though lucerne will not stand waterlogging so well as the others. Once these crops are established, they are encouraged to root deeply by being given heavy irrigations at as long intervals as possible, so the roots take as much water as they can from the subsoil before the next irrigation, though they must not be allowed to dry the soil so much that the soil solution becomes sufficiently concentrated to harm the roots. The first crop to be taken is often ploughed in as green manure, as the plant may contain too much salt for high feeding quality, and the green manure will not only produce carbon dioxide in the soil during its decomposition, but will also slowly set free plant nutrients such as phosphate, iron, manganese and zinc, which may be very unavailable in alkaline soils.

A good crop rotation is an excellent insurance against alkali trouble, for grass, clover and lucerne leys can all build up the structure of a soil and improve its stability; and if these leys are consumed on the farm by dairy cattle, they will be returned to the land as farmyard manure, which again has a valuable action in maintaining the permeability of the surface soil.

The most usual addition to the soil to help displace exchangeable sodium is gypsum, $CaSO_4.2H_2O$, for this is more efficient than calcium carbonate because 1 litre of water will dissolve 30 m eq of calcium as calcium sulphate, but at pH 8.4 only 1 m eq of calcium from the carbonate; although at pH 7 it will dissolve 5 m eq. Sulphur is also used when it can be obtained cheaply. If these ameliorating substances are used with complete efficiency 10 tons of gypsum correspond to 5.8 tons of calcium carbonate or 1.9 tons of sulphur, and if applied to a hectare of land would displace 2.2 m eq of sodium per 100 g soil from the top 30 cm layer. Since it is difficult to determine how much exchangeable sodium a soil holds when in the presence of sodium salts, R.K. Schofield and A.W. Taylor[6] suggested it is preferable to determine how much calcium the soil would need to take up to saturate its exchange complex with calcium, and they developed a simple method which gives this figure to an adequate accuracy for most practical purposes.

Egyptian Research Results

As in the United States, Pakistan, India and other countries plagued with waterlogging and salinity problems, the effects of these adverse soil conditions upon crop yields have been the subject of substantial research in Egypt. The work of the Soil Salinity Laboratory at Alexandria is especially noteworthy in this regard. Rather than listing the various studies by Egyptian scientists, the findings from one such study will better serve to indicate the results that can be expected from particular treatments applied to Egyptian soils. These findings also provide a basis for judging the applicability of the U.S. research results summarized above.

For this purpose, an experiment by Movelhi, Saraf and Badawi is presented here to illustrate the results that generally can be expected on affected delta soils.* The experiment was conducted at Sakha on a soil which was 45 percent clay. The water table was 70 cm from the soil surface and the electrical conductivity (E.C.) was less than 4 mmhos/cm. The exchangeable sodium percentage (ESP) was 29-38 percent.

Soil Treatments

As indicated by Table IX. 5, drainage, subsoiling and gypsum all increased the yield of hemp. The highest yield increases were obtained when all three treatments were applied in combination.

Infiltration Rate

Infiltration rate was lowest in untreated plots and tended to increase as

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* El-Moselhy, M.M., Saraf El-din, F. and Badawi, A.M. "Effect of Drainage Subsoiling and Gypsum Application on Improving Sodic Soils of Egypt." Agricultural Research Review. 54: 9-20, 1976.

TABLE IX. 5

YIELD EFFECTS OF SPECIFIED SOIL TREATMENTS

Treatment	Cotton		Hemp	
	Yield per feddan	Increase Over Base	Yield per feddan	Increase Over Base
	Kantar	Percent	MT	Percent
Untreated Plots	4.40	--	6.00	--
D.G.S.	7.48	70	9.29	54
D.S.	7.67	74	8.76	46
D.G.	7.42	69	7.80	30
D.	N/A	N/A	7.20	20
S.G.	7.06	60	N/A	N/A
S.	6.69	52	N/A	N/A
G.	6.64	51	N/A	N/A

D=Drainage, S=Subsoiling, G=Gypsum. Source did not give further details with respect to treatments, but, on hemp, the above data are for gypsum applied at the rate of 6 MT per feddan and subsoiling perpendicular to drains at one meter spacings to a depth of 40 cm.

more treatments were applied (Table IX. 6). This may be explained by subsoiling opening up channels through the soil, gypsum improving the aggregation, and drainage drawing off the water. Subsoiling was the most effective treatment in increasing infiltration rate the first six months. The rate declined after that time and indications are that the treatment persists for 18-24 months.* The effect of gypsum intensified with time, reaching a maximum at the end of the experiment.

As indicated by Table IX. 7, gypsum has a very significant effect on the exchangeable sodium percentage (ESP). Drainage and drainage plus subsoiling have little effect on the ESP. However, any treatment with gypsum has a very desirable

* Other research and field experience indicates that with deep-rooted crops like cotton, the yield-increasing effects of subsoiling last about 5 years with significant decline after the third year. See Chapter XI in this report.

TABLE IX. 6

EFFECT OF DIFFERENT AMELIORATION TECHNIQUES
ON
INFILTRATION RATE AT VARIOUS SAMPLING PERIODS.

Treatment	Infiltration Rate mm/min			
	Time in Months			
	0	6	12	24
Control	0.18	0.18	0.18	0.18
D	0.18	0.24	0.24	0.24
D + G_6	0.18	0.28	0.28	0.34
D + G_{12}	0.18	0.28	0.29	0.37
D + S	0.18	0.35	0.34	0.25
D + S + G_6	0.18	0.39	0.39	0.46
D + S + G_{12}	0.18	0.39	0.40	0.48

D=Drainage, G_6=Gypsum@6T/Feddan, G_{12}=Gypsum@12T/Feddan, and S=Subsoiling perpendicular to drains at one meter spacing to a depth of 40 cm.

TABLE IX. 7

EFFECT OF DIFFERENT AMELIORATION TECHNIQUES
ON
ESP AT VARIOUS SAMPLING PERIODS.

Treatment	Exchangeable Sodium Percentage (ESP)			
	Time in Months			
	0	6	12	24
Control	29	30	29	29
D	29	28	29	29
D + G_6	29	26	21	14
D + G_{12}	29	26	21	14
D + S	29	28	29	29
D + S + G_6	29	26	21	14
D + S + G_{12}	29	26	21	14

effect with respect to the ESP. This effect is primarily noticeable after a year or more and does not extend beyond the 40 cm depth.

Soil Structure

Bulk, density and porosity were increased in the top soil by all treatments compared to the control. These parameters were not changed at 25-35 or 55-65 cm depths by any of the treatments except drainage, gypsum and subsoiling or drainage and subsoiling. The structure of the soil was improved at 0-10, 25-35 and 55-65 cm quite consistently by all treatments. Applying more than one treatment at a time resulted in an additive effect.

Subsoiling alone improved the structure of the 0-10 and 25-35 cm zones but did not affect the 55-65 cm zone. Gypsum alone only improved the top 10 cm. Soil compaction is an important soil factor and it was lowest in treatments with a combination of drainage, subsoiling and gypsum. Treatments with only one factor were not substantially different from the control. The data indicate that gypsum has its main effect on soil aggregation and that other soil improvement techniques facilitate the downward movement of gypsum to the subsurface.

Permeability

The water permeability of the soil also shows the effect of the various treatments (Table IX. 8). At the 0-5 cm zone, permeability of all treatments is about 1 cm per hour. At the 25-30 cm zone, soil permeability is improved about five-fold for subsoiling alone, is almost unchanged with gypsum, but has a slight increase with drainage. However, drainage and subsoiling increase water permeability 27-fold and drainage, subsoiling and gypsum increase water permeability 33-fold. At 55-60 cm only the combined drainage, subsoiling and gypsum improve water permeability to any degree, a seven-fold increase.

TABLE IX. 8

EFFECT OF SOIL IMPROVEMENT TECHNIQUES
ON
PERMEABILITY COEFFICIENT (K CM./HR.)

Treatment	(K cm/hr)		
	0-5 cm	25-30 cm	55-59 cm
D.G.S.	1.15	1.00	0.70
D.S.	1.12	0.81	0.09
D.G.	1.51	0.10	0.08
D.	1.11	0.05	0.11
S.G.	1.08	0.13	0.12
S.	0.94	0.15	0.10
G.	1.06	0.04	0.08
Control	1.01	0.03	0.10

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CHAPTER X

OPTIMIZING TRACTOR POWER

Introduction

Farm mechanization in Egypt in recent years has mainly been a process of "tractorizing" the plowing and threshing operations. Even these operations are yet only partially mechanized. And where tractors are used, their efficiency is substantially reduced by the lack of other modern implements. Because only a chisel plow is used, seed bed preparation is both less effective and more costly than it needs to be. Powering a drum thresher that requires only 20hp with a 65hp tractor makes poor use of mechanical power needed at the same time for field work. Consequently, the optimization of tractor power involves not only the number of tractor but also the effects of associated implements upon the efficiency of tractor use.

Concern in the present study is primarily with determining the feasibility of further mechanization as a means of increasing farm production. Thus, the yield effects of substituting tractor power for that now provided by work animals and human labor becomes an essential factor in the optimization process. A third dimension of the problem concerns the size of tractor best suited to Egyptian farming conditions. That Egyptian farms typically are quite small and fragmented assumes particular significance in that regard. Also, the way tractors are owned and used have a pre-eminent bearing upon practical tractor size and the overall feasibility of tractor-based mechanization.

In succeeding sections, the optimization of tractor power is explored from

these several perspectives. As they influence what is practical to achieve during any given period of time, other relevant factors also are brought into the analysis in various contexts, e.g., availability of credit, sources of supply and government policy with respect to imports and local manufacture. Based upon the Study Team's analysis of these many and complex interrelationships, the final section of this Chapter outlines a recommended strategy for optimizing tractor power over the next five years and the necessary actions for implementing such a program.

Machinery Inventory

Egyptian mechanization planning and implementation efforts alike are severely handicapped by lack of definitive information on the current equipment stock. As indicated in Chapter 1, the present study has endeavored at least partially to remedy that situation through a broad-based large-sample farm machinery survey. Tables X. 1 and X. 2 summarize the Study Team's estimates of the number of tractors, associated implements and other motorized equipment. These estimates are based on the results of the Farm Machinery Survey, the Farm Management Survey (which also was carried out as a part of the present study) and data available from MOA and other secondary sources. These data highlight four particularly significant features of Egypt's present stage of mechanization:

-- The ratio of tractor power to cropland, for the country as a whole, is still quite low.

-- That ratio varies widely among areas.

-- Tillage remains little mechanized beyond plowing.

-- Mechanized equipment now is largely privately owned by custom-operators who are also farmers.

TABLE X. 1

ESTIMATED NUMBER OF FARM TRACTORS, BY GOVERNORATE, 1978*

Governorate	Co-op Owned	Privately Owned	Total	Cultivated Area per Tractor in Feddans
	----------number----------			
Alexandria	10	216	226	297
Beheira	421	1917	2338	296
Gharbia	353	2000	2353	186
Dakahlia	141	3555	3696	167
Kafr El Sheikh	463	2112	2575	191
Danuetta	46	382	428	220
Menoufia	320	1072	1392	246
Kalubyia	158	673	831	246
Sharkia	606	2420	3026	223
Ismailia	17	104	121	356
Suez	8	11	19	200
Giza	112	450	562	302
Beni Suef	379	1022	1401	201
Fayoum	240	849	1089	280
Minyeh	409	1051	1460	329
Assiut	158	895	1053	341
Sohag	167	949	1116	287
Kena	142	571	714	490
Aswan	42	241	283	361
Total	4190	20,490	24,680	249

* Based on 2-part Farm Machinery Survey, 1978 with cross-check reference to Ministry of Agriculture data supplied by respective Governorates. In addition to above tractors serving private farmers MOA 1978 data indicate an additional 5,336 are on the state farms reclaiming New Lands. Of these only 55 percent were reported to be in operating condition.

TABLE X. 2

FARM MACHINERY INVENTORY, BY TYPE, 1978*

Item	Estimated Total No.	Percent owned privately
	No.	Present
Tractors	24,680	83
Tractor Plows	19,900	86
Subsoiler/ditcher excavator	125	88
Harrows	8,820	86
Planters	6,430	95
Irrigation pumps:		
Electric powered	2,160	98
Diesel or gasoline powered	24,830	98
All motor-driven pump sets	26,990	98
Threshers and winnowers**	3,580	89
Dusters:		
Manual	2,580	98
Motor operated	960	8
Sprayers:		
Motor operated	160	38
Other	2,640	20
Spraying equipment:		
Motor operated & car carried	4,730	10
Motor operated & back carried	1,940	55
Manual and back carried	50,600	23

* Based on 2-part farm machinery survey, 1978 with cross-check reference to Ministry of Agriculture data supplied by respective Governorates. In addition to above numbers of implements MOA 1978 indicate the following are on the state farms reclaiming new lands: Chisel plows 2270; trailers 1704; drum threshers 631; mobile irrigation pumps with motors 1696; stationary irrigation pumps with motors 2588; and snapsack sprayers 600.

** Drum threshers and hand winnowers. Responses were unclear as to how the numbers reported are divided between the two pieces of equipment or whether the numbers given were intended to refer to each type. Indications are that Egypt currently has in operation some 3-4000 drum threshers.

According to the Study Team's analysis, optimal mechanization of Egyptian agriculture would require about one fully operational 65 hp tractor per 105 feddans of cultivated area. This tractor density would give Egypt 0.62 hp per feddan of cultivated area--a level roughly comparable to that already achieved by the more advanced developing countries, yet well below that of industrialized nations like Japan, Western Europe and the U.S. By way of comparison, a 1974 study by Giles concluded that Egypt needed 0.40 horsepower per feddan and a 1977 report by Garrett indicated a need of 0.96 hp/fd.* West Germany, with one of the highest levels of machinery use in the world, approximately 2.184 hp/fd.

If (a) all the tractors now on Egyptian farms were in mint condition--which they are not, (b) all tractors serving Egyptian agriculture were operated at full efficiency--which they are not, and (c) all new tractors in stock in Egypt or in the import pipeline were on farms, Egypt nominally would have 0.295 per feddan. Table X. 3 shows the distribution by age and horsepower of cooperatively owned and privately owned tractors respectively. Taking 55 hp as the average size, the current inventory implies that, for the country as a whole, 0.226 horsepower are available per feddan of cultivated area. A recent Massey-Ferguson study indicated that 0.295 hp per feddan were available.

In the Farm Machinery Survey, government-owned tractors on State Farms developing the new lands were not included. MOA estimates there are 5,336 tractors on those "company" farms. Many of these are older tractors from Eastern

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TABLE X. 3

AGE OF TRACTORS BY HORSEPOWER
FARM MACHINERY SURVEY, 1978

Co-operatively Owned

Age	Horsepower 40 & Under	41-45	46-50	51-55	56-60	61-65	66 & Over	Total
			Percent					
1	.6	-	6.2	6.2	18.8	17.2	50.0	100.0
2	-	1.2	1.2	4.8	3.6	13.3	75.9	100.0
3	-	-	3.3	36.7	3.3	36.7	20.0	100.0
4	-	3.2	3.2	3.2	-	51.6	38.8	100.0
5	2.7	-	2.7	5.4	6.8	67.5	14.9	100.0
6	-	-	2.7	-	8.1	75.7	13.5	100.0
7	-	2.9	14.7	-	35.3	41.2	5.9	100.0
8	-	-	15.0	15.0	17.6	50.0	2.5	100.0
9	-	-	26.3	-	36.9	31.5	5.3	100.0
10-15	-	6.3	47.4	27.5	4.5	11.0	3.3	100.0
15-20	-	6.7	46.6	40.0	1.7	3.3	1.7	100.0
20 & Over	4.2	25.0	20.8	33.3	-	16.7	-	100.0
Unspecified	3.0	3.0	32.8	20.9	4.4	29.9	6.0	100.0
Total	.5	4.7	32.6	21.2	5.8	21.4	12.8	100.0

Privately Owned

Age	Horsepower 40 & Under	41-45	46-50	51-55	56-60	61-65	66 & Over	Total
			Percent					
1	.5	2.0	6.7	5.1	20.0	42.3	23.4	100.0
2	1.1	4.7	9.5	3.3	20.2	46.2	15.0	100.0
3	1.2	7.8	17.3	9.9	16.1	36.4	11.3	100.0
4	2.9	6.6	14.7	10.3	19.9	37.5	8.1	100.0
5	2.7	8.4	17.6	8.7	20.3	38.4	3.9	100.0
6	4.0	9.9	17.0	12.9	15.8	35.1	5.3	100.0
7	2.1	7.7	25.9	15.4	23.7	21.8	3.4	100.0
8	4.1	13.8	28.7	13.2	22.4	15.8	2.0	100.0
9	-	15.8	31.6	15.8	19.3	17.5	-	100.0
10-15	6.2	19.9	37.8	15.1	10.5	8.8	1.7	100.0
15-20	14.2	32.6	30.9	11.4	4.6	5.8	.5	100.0
20 & Over	40.0	28.4	14.1	10.2	3.9	2.4	1.0	100.0
Unspecified	12.1	12.1	28.0	4.4	8.3	25.5	9.6	100.0
Total	5.8	12.9	21.7	10.0	15.2	26.2	8.2	100.0

Bloc countries. Nearly half reportedly are inoperable. Given the importance the ARE accords the development of additional land resources, overall mechanization planning obviously must take account of the special circumstances of State Farms. In the Study Team's judgement, the mechanization needs can be addressed realistically only in the larger context of New Lands development.

Trends in Tractor Numbers

The present study indicates that 60,000 tractors plus associated implements would essentially replace all the animal power currently used in Egyptian agriculture. How rapidly it is feasible to move toward that objective depends heavily upon the absorptive capacity of the market. Using recent sales trends local assembly and imports as a guide, the Study Team estimates that Egypt practicably could reach a total tractor population of about 35,000 by 1985. The feasibility study for the proposed Massey-Ferguson/NASCO private sector manufacturing facility puts the projected absorptive capacity a bit higher and sees a total tractor population of 37,000 by 1985.

Tables X. 4-7 summarize historical and projected trend data from various sources. Particularly striking is the upsurge in tractor imports and sales following introduction of the Open-Door Policy in 1973. With the freeing of tractor import restrictions, Egyptian importers and foreign manufacturers alike rushed to supply the pent-up demand generated during several years of restricted imports. As a result, imports plus NASCO assembly had, by the end of 1977, out stripped sales by a considerable margin. In mid-1978, 4200 tractors reportedly remained unsold. These were Massey-Ferguson, Yugoslavian and Rumanian units at NASCO plus a limited number of other tractors in the hands of private and

TABLE X. 4

TRACTOR PROJECTIONS

Year	Tractor Units	Average HP	1000 HP
1961 - 65 average	13607	45	612
1969	16962	45	763
1970	17500	48	840
1974	18597	55	1023
1977	21000	58	1218
1980	28700	60	1722
1985	37000	65	2405

Source: Adapted from feasibility report for Massey-Ferguson/NASCO tractor manufacturing facility.

TABLE X. 5

TRACTOR SHIPMENTS, 1968-1977

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Units TOTAL	3719	3182	1901	1632	1670	1500	1952	2850	3398	6061
Less than 40 HP	--	--	600	--	--	--	1	3	3	65
41 - 50 HP	3749	2858	124	121	10	26	4	73	235	4
51 - 60 HP	--	174	1027	1153	604	335	562	1639	1353	1777
61 - 70 HP	--	150	150	150	986	1089	1273	961	1691	4201
71 - 80 HP	--	--	--	--	--	--	110	141	40	4
81 - 100 HP	--	--	--	3	--	--	2	3	--	3
Over 100 HP	--	--	--	--	--	--	--	--	15	4
Crawlers	--	--	--	205	70	50	--	30	61	3
Percent TOTAL	100	100	100	100	100	100	100	100	100	100
Less than 40 HP	--	--	31.6	--	--	--	--	0.1	0.1	1.1
41 - 50 HP	100	89.8	6.5	7.4	0.6	1.7	0.2	2.6	6.9	0.1
51 - 60 HP	--	5.5	54.0	70.6	36.2	22.3	28.9	57.5	39.8	29.3
61 - 70 HP	--	4.7	7.9	9.2	59.0	72.6	65.2	33.7	49.8	69.2
71 - 80 HP	--	--	--	--	--	--	5.6	4.9	1.2	0.1
81 - 100 HP	--	--	--	0.2	--	--	0.1	0.1	--	0.1
Over 100 HP	--	--	--	--	--	--	--	--	0.4	0.1
Crawlers	--	--	--	12.6	4.2	3.4	--	1.1	1.8	--

Source: Feasibility report for Massey-Ferguson/NASCO tractor manufacturing facility.

TABLE X. 6

TRACTOR SALES (PUBLIC & PRIVATE)

Description HP / Make		1957	1968	1969	1970	1971	1972	1973	1974	1975	1975	TOTAL
						Y E A R S						
50	IMR Assm.	--	500	500	500	500	500	500	500	500	--	4000
60	IMR "	--	300	500	500	500	500	500	500	500	500	4300
65	Univ (Rom)	--	--	--	--	500	500	1500	1000	1000	1500	6000
54	Fiat "	--	--	--	--	--	--	--	--	504	--	504
60	IMR Imp.	--	--	--	--	--	--	200	500	300	--	1000
45	Otus (Rom)	--	500	500	--	--	--	--	--	--	--	1000
50	Zeilor	--	1000	1500	--	--	--	--	--	--	--	2500
60	TMT	--	--	--	--	--	100	--	--	450	350	900
60	Ebro	--	--	--	--	--	--	--	79	71	--	150
65	Univ	--	--	150	150	150	--	--	--	--	--	450
55	U550	--	250	100	150	--	--	--	--	--	--	500
45	Belaros	2000	1500	--	--	--	--	--	--	--	--	3500
50	Fordson Major	200	--	--	--	--	--	--	--	--	--	200
50	David Brown	300	200	--	--	--	--	--	--	--	--	500
50	John Deere	100	--	--	--	--	--	--	--	--	--	100
TOTAL		2600	4250	3250	1300	1650	1600	2700	2579	3325	2350	25604

Source: Ministry of Agriculture

Note: Assm. = Assembled
Imp. = Imported
(Rom) = Romania

TABLE X. 7

TRACTOR MANUFACTURE BY NASCO, 1962-1977

Year	Yugoslav IMR HP	Yugoslav IMR 60 HP	Romanian UT 65 HP	Italian Fiat (3-cyl)	"UK" MF 165 65 HP	"USA" MF 265 65 HP	TOTAL
1961	-	-	-	-	-	-	-
1962	426	-					426
1963	533	-					533
1964	537	-					537
1965	788	-					788
1966	1,078	-					1,078
1967	751	-					751
1968	564						564
1969	76	474					550
1970	-	1,176					1,176
1971	-	950					950
1972	-	251	976				1,227
1973	-	133	1,010				1,143
1974	-	-	1,201	58			1,259
1975	-	194	795	446			1,435
1976	-	561	1,132	1			1,694
1977 to 31/10	-	274	1,720	-	241	1	2,236
Total to 31.10.77	4,753	4,013	6,834	505	241	1	16,347
Nov-Dec 1977(Est)		200	-	-	-	159	359
Total to end 1977	4,783	4,213	6,834	-	-	160	16,866
To come/ on order or already in stock	-	1,904	548	-	9	2,240	4,497
Final Total	4,783	6,117	7,382	505	250	Continuing	

Source: Nasr Automotive Co.

public sector dealers. An additional 1300 tractors were in the import pipeline. In September 1978, ARE placed a 3-year embargo on private imports of assembled farm tractors of 45-75 hp to discipline the market and give time to work off the backlog in an orderly manner. That embargo does not apply to foreign aid-financed imports. Cooperatives, which do their procurement on a pooled basis through government-administered tenders, also will be free to continue importing assembled tractors, provided their purchase price does not exceed NASCO's sale price by more than 15 percent. The embargo itself can be lifted by the Minister of Agriculture at any time within its 3-year effective period if market conditions warrant. Indications are that on-hand supplies will about cover 1979 sales. By early 1980, additional imports will be required either in the form of components for NASCO assembly or as assembled units. The same will be true in 1981, as the MF/NASCO manufacturing facility is not scheduled to become operational until late in 1981.

Study Team discussions with local and national banking officials indicated that inadequate loan funds, particularly at Agricultural Credit Banks, significantly depressed tractor sales in 1978 (Chapter XXII). Virtually every village and governorate bank visited had a backlog of applications for tractor loans that could not be acted upon until new funds became available in January 1979. Needless to say, the adequacy of tractor loan funds is a highly important factor in any projection of future tractor sales. The Study Team estimates noted above assume an adequate supply of credit. They also assume that the Service Centers proposed in Chapter XIV will become operational in 1980 and thus serve to make dealer supplies and services much more accessible to farmers than they are today. At the same time, the machinery services aspect of that subproject will dampen demand over time as those facilities increase the reliability and usefulness of

tractors already in service.

By insuring an uninterrupted supply, the planned initiation of local manufacture of tractors by 1982 will help increase the demand. Long in the making, the Massey-Ferguson/NASCO private sector joint venture agreement reportedly was essentially ready for execution at the end of 1978. This new plant will be located in Alexandria and use a progressively increasing percentage of locally fabricated components. It is expected to begin production in 1981 and to produce 6,000 units per year, 4,000 for sale in Egypt and 2,000 for export. In the interim, NASCO will continue assembling farm-size tractors from imported components.

Future demand for farm tractors, like that during the recent years of rapidly increasing numbers, will, in the end, be determined by the rates farmers are willing to pay for custom tractor services. Even in today's tractor-short custom services market, many farmers appear to wait for custom plowing and threshing. This indicates both a strong demand for such services and that custom hire rates at their current levels are acceptable to farmers in general. That these rates provide a return acceptable to custom operators is evident from the increase since 1973 in the number of privately owned tractors. Very few farm operators could afford a tractor without using it extensively for custom work.

Increasing tractor density will heighten competition among custom operator, hence push custom rates downward, if nothing else changes. If the custom rate drops appreciably, so too, of course, will the demand for additional tractor purchases. But other things will change. Increased numbers of better maintained tractors will undoubtedly result in more dependable custom service, and this, in turn, will bring many farmers still using animal labor into the custom tractor market. With further experience, farmers will extend tractor usage to more

crop operations, a trend certain to be intensified by growing peak season shortages of labor and rising farm wage rates. Even small farmers are not exempt from these twin pressures. The number of privately owned tractors is expected to continue to increase relative to the number owned by co-ops. This will relieve custom rates in general from the dampening effect of duty-free co-op tractor imports and generally underpriced co-op tractor services.

All things considered, the Study Team sees a sustained demand for at least 4,000 tractors per year over the 1980-84 period. Some other sources put the prospective demand higher, others lower. Plans for the Massey-Ferguson/NASCO enterprise are based on projected in-Egypt sales of 4,000 a year when their manufacturing plant comes on stream three years hence. However, that plant will have a production capacity of 6,000 units of which 2,000 are expected to be exported to other Middle East countries. The 2,000 unit export margin suggests the in-Egypt sales projected may represent a minimum estimate. Taking account of replacement requirements of some 2,500 per year, annual average sales of 4,000 units would bring the 1985 number on farms to the 35,000 total indicated earlier.

Characteristics of Tractor Stock

The Farm Machinery Survey provided detailed information on many characteristics of the Egyptian tractor stock, about which little previously had been known. Tables X. 8-12 present data on several of those characteristics which are especially relevant to optimizing the tractor power available to Egyptian agriculture in the years ahead. In summary, these are: condition, age, ownership, make, amount and type of annual use and size of farm using custom tractor services. As inspection of the referenced tables (X. 8-12) reveal, most of these charac-

TABLE X.8

AGE OF FARM TRACTORS BY CONDITION AND OWNERSHIP
FARM MACHINERY SURVEY 1978

Privately Owned

Age	Condition			All Conditions	
	Good	Fair	Inoperable	Percent	Number Reported
Years	Percent of total reported				
1	24.9	1.5	6.1	15.2	692
2	19.9	3.0	2.0	12.7	578
3	12.2	4.1	3.3	8.8	400
4	6.7	4.0	1.4	5.5	251
5	7.8	6.5	2.7	7.1	325
6	3.3	4.2	1.4	3.6	165
7	2.5	3.9	1.4	3.0	139
8	3.4	5.1	3.4	4.1	186
9	.9	1.9	1.4	1.3	60
10	4.3	12.6	6.1	7.6	347
Over 10 1/	14.1	53.1	70.8	31.1	1423
All ages	100.0	100.0	100.0	100.0	-
Total number Reported	2637	1781	148	100.0	4566

Co-op Owned

1	16.4	1.0	1.5	5.6	68
2	21.2	1.9	.4	7.2	87
3	5.9	1.7	.7	2.7	33
4	5.1	1.0	1.8	2.4	29
5	10.5	6.0	4.0	6.9	83
6	4.2	2.6	3.7	3.3	40
7	3.6	2.4	3.9	2.9	35
8	5.4	2.0	3.7	3.6	43
9	.8	1.5	1.5	1.3	16
10	4.0	8.7	9.2	6.6	90
Over 10 1/	22.9	70.8	70.6	57.3	691
All ages	100.0	100.0	100.0	100.0	-
Total number Reported	354	588	273	-	1215

1/ Of all privately owned tractors in this age group 66 percent were reported to be 10-15 years of age; 22 percent 15-20 years and 12 percent 20 or more years. Comparable data for cooperative-owned tractors are: 89 percent 10-15 years, 8 percent 15-20 years and 3 percent 20 or more years.

TABLE X. 9

MAKE OF FARM TRACTORS BY CONDITION AND OWNERSHIP
FARM MACHINERY SURVEY 1978

Privately Owned

Make	Condition			All Conditions	
	Good	Fair	Inoperable	Percent	Number Reported
	Percent of total reported				
Yugoslavian	43.9	27.1	10.1	36.1	1693
Rumanian	21.3	6.9	10.1	15.2	714
Russian	3.1	11.3	8.8	6.5	307
Zetor	8.0	10.2	10.7	9.0	420
Fiat	2.6	.8	.6	1.8	84
Ebro	4.0	.6	1.3	2.6	121
David Brown	1.5	2.6	3.1	2.0	94
Massey-Ferguson	2.5	.9	1.3	1.8	86
IHC	2.7	2.3	3.8	2.6	121
Other	10.4	37.3	50.2	22.4	1051
All makes	100.0	100.0	100.0	100.0	-
Total number Reported	2673	1859	159	-	4691

Co-op Owned

Yugoslavian	63.8	52.8	35.2	52.1	662
Rumanian	14.6	13.3	21.8	15.6	198
Russian	4.9	9.7	15.2	9.5	120
Zetor	5.2	5.3	4.6	5.1	65
Fiat	3.6	.3	-	1.3	16
Ebro	-	.2	-	.1	1
David Brown	1.8	7.0	6.3	5.2	67
Massey-Ferguson	-	-	.3	.1	1
IHC	.3	-	5.3	1.3	16
Other	5.8	11.4	11.3	9.7	123
All makes	100.0	100.0	100.0	100.0	-
Total number Reported	384	601	284	-	1269

TABLE X. 10

FARM MACHINERY SURVEY 1978

Privately Owned

Make	Condition			All Conditions	
	Good	Fair	Inoperable	Percent	Number Reported
	Percent of total reported				
Yugoslavian	69.3	29.8	.9	100.0	1693
Rumanian	79.7	18.1	2.2	100.0	714
Russian	26.7	68.7	4.6	100.0	307
Zetor	51.0	45.0	4.0	100.0	420
Fiat	82.1	16.7	.2	100.0	84
Ebro	89.3	9.1	1.6	100.0	121
David Brown	43.6	51.1	5.3	100.0	94
Massey-Ferguson	77.9	19.8	2.3	100.0	86
IHC	59.5	35.5	5.0	100.0	121
Other	26.5	65.9	7.6	100.0	1051
All makes	57.0	39.6	3.4	100.0	---
Total number Reported	2673		159	---	4691

Co-op Owned

Yugoslavian	37.0	47.9	15.1	100.0	1662
Rumanian	28.3	40.4	31.3	100.0	198
Russian	15.8	48.3	35.8	100.0	120
Zetor	30.8	49.2	20.0	100.0	65
Fiat	87.5	12.5	--	100.0	16
Ebro	--	--	--	100.0	1
David Brown	10.4	62.7	26.9	100.0	67
Massey-Ferguson	--	--	--	100.0	1
IHC	6.2	--	93.8	100.0	16
Other	17.9	56.1	26.0	100.0	123
All makes	30.3	47.4	22.3	100.0	--
Total number Reported	384	601	284	--	1269

TABLE X. 11

HOURS OF TRACTOR USE, BY TYPE AND OWNERSHIP

Farm Machinery Survey, 1978

Ownership	Type of Use					
	Plowing	Irrigation	Threshing	Transportation	Other	All uses
		Hours per tractor*				
Co-operative	291	8	162	96	-	557
Private						
Own farm	85	37	58	46	9	235
Custom work	271	28	260	100	14	673
Total Private	356	65	318	146	23	908
All tractors	345	56	291	137	19	848
		Percent of all uses				
Co-operative	52	2	29	17	-	100
Private						
Own farm	36	16	25	19	4	100
Custom work	40	4	39	15	2	100
Total private	39	7	36	16	2	100
All tractors	41	7	34	16	2	100
		Percent of total hours				
Co-operative	16	3	10	13	-	12
Private						
Own farm	20	55	16	27	38	23
Custom work	64	42	74	60	62	65
Total private	84	97	90	87	100	88
All tractors	100	100	100	100	100	100

* Inoperable tractors are excluded from base numbers.

TABLE X. 12

FARMERS USING CUSTOM-HIRE TRACTORS
FOR SPECIFIED OPERATIONS

Farm Machinery Survey, 1978

Farm Size* (cultivated area)	Users as Percent of Total Number in Size Group			Percent of All Users		
	Plowing	Threshing	Transp.	Plowing	Threshing	Transp.
feddans						
Less than 1	62.3	49.9	5.3	38.6	38.5	24.9
1 - 3	66.7	53.6	8.9	37.4	37.4	38.1
3 - 5	68.4	56.9	10.5	13.8	14.3	16.0
5 - 10	67.7	52.6	14.7	6.5	6.2	10.6
10 - 15	58.4	45.4	18.1	2.3	2.2	5.4
15 and over	65.1	50.3	30.6	1.4	1.4	5.0
All Sizes	65.0	52.2	8.6	100.0	100.0	100.0

* Wording of questionnaire unfortunately prompted some respondents to interpret farm size as area owned, instead of total area cultivated as was intended. This resulted in some downward skewing in the farm size distribution. Indications are, however, that this skewedness does not seriously affect the general conclusions regarding custom tractor usage. The Farm Management Survey which did reflect operating units found an even higher percentage of very small farms using tractors for plowing—a difference well within the range of sampling error.

teristics are highly interrelated. Taken together, the tables bring out the more significant of these interrelationships in the form of cross tabulation.

Condition

As evidenced by Table X. 8, more than one-fifth of all cooperative-owned tractors were inoperable at the time the Farm Machinery Survey was conducted. Three percent of the privately owned tractors likewise were reported to be inoperable. These ratios indicate that approximately 1500 of Egypt's apparent tractor stock is not in operable condition. In both instances, 70 percent of the inoperable units were more than 10 years old. However, this does not mean that with proper repair those tractors could not work for several more years. A surprising number that were 20-25 years old reportedly did several hundred hours of custom work during the preceding year. Even more surprising are the numbers of fairly new machines reported to be inoperable. As there was no indication as to how long the respective tractors had been inoperable, some may only have been waiting for spare parts. In many instances, though, the number of hours worked indicated the inoperable tractors had been out of service for some time.

That 48 percent of the co-op-owned tractors and 39 percent of those privately owned were reported to be in only "fair" condition suggests the amount of tractor power actually available to Eygptian agriculture may be considerably less than the number multiplied by horsepower implies. Again, age is a factor. At the same time, the high percentage under five years of age that are in only fair condition bears mute testimony to the lack of availability and quality of maintenance services.

In addition to confirming the well-known problems that cooperatives have experienced in keeping their tractors in working condition, the generally poor

condition of Egypt's existing tractor stock has two particular points of relevance with respect to optimizing tractor power. Both concern repair facilities and spare parts. Unless major and rapid progress is made on those fronts, the outcome is evident: additional tractors would be needed to produce any given increase in horsepower per feddan than if both present and additional tractors were kept in full working condition. Thus, the Service Center complex proposed in Chapter XIV plays a key role in determining investment requirements for optimizing tractor power. The second point alluded to concerns the as yet unexploited opportunities for getting the large number of presently inoperable tractors into productive use either through rehabilitation as complete units or as spare parts for other machines in need of repair. As indicated in Chapter XIV, the proposed Area Service Centers would provide the means for capitalizing upon those opportunities.

Finally, to the extent that tractor condition reflects quality of repair and maintenance services, it also reflects a deterrent to tractor purchases by custom operators and to farmers' dependence upon custom tractor services. Either would reduce the absorptive capacity of the tractor market, thus lowering the degree of mechanization that practicably can be achieved.

Age

In addition to its effect on condition, tractor age is relevant to the problem at hand mainly in terms of replacement requirements. With more than one third of all farm tractors over 10 years of age, replacement needs will be high over the next several years. Part of the investment that buyers are able and willing to make in new tractors, consequently, will go to replacing machines too old for economical repair. To be sure, in terms of power available, replacements may add nearly as much as do additions to existing stock; nonetheless, they are

a factor to be reckoned with in estimating the feasible degree of mechanization over the next several years.

Ownership

Table X. 8 confirms the declining role of the cooperatives as suppliers of custom tractor services. Since 1973, purchases by private owners have far outstripped those by cooperatives. In fact, it appears that co-ops in general are not even replacing their worn out machines, hence are reducing their tractors in numbers. In many villages, the number of privately owned tractors so far exceeds that of cooperative owned units as to leave the co-ops essentially in the position of suppliers of last resort. However, with even a modest role in the custom service market, cooperatives can, and apparently do, provide a user-controlled means of keeping custom rates within reasonable bounds. That role likely will become less important as the number of privately owned tractors increase and competition among private owners regulates custom rates.

Make

A variety of tractor makes complicates the spare parts problem and therefore creates uncertainty about the total output that can be expected from a given tractor fleet. Egypt's current fleet includes at least 15 different makes, each ranging from perhaps 100 to several thousand in number. As indicated by Table X. 9, Yugoslavian and Rumanian models make up about half of the total. Both of these tractors are assembled by MASCO. Most of the Russian-made Belaros tractors are getting old and informed sources say spares are next to impossible to get. The same generally is true of the minor makes. The large number listed as "other" has little significance from the standpoint of diversity of tractor makes. This category includes all machines for which the

make was not reported but other data on the schedule were usable.

As age strongly affects condition, it is doubtful that any significance should be attached to differences among makes in Table X. 10. Those differences are important, however, from the standpoint of keeping the different makes in working conditions.

Annual Use

Table X. 11 mainly confirms several popular impressions about tractor usage in Egyptian agriculture as follows: Tractors are used mainly for custom work accounting for roughly 80 percent of all tractor hours; plowing and threshing account for the bulk of all tractor hours; co-ops utilize their tractors less effectively than do private operators.

The gross data for irrigation and transportation in Table X. 10 are somewhat misleading in terms of general practice. Inspection of the individual reports indicates that a high percentage of the tractors used for irrigation are quite old, hence may have little use other than as stationary engines. The transportation data are heavily influenced by the fact that some operators use their tractors a large number of hours per year for hauling bricks. Indications are that, by and large, farm transportation is a small factor in the total use of most tractors.

As regards optimal tractor power for the years ahead, interest in the Table X. 11 data centers upon the possibility of increasing total tractor hours per year, especially those of co-op owned machines; reducing the hours devoted to threshing so as to make more time available for widening tractor use in land preparation; and the prospect of transportation becoming a large claimant uo-on total tractor hours. Egypt's custom based system and two-season agricul-

ture enable tractors to work more hours per year than is the case in many other countries. Even so, it seems doubtful that average annual use can be expected to go much above the 900 hours now realized by private operators unless transportation assumes more significance than presently seems likely. However, with more efficient threshers, enough tractor time could be saved to both extend tractor plowing to a larger acreage and properly prepare seed beds with modern tillage equipment.

Users of Custom Services

As indicated by Table X. 12, the Egyptian custom service system has brought access to tractor power to even the smallest farmers. To avoid confusion, it must be stressed that the data in Table X. 12 refer to number of users, which is not necessarily the same as the percent of a given operation performed with tractor power. For instance, the tractor hours used for plowing in Table X. 11 indicate that about 40 percent of all plowing is done by tractor. By comparing that with the figures in Column 1 of Table X. 12, it is clear that many farmers who use a tractor for plowing are doing their second plowing with animal power.

Optimizing tractor power necessarily must include consideration of the way the benefits of mechanization are shared among different groups of farmers. So far as the Study Team could discern, the only economies of scale under Egyptian conditions are those resulting from reduced hired labor requirements on the one hand and reduced milk and meat losses on the other. The former obviously favors operators of larger than family size farms; the latter, those on the smaller size units. Over all, small farmers probably benefit nearly as much percentage-wise from the use of tractors as do the larger ones which have as high a cropping intensity. As large farms presently have a lower average cropping intensity than small ones, they have more scope for increasing crop production. As

increased tractor power will enable such operators to use their lands more intensively, they and the nation will benefit more from mechanization than will families tilling only 1-3 feddans.

Tractor Size Considerations

Optimal power is that best suited to the circumstances under which it is to be applied. As any given quantity of power is simply the product of unit size and number, the quantity of tractors needed to provide a certain level of horsepower per feddan depends upon their size and vice versa. It follows, therefore, that the number of tractors "best suited" to Egyptian farming conditions depends, in the first instance, upon the weight given the respective technical, economic and psychological circumstances that influence decisions by tractor buyers and users with respect to unit size. Of course, existing preferences can be altered if national interests warrant the time, effort and/or controls necessary to effect the behavioral change involved. In that context, the analysis that follows explores various options with respect to tractor size as a basis for coping with that aspect of national mechanization strategy planning.

Performance Requirements

To be acceptable, any given power unit must meet the technical criteria which significantly affect its efficiency. Chief among these are:

1. Time

Primary tillage represents the largest power requirement and the most severe time constraint. Timely planting is essential to avoid severe yield penalties. Consequently, there generally is a high premium upon completing

seedbed preparation in the shortest possible time following removal of the preceding crop.

2. Working depth

All tractors must be capable of operating some suitable primary tillage tool or device at a depth of fifteen to twenty centimeters.

3. Transport

A tractor must be able to move itself and its allied equipment between the village and the fields without damage to road surfaces. Assuming that the tractor will be used for at least part of the transportation of agricultural inputs and marketable surplus, it must be capable of operation at speeds appropriate for road travel.

4. Fuel

All tractors must operate on diesel fuel to minimize fuel supply facilities requirements. Diesel engines already are well accepted.

5. Field size

All tractors must be able to perform economically on Egypt's typically small fields. In this connection, it should be noted that cultivation units frequently are much larger than data on holding size and fragmentation imply. The so-called Land Reform areas are a particular case in point as are the New Lands that have been distributed to individual farmers upon completion of their reclamation. In both these instances, the pattern of land distribution was designed to permit joint cultivation of large blocks of land under the same crop. Even plots may be cultivated as parts of much larger "fields". Nonetheless, size of cultivation unit is a factor to be reckoned with in considering the comparative advantages of alternative tractor sizes.

6. Soil conditions

The agricultural lands have mostly heavy clay soils. Primary tillage with the "ard" (local animal drawn plow) is done at a depth of 7-10 cm under dry conditions and as deep as 15 cm in wet soils. Hardpan is common at relatively shallow depth--7 to 15 cm. Significant yield increases have been shown to result from deeper cultivation with chisel plows and better seedbed preparation.

Small Tractors

The small tractor-small farm model is conceptually quite attractive from the standpoint of providing the individual farmer with the independent capability of performing all operations within some optimum time period. A small tractor is defined as having up to thirty horsepower in either a two-wheel or four-wheel configuration. Tractor size is expressed in terms of PTO (power take-off) horsepower at rated engine speed.

In Egypt, small tractors have found wide application in special uses: low profile models for orchard use, narrow designs for vineyard cultivation and specially equipped versions in horticultural or truck gardening operations for soil mixing. They are little used, however, for general field work. Small tractors usually are more expensive per horsepower than larger tractors because the basic component costs do not vary greatly with size. Materials may represent a relatively small portion of costs while the labor component and machining may be much the same.

Within the small tractor category, the low horsepower two-wheel power tiller type would come closest to fitting Egypt's typically small farms. Two-wheel tractors in a range of sizes are used very extensively in rice culture in Japan Taiwan, Korea and other countries in that region. Egypt presently imports

in some volume two-wheel tractors equipped as power tillers. All such units reportedly are going into orchard cultivation. Manufacturers' attempts to introduce two-wheeled tractors for general field use have so far all been unsuccessful.

Two-wheel tractors meet the performance requirements outlined above with certain limitations. Time and working depth are particularly significant. The production per hour using a power tiller can be approximated as 0.02 feddan/hour per horsepower at 80 percent field efficiency, based on sample calculations for an 8 hp unit with a working width of 640 mm and a first gear speed of 1.7 km/hr. This corresponds to an orchard cultivation operation. At a working depth of 15 cm, the production of a power tiller would be considerably less. Based on field observations, primary tillage to a depth of 20 cm is impractical with a power tiller. Even 15 cm, the normal depth for wet plowing, would be impractical with two-wheel units.

The requirement that an agricultural tractor have the power to operate a suitable primary tillage tool at a minimum working depth of 15 cm makes it necessary to consider both the type of tool and the power required to go with it. The only generally available tool for two-wheel tractors that meets this requirement is a 25 cm (10 inch) moldboard plow. This plow also is made in a reversible configuration. It requires a minimum of 10 hp; 13-14 hp would be required for heavy soils. Such a unit could plow one half a feddan per day and meet all of the tillage power requirements for a 20-feddan farm. A disk harrow would be required to complete seedbed preparation. This tillage equipment package comes as close to the one-farm, one-tractor model as appears to be possible in Egypt. However, it is obviously too large for the great majority of Egyptian farms.

It also introduces a new tillage system requiring an additional piece of equipment.

As regards transport requirements, two-wheel tractors are available with top speeds in the range of 15 km per hour. This would be satisfactory for rural roads. The fuel criterion imposes a lower limit on practical size. The smallest two-wheel tractor found to be available with a diesel engine is 6 hp.

Four-Wheel Tractors

In the succeeding critique, nominal size ranges of 25-35, 45, and 60 hp are considered. The basic operation is chisel plowing, a minimum of two times. Any commercially available tractor could be expected to meet the four performance requirements. A basic tillage capability for each size tractor is computed using the following assumptions:

1. Field efficiency equals 70 percent.
2. Eight hours per working day are devoted to field operations.
3. Half the days available are devoted to primary tillage, the balance to other seedbed preparation or associated work in getting the land ready for planting.
4. The working speed is 3.5 km/hr.
5. The most severe time constraint is imposed by the necessity for chisel plowing two times to produce a reasonably acceptable seedbed.

The crop area that can be handled per available day by a given tractor size equipped with the appropriate width of chisel plow is given below. The last column shows the total farmed area that could be handled by each tractor, assuming a three-year rotation and 16 days available for seedbed preparation.

Tractor hp	Chisel Plow	Feddans/day	Total farmed area feddans
65	9 tines (2.25 m)	10.5	176
65	7 tines (1.75 m)	8.0	132
45	7 tines (1.75 m)	8.0	132
30	5 tines (1.25 m)	6.0	98

These approximations ignore downtime. They likewise do not consid r other tractor uses that might well impose additional time constraints or that the farmer might consider of more immediate importance. Under present conditions, providing power for a drum thresher typically competes with summer seed bed preparation for available tractor time.

Appropriate Tractor Size

As indicated by the preceding analysis, soil conditions appear essentially to preclude efficient use of two-wheel tillers in Egyptian agriculture. However, even small tractors that have the capacity for the needed depth of tillage would have the capacity to meet all tillage requirements on a 20 feddan farm. As all tillage requirements are that large, economical use of small tractors outside of orchard cultivation would require that they be used extensively for custom work. Consequently, a one-farm one-tractor concept would not be a viable option under Egyptian farming conditions even if the prevailing custom hire system of tractor usage were less universally accepted.

If technical and economic efficiency were the only considerations, the Study Team's analysis indicate a 45 hp four-wheel unit would best meet Egypt's tractor power needs. Custom hire services are well accepted and widely used by Egyptian farmers as are four-wheel tractors. As indicated earlier, most of the farm tractors now in use are 60-65 hp units. As they are now being used, the predominance of tractors in that size range does not appear warranted.

In the calculations above, a field efficiency of 70 percent was used in estimating field capacity, but this may be optimistic. Local observers have reported that the same 7-tine plow is used with both 45-50 hp and 60-65 hp tractors. Tractors usually are operated at low speeds. Consequently, the 45-50 hp tractor is not adequately loaded for efficient field work in some soils. Use of a larger tractor than needed appears to be a waste of capital.

Operating costs per hour for a 45 hp tractor are only slightly lower than for the 65 hp. Although a 65 hp unit has a lower initial cost per rated horsepower, investment cost per hour is 20 percent less for a 45 hp tractor than one of 65 hp. If 65 hp tractors were effectively utilized, there would be little economic advantage in one size power unit compared with the others. However, given the way tractors presently are used and the power actually needed on Egypt's typically small farms, the investment cost advantage lies with the 45 hp tractor.

This conclusion speaks only to comparisons based on technical and economic considerations. Discussions with many Egyptians familiar with the farm mechanization scene and Study Team field contacts alike left no doubt that psychological factors outweigh technical and economic considerations in farmers' preference for the larger 65 hp tractor, as indicated in the Farm Attitude Survey. In the first place, that is the machine with which they have become familiar. Second, Egyptian farm families clearly attach high prestige value to tractor size.

If only 45 hp units were available, many farmers no doubt would buy them. And over time, a strong educational effort might well shift farmers' priority from psychological to economic and technical efficiency considerations. For the immediate future, however, progress toward achieving optimal tractor power

serving Egyptian agriculture will be improved by continued provision of the larger, 65 hp tractors. This conclusion is further supported by the fact that the new Massey-Ferguson/NASCO manufacturing facility is scheduled to produce 65 hp farm tractors, thus providing no Egyptian-produced alternative.

What the preceding analysis suggests in particular is the probable advantage in Egypt's pursuing a two-part strategy with respect to tractor size. Given existing circumstances, the near term premium rests with operating 65 hp tractors more effectively. This is one of the priority objectives of the Machinery Management Extension activity proposed in Chapter XIII. For the longer run, recurring consideration advantageously could be given to the feasibility of shifting to 45 hp tractors. Where the balance is struck on that score will depend heavily upon the success of near term efforts to achieve higher operational efficiency from 65 hp tractors.

Time Constraints and Tractor Numbers

With its year-long growing season and full irrigation, there is no apparent reason why Egypt should not achieve an overall cropping intensity of at least 200 percent compared with today's average of 190. However, to do so will require getting each crop off the land as quickly as possible and completing seedbed preparation for the succeeding crop much more quickly than is done at present. Complicating the timing problem is the practice of the 3-year rotations typically followed by Egyptian farmers. As these rotations make economic and agronomic sense as well as being firmly rooted in tradition, changing the cropping pattern to relieve the timing pressure upon available power supplies does

not represent a viable option--at least for the foreseeable future. Consequently, the challenge to strategy planning is finding practicable ways for relieving the time constraints by increased use of tractor power. The intensity of these constraints and the distance to be travelled in relieving them are seen in a general way in the time distributions of labor requirements shown in Chapter V. Their effects on particular crops are examined below in the context of typical crop sequences and indicated power requirements.

Cotton

All told, about 1.4 million feddans of cotton are planted following catch crop berseem. Table 13 shows that, in 1977, 728,000 feddans of berseem were harvested only once and 430,000 feddans had only two cuttings. This leaves 265,000 acres of cotton to be planted on land from the total area planted to cotton. Results from the Farm Management Survey similarly indicated that about 25 percent of the cotton is planted after the optimum time.

For illustrative purposes, say the first cutting of berseem is started about December 5, the second about January 20. The third cutting then starts 45 days later, about March 5. Cotton must be planted by early March to obtain the highest yield. If done piecemeal, land preparation of the one- and two-cutting areas can be essentially completed during the 45-day second-cutting period and the additional area from the three-cutting crop can be prepared as the crop is removed. As there are no other tillage requirements during February, land preparation for cotton does not require tractor numbers beyond those required for other crops grown in the same area.

Maize

In 1977, roughly 1.8 million feddans of maize were planted following, for

TABLE X. 13

EGYPT: AREA AND YIELD OF BERSEEM BY CATCH-CROP AND PERMANENT-CROP AND BY CUTS, 1971-1977

	Catch-Crop		Permanent-Crop		
	1-Cut	2-Cuts	3-Cuts	4-Cuts	5-Cuts
1971					
Area (000 feddans)	807	378	822	582	182
Yield (metric tons)	6.3	12.7	18.8	25.4	32.7
1972					
Area	848	385	765	636	185
Yield	6.3	12.8	19.2	25.6	33.2
1973					
Area	868	415	777	647	166
Yield	6.2	12.6	19.1	25.8	33.4
1974					
Area	699	480	712	746	159
Yield	6.0	12.1	18.6	25.4	32.7
1975					
Area	736	388	751	742	194
Yield	6.0	12.4	18.7	25.5	33.4
1976					
Area	707	399	723	759	228
Yield	6.0	12.2	19.2	26.0	31.7
1977					
Area	728	430	713	702	242
Yield	6.1	12.7	20.0	26.3	33.5

Source: Ministry of Agriculture, Agricultural Economics Research Institute.

the most part, full crop berseem or wheat. The fourth cutting of berseem and wheat harvest both overlap the desirable dates for maize planting. The fourth cutting of berseem starts in mid-April and takes 35 to 45 days. Wheat generally is ready for harvesting in late April. Since the optimum planting date for maize is May 15, the time constraint is seen to be very severe.

Preparation of the 448,000 feddans of the three-cutting berseem area can begin the first week in March, leaving 1,317,000 feddans. Since the maize area exceeds the berseem area by 373,000 feddans, that amount must come largely from wheat land. Taking the acreages cited together leaves 944,000 feddans to be prepared during a three-week period. Computations of the farmed area per tractor in the earlier discussion of tractor size show that a tractor and 1.75 meter plow could handle all tillage operations for a farmed area of 132 feddans when the most severe time constraint for basic tillage is 16 days. Since the maize area represents one-third of the cropped land, one tractor would be required for each 44 feddans of maize. On that basis, 21,450 tractors would be required for maize seedbed preparation alone.

These illustrative calculations assume for convenience that all maize is planted following berseem. Actually, a considerable part of the Egyptian maize crop follows wheat. Then, time constraints becomes exceedingly severe, especially under present conditions of seasonal shoratages of tractor power and the competition for available tractors during simultaneous wheat threshing and maize land preparation.

Rice

About 1.3 million feddans of rice are planted following full crop berseem or wheat. Transplanting is done 30 to 40 days after sowing the nursery. When rice follows wheat, the period from April 24 to May 30 (36 days) is available

for cutting, drying in the field, transport to the village or threshing area, land preparation, and rice transplanting. Allowing two weeks for the wheat to be cut and removed from the field, 22 days remain for all of the land preparation and transplanting. Following the same analysis as for maize, one tractor would be required for each 88 feddans when the tillage time period is 16 days. This assumes that the rice land will be plowed once with a tractor and pulled with animals in the short run. On this basis, 11,800 tractors would be required to plow the land once, 23,600 to plow it one time and puddle it two times.

More than 40 percent of the rice is now planted late. Wheat threshing is a heavy labor demand on top of that for rice transplanting. Since much of the wheat is threshed with a drum thresher, using the tractor for power, this function occurs at the same time the tractor is urgently needed for seedbed preparation. This causes rice to be planted late, resulting in lower yields.

Number of Tractors

A first estimate of a desirable total number of tractors in Egyptian agriculture is made on the basis of the farmed area that a single tractor could serve. In the section on tractor size, this was found to go to 132 feddans for a tractor of 45-65 hp. Therefore, only a very small number of farms in Egypt could utilize this machine to its full capacity. A farmer doing his own work plus custom work for a number of other farmers could adequately serve 105 feddans. Since there are approximately 6,000,000 feddans of cropland in Egypt, a minimal long-term goal would be a tractor population of 57,000.

An alternative analysis would be to examine the number of tractors needed to satisfy peak power requirements. Rice and maize are the two crops with the most severe time constraints. The number of tractors needed on the basis of

the time constraints for rice and maize treated as separate areas = 21,450 + 23,600 = 45,050. Adjusting for a productivity index of 0.8 when working on small fields, this becomes 45,050 ÷ 0.8 = 56,300. It is recognized that there is some overlap between the rice and maize areas. However, this is compensated for, to some extent, by omitting miscellaneous crops and sugar cane from these computations. The computation is thus in reasonable agreement with the 57,000 estimate based only on total cultivated area.

Egypt lacks the infrastructure to distribute, finance, and service the number of tractors required by land preparation for timely planting of all major crops. Also, in the Study Team's judgment, the Egyptian market probably will not absorb much more than an average of 4,000 new tractors per year over the next five years. A reasonable five-year goal appears to be to increase the tractor population to 35,000. While such an increase in tractor power would be close to optimal for the period suggested, all factors considered, it would not relieve the critical time constraints sufficiently to permit full double cropping of all cultivated land nor to get all maize and rice planted by the dates that indicates research will produce the best yields.

Effects of Tillage on Crop Yield

Crop production is a complex process and many inter-related factors must be taken into account to achieve high yields. One of these is the requirement for good seedbed preparation, i.e., tillage operations that provide conditions for good soil-seed contact so that the seed can imbibe water and start the growth process. Utilizing research papers published in scientific journals by Egyptian agricultural scientists, the Study Team derived estimates of yield

increases that may be expected from improved tillage. In general, these studies show that tillage operations which result in good seedbed preparation also result in increased seed germination, crop growth and yield. (Tables 14, 15, 16, and 17.)

Seedbed preparation in Egypt may not be as crucial as in other areas of the world because of the possibility of irrigation shortly after planting. But even in Egypt, where post-planting irrigation reduces the importance of initial soil-seed contact, the benefits of a good seedbed are evident. Yields of all crops are highest with the rotary plow, indicating that more intensive tillage results in greater yield; it also appears that cotton is more responsive to tillage than either of the other two crops. The disk plow gives the highest yield of corn grain (Table X. 16); this results from the disk plow turning over the soil more, thus producing a higher quality seedbed than any of the other treatments.

Table X. 17 shows the relationship between plow type and depth of plowing to the yield of three crops. Only corn responded significantly to deeper plowing; none of the crops studied responded to type of plowing. As no tillage other than plowing was done, this experiment is not a fair evaluation of tillage method. What it does confirm, however, is that plowing alone, regardless of the means, is not sufficient basic tillage to obtain optimal yield.

Yield response to tractor-drawn plows (plowing with disk plow, moldboard plow, chisel plow or rotary plow) compared with the animal-drawn baladi plow

TABLE X. 14

GERMINATION OF COTTON AND BEANS AS AFFECTED BY TILLAGE

Plowing treatment	Percent Germination	
	Cotton	Beans
None	56	50
Baladi	71	55
Chisel	71	60
Moldboard	75	60
Rotary	82	85

Source: Zein A. El Abedine, George B. Hanna, M.M. Abdulla and M.S. Seoudy, 1970. "The Effect of Different Types of Plows on Germination, Plant Growth and Yield." UAR Journal of Soil Science. 10:1-21.

TABLE X. 15

YIELD OF MAIZE, COTTON AND BEANS AS AFFECTED BY TILLAGE

Plowing Treatment	Kg/feddan		
	Maize	Cotton	Beans
None	1608	643	450
Baladi	1698	821	457
Chisel	1783	812	487
Moldboard	1834	969	496
Rotary	1918	1030	521

Source: Ibid

TABLE X. 16

YIELD OF CORN GRAIN AS AFFECTED BY TILLAGE

Plowing Treatment	Grain yield kg/feedan	
	Year One	Year Two
Baladi	362	577
Baladi + Subsoil	340	675
Chisel	407	642
Moldboard	473	560
Disk	488	716
LSD .05	89	120

Source: Abd-Elnaim E.M., M.A. Negm and N.A. Bayoumi. 1975. "Interaction Effect of Different Plows and Organic Manuring on Calcareous Soil Properties and Productivity." Agricultural Research Review. 53:93-98.

TABLE X. 17

YIELD OF COTTON, WHEAT AND MAIZE
AS AFFECTED BY PLOWING DEPTH AND TYPE OF PLOW

Plowing Depth(CM)	Type of Plow		
	Baladi	Chisel	Moldboard
	Cotton yield kg/feddan		
13	948	947	942
25	952	917	1010
	Wheat yield kg/feddan		
13	1375	1358	1433
25	1409	1443	1591
	Maize yield kg/feddan		
13	1078	1118	1120
25	1194	1284	1284

Source: Hassan Hamdi, George Bassily, Bishai Guindi. 1963 "A Comparative Study of Shallow and Deep Plowing on Yield and the Soil Physical Properties". UAR Journal of Soil Science 3:1-30.

varied between 0 and 35 percent. In general, rotary and disk plows performed better than the moldboard and chisel plows. Good seedbeds can be prepared in more than one fashion and with different tillage implements. Thus, a choice of techniques becomes a question of economics and engineering once the basic agronomic principle has been established.

It appears that good seedbed preparation can increase yields 25 to 35 percent in somes cases, while in others it ranges downward, from 10 to 15 percent to zero, particularly if management is poor or there are adverse envirnomental conditions.

The primary issue, however, has to do with the potential increases in yield if, as a result of increased mechanization, good seedbed preparation were to be made available in Egypt. This is largely a matter of judgment. If there is to be significant change, farmers will need education on the benefits of improved tillage and the proper use of equipment for achieving better seedbeds. The contribution which improved equipment and farmer knowledge of tillage practices can make to increased farm production warrants considerable investment.

While the potential increase could be as high as 25 to 35 percent, this is probably well above what could be expected on the average for some time. Because the first year would actually be a period of learning and adjustment, probably no general increase should be expected. For purposes of analysis, the Study Team assumed that deeper plowing would not result in an increase in yield,

deeper plowing. It was further assumed that without an extension effort, it would take farmers eight years to learn how to use disks and spiked-tooth harrows in order to exploit the full yield increase potential that exists. With an effective extension input, that learning period could be shortened appreciably.

Relationship of Planting Dates to Crop Yield

High efficiency in the production of crops probably constitutes the single most important factor in the overall success of the agricultural sector in Egypt. In general, crop productivity in the country is high due to the fertile alluvial soils of the Nile Valley and Delta, adequate fresh water from the Nile, weather that permits year-round cultivation of the land, the high photosynthetic potentials from intense sunlight and the hardwork of skilled farmers. However, the year-round production schedule creates a situation where delays in harvesting one crop cause delays in planting a subsequent crop.

The Study Team utilized available research results on the yield effects of late planting and data on date of planting from Farm Management Survey to derive estimates of the reduction in yields currently experienced due to planting delays. The crops studied are the major summer crops grown in Lower Egypt: maize, cotton, and rice. Within reason, wheat yields are little affected by planting date. Berseem yields are affected only to the extent that later seedings have less time to produce usable growth before cotton planting or the mandatory irrigation cut-off date as the case may be. Each summer crop is generally planted after wheat or berseem. The northern part of the Delta area has essentially cotton and rice as summer crops; the southern part has maize and cotton.

Data on the relationship between planting dates and yields are very sparse. For this analysis, the yield data were obtained from researchers working at the agricultural experiment and government research stations. Most of them were developed from experiments conducted over a five-year period, the findings from which have not yet been published. Unfortunately, the yield data do not cover as wide a range of planting dates as they should. Consequently, extrapolations were necessary in many instances to cover the later dates on which many farmers said they planted their respective crops. More adequate supplies of tractor power will enable farmers to get one crop in sooner after the preceding crop is harvested. The importance of this contribution to increasing agricultural production is apparent from the succeeding analysis.

Maize

The highest yield for maize was obtained when plantings were made during the third week of May (Table X. 18). The decline in maize yields from May 15 to July 30 is almost linear, declining 61 percent, or 1,390 kg per feddan, between these two planting dates. Maize yields were 2,292 kg per feddan when planted May 15; 1,926 kg when planted June 15, a 15 percent decline; and 1,165 kg when planted July 15, a 49 percent decline. The average yield loss per feddan per day from the May 15 planting date to the July 30 date was 18.3 kg. Daily losses in yield between weekly planting dates were higher during the latter part of the planting season, particularly after June 22 (Table X. 19). The relationship between reported planting dates and yield decline due to late planting is illustrated graphically in Figure X. 1.

TABLE X. 18

MAIZE: RELATIONSHIP OF PLANTING DATE TO YIELD

Planting Dates 1/	Yield, Kg per feddan	Decrease in yield per week between weekly planting dates from May 15		Decrease in yield per day between weekly planting dates	
		Kg per feddan	cumulative percentage	Kg per feddan	Kg/feddan (cumulative)
May 15	2.292	---	----	----	----
May 22	2.165	127	5.5	18.1	18.1
May 30	2.022	270	11.8	20.5	38.6
June 7	1.970	322	14.0	7.4	46.0
June 15	1.926	366	15.4	6.3	52.3
June 22	1.750	542	23.6	25.1	77.4
June 30	1.621	671	29.2	18.5	95.9
July 7	1.380	912	40.0	34.4	130.3
July 15	1.165	1.127	49.2	30.7	161.0
July 22	1.110	1.182	51.6	7.9	168.9
July 30	902	1.390	60.6	29.7	198.6
Average kg loss per day per feddan from May 15 planting date				18.3	----
Percent kg loss per day per feddan from May 15 planting date				----	0.8

1 Twenty-nine percent of the farmers interviewed reported planting their maize before May 15. No yield data are available on the relationship of yield to planting dates prior to that time.

Source: Derived by Study Team from secondary data and filed survey results.

FIGURE X. 1

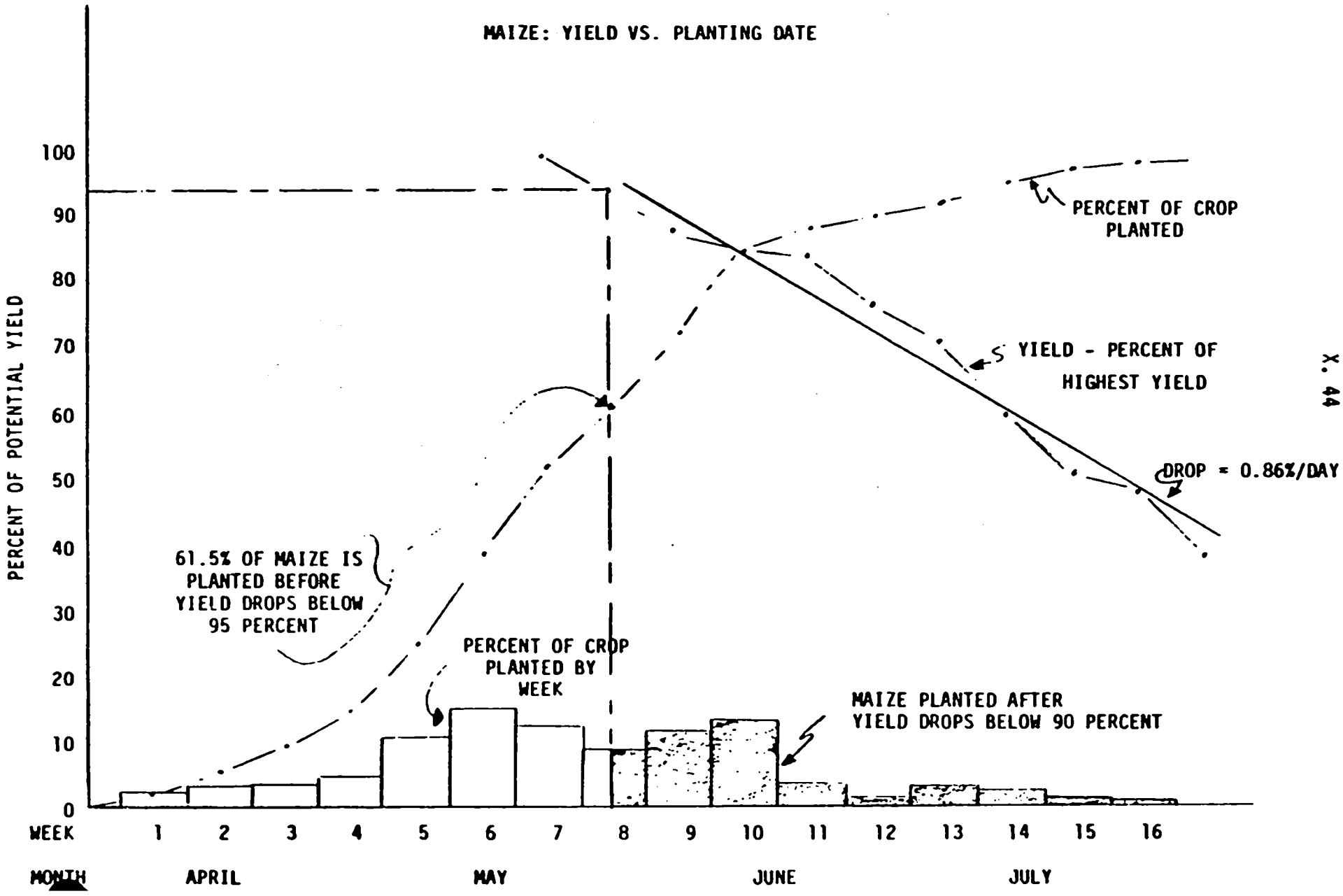

MAIZE: YIELD VS. PLANTING DATE
PERCENT OF POTENTIAL YIELD
100
90
80
70
60
50
40
30
20
10
0
PERCENT OF CROP PLANTED
YIELD - PERCENT OF HIGHEST YIELD
DROP = 0.86%/DAY
61.5% OF MAIZE IS PLANTED BEFORE YIELD DROPS BELOW 95 PERCENT
PERCENT OF CROP PLANTED BY WEEK
MAIZE PLANTED AFTER YIELD DROPS BELOW 90 PERCENT
WEEK
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
MONTH
APRIL
MAY
JUNE
JULY

TABLE X. 19

MAIZE ACREAGE AFFECTED BY LATE PLANTING*

Planting Date		Percent Planted	Percent Yield
4-1		2.4	Note: No yield data are available for planting dates before 5-2.
4-2	52.1%	3.4	
4-3		3.7	
5-1		10.8	
5-2		14.9	
5-3		12.2	100
5-4		8.8	94.5
6-1		11.5	88.2
6-2		13.2	86.0
6-3		3.7	84.6
6-4		1.4	76.4
7-1		3.0	71.8
7-2		2.4	60.0
7-3		2.4	50.8
7-4		1.0	48.4
8-1		0.7	39.4

* 1977 planted area = 1.8 million feddans. Note that 47.9 percent of the maize is planted late .

1 Based on 1978 farm management survey.

Cotton

Data on cotton yields indicate that peak yields occur when cotton is planted between February 15 and March 1 (Table X. 20). Declines in cotton yields are modest during the first half of the planting season: only 4 percent from February 15 through March 8. However, during the last half of the planting season and as the date advances, yields decline much more rapidly (Table X. 21). Cotton planted the week of April 8 yielded 33 percent less than if it were planted prior to March 1. The average kantar yield loss per feddan per day from the February 15 planting date to the April 8 date was .052, equivalent to 8.19 kg. Judging from reported planting dates, most cotton is planted early enough to avoid severe yield loss (Figure X. 2).

Rice

The yield of rice remains relatively constant when transplanted between the third week of April and the third week of May (Table X. 22). Transplanting rice after the third week of May results in a rather sharp drop in yield; over 40 percent from the reported yield for rice planted during the May 15 week (Table X. 23). The average loss per day per feddan from the week of April 22 to the week of June 7 was .086 tons per hectare, equivalent to about 80 pounds. As indicated by Figure X. 3, a high percentage of all rice suffers substantial yield loss due to late transplanting.

Tractor Supply Sources

Preceding sections have developed the bases for the Study Team's estimate of an optimal farm tractor fleet comprising 35,000 units consisting largely of

TABLE X. 20

COTTON: RELATIONSHIP OF PLANTING DATES TO YIELD[1]

Planting Dates[2]	Yield Kantar per feddan[3]	Decrease in Yield per week between weekly planting dates from February 15		Decrease in Yield per day between planting dates	
		Kantar per Feddan	Percent (cumulative)	Kantar per Feddan	Kantar per feddan (cumulative)
Feb. 15	6.77	--	--	--	--
Feb. 22	6.79	+0.02	+0.3	+.003	.003
March 1	6.75	0.04	0.6	.006	.009
March 8	6.51	0.24	4.1	.034	.043
March 15	6.16	0.35	9.3	.050	.093
March 22	5.75	0.41	15.3	.056	.149
April 1	5.20	0.55	23.4	.079	.228
April 8	4.55	0.65	33.0	.093	.321
Average kantar loss per day per feddan From February 22 planting date				.052	--
Percent kantar loss per day per feddan From February 22 planting date				--	0.77

1 Data for both planting dates and yields are for Lower Egypt

2 Ten percent of the farmers planted cotton before the February 15 planting date and 4 percent after the April 8 planting date. No yield data are available prior to the February 15 or after the April 8 planting dates.

3 One metric kantar of unginned cotton weighs 157.5 kg.

Source: Derived by Study Team from secondary data and field survey results.

TABLE X. 21

COTTON ACREAGE AFFECTED BY LATE PLANTING*

Planting Date [1]		Percent Planted	Percent Yield
2-1		5.7	↑
2-2		8.4	
2-3		14.5	100
2-4	75.2%	17.2	100
3-1		29.4	99.4
3-2		10.1	95.9
3-3		7.5	91.7
3-4		4.0	84.7
4-1		0.5	76.6
4-2		2.2	67.0
4-3		0.5	↓

* 1977 planted area = 1.4 million feddans. Note that 24.8% of the cotton is planted late.

1 Based on 1978 farm management survey.

FIGURE X. 2

COTTON: YIELD VS. PLANTING DATE

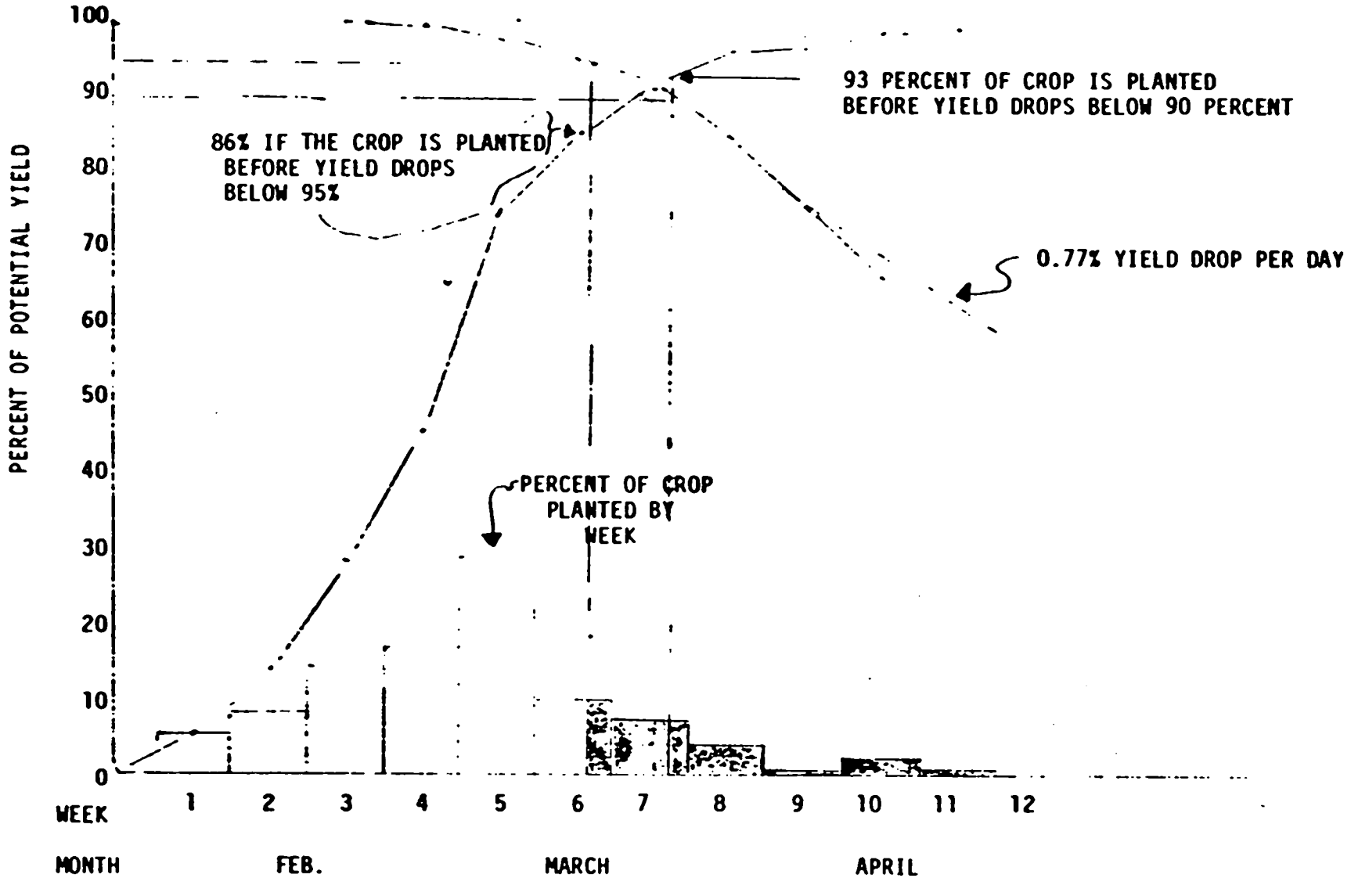


TABLE X. 22

RICE: RELATIONSHIP OF PLANTING DATES TO YIELD

Planting Dates[1]	Yield, tons Per Ha[2]	Decrease in Yield per week between weekly planting dates from April 22		Decrease in Yield per day between weekly planting dates	
		Tons per Ha	Percent (cumulative)	Tons per Ha	Tons per Ha (cumulative)
April 22	9.45	--	--	--	--
April 30	9.45	.00	0	0	0
May 7	9.48	+.03	+0.3	+.004	.004
May 15	9.35	.10	1.1	.019	.023
May 22	8.50	.95	10.1	.121	.144
May 30	7.20	2.25	23.8	.186	.330
June 7[3]	5.50	3.95	41.8	.243	.573
Average tons per Ha loss per day per feddan from the April 22 planting date				.086	--
Percent tons per Ha loss per day per feddan from the April 22 planting date				--	0.91

1 Three percent of the farmers planted rice before the April 22 planting date and 25 percent after the June 5 planting date. No yield data are available prior to April 22 or after the June 5 planting dates.

2 One hectare is equal to 2.38 feddans.

3 Estimated from June 5 planing yield data.

Source: Derived by Study Team from secondary data and field survey results.

TABLE X. 23

RICE ACREAGE AFFECTED BY LATE PLANTING*

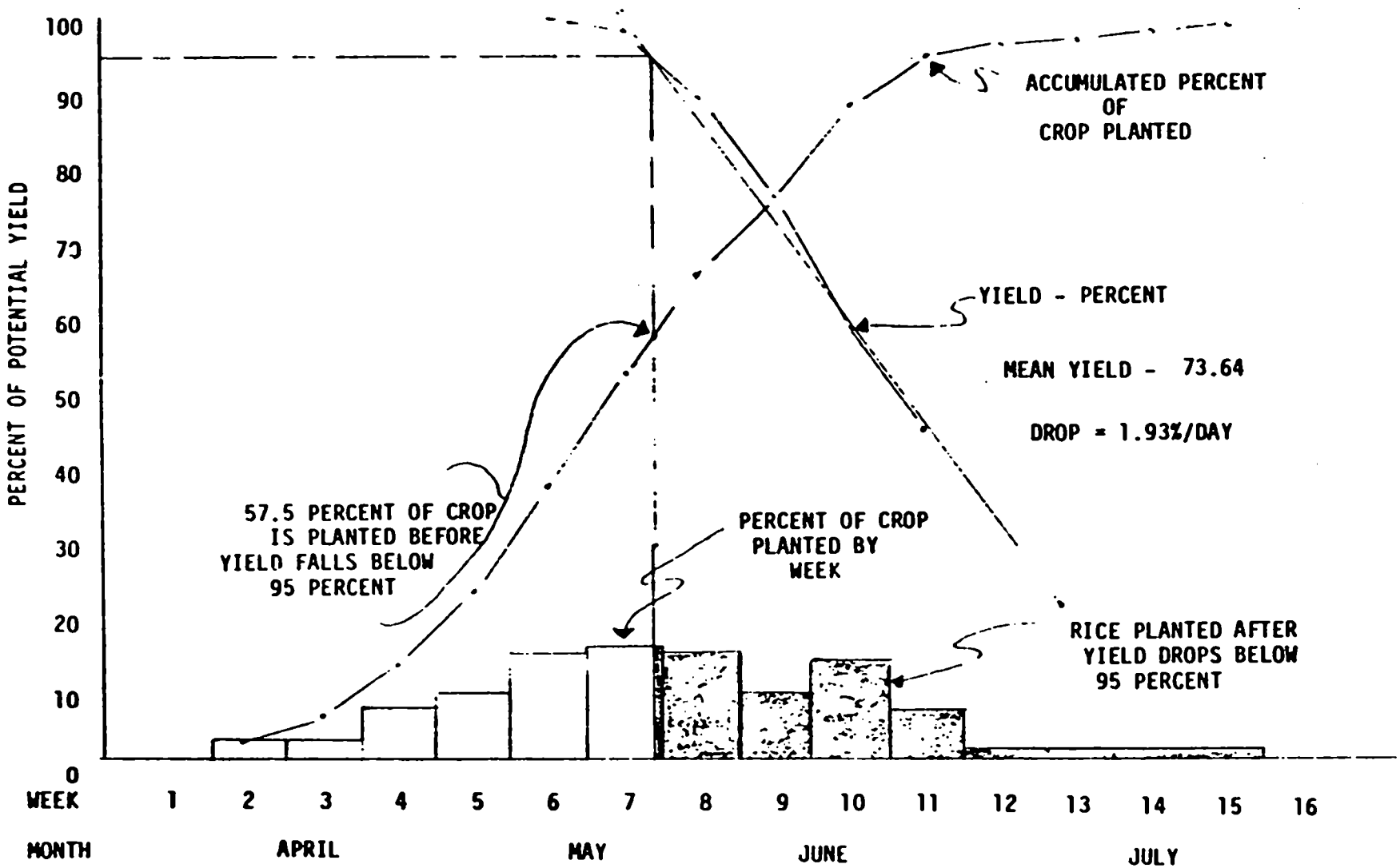
Planting[1/] Date		Percent Planted	Percent Yield
4-2		3.1	
4-3		3.1	
4-4		7.2	
5-1		9.3	
5-2	52.6%	14.4	100
5-3		15.5	98.9
5-4		14.4	89.9
6-1		9.3	76.2
6-2		13.4	58.2
6-3		6.2	45
6-4		1.0	
7-1		1.0	
7-2		1.0	
7-3		1.0	

* 1977 planted area = 1.0 million feddans. Note that 47.4% of the rice is planted late.

1 Based on 1978 farm management survey.

FIGURE X. 3

RICE: YIELD VS. PLANTING DATE



60-65 hp tractors. It will be recalled that the estimate takes account of the horsepower per feddan needed to maximize crop production on the one hand and the prospective near term absorptive capacity of the market on the other. Preceding sections also have demonstrated the production gains that added tractor power can help achieve through more timely planting and improved seedbed preparation. The remaining questions concern the feasibility of Egypt's obtaining enough additional tractors over the next several years to bring the 1985 stock up to the 35,000 unit optimum.

Scheduling

Without repeating the sources of the respective numbers, following is the Study Team's view of a realistic scheduling of tractor imports, production and sales over the next several years. Even though the five-year program recommended in this report is based on an assumed starting date of January 1980, data for 1978/79 are included in the schedule to illustrate how the current backlog would be worked off and where the local manufacture/domestic sales balance likely will stand at the end of first year after the overall AID mechanization-assistance program is presumed to end.

Date	Activity	In Stock
July 1978	In stock	5500
By Dec. 30, 1978	Sell 1500	4000
During 1979	Sell 3000, Import the 1300 on tenders already let plus private import of 200	2500
During 1980	Sell 3300, Import 3000 as components or assembled units	2200
During 1981	Sell 3500, Import 3000 as components or assembled units	1700

(con't)

Date	Activity	In Stock
During 1982	Manufacture and/or import 3500, sell 3800	1400
During 1983	Manufacture and/or import 4000, sell 4200	1200
During 1984	Manufacture and/or import 4300, sell 4500	1000
During 1985	Manufacture 6000 and export excess over local demand estimated at 5000 units	1000

Replacements among Egypt's aging tractor stock will require an estimated 2300 units per year after allowance for those rehabilitated as part of the proposed Machinery Service Center activity discussed elsewhere in this Study Team report. Thus, the above combination of stock drawn-down, component/assembled tractor imports and domestic manufacture would result in a net increase of 9,500 in the total number of tractors on farms.

Replacement Strategy

To fulfill the projected schedule will require import financing for 6000 tractors--or their equivalent in components--at an estimated total cost of $30 million, including a 10 percent allowance for inflation. NASCO's general plans call for assembly of 2,000 units in each of the next three years until the MF/NASCO plant becomes operational. Given the current stocks of unsold tractors, the Study Team sees no reason for NASCO to assemble any units in 1979. To be ready for 1980 production, however, they obviously would have to make procurement arrangements during 1979. Superficial review of NASCO's foreign exchange cover plans indicates that reliance is placed predominantly on AID CIP financing to cover component imports.

Whether AID assistance in this area is provided through CIP or through the present project would seem largely a matter of AID preference. This assumes, however, that the same conditions precedent practicably can be attached to either method of financing. If they cannot, projectizing NASCO component imports appears to be much the better strategy. This is because the Study Team feels quite strongly that mutual planning of essential related actions on the service and machinery management fronts can best be conducted in the context of the total mechanization assistance strategy presented in this report.

Assuming that the critical preconditions to AID's financing further tractor imports can be met satisfactorily, the Study Team's further concern is that the volume of total imports during 1980 and 1981 be adequate to enable Egypt to have available to farmers a total fleet of 35,000 tractors by the end of calendar year 1984. This would mean raising NASCO's projected assembly schedule by 1000 units during each of these two years--or ARE's permitting private importers to bring in 2000 assembled tractors during 1980-1981. As Egypt's total farm tractor requirements are presumed to be met by local manufacture from 1982 onward, increasing NASCO assembly would be preferable to again opening the door briefly to unregulated private imports. The latter course could but worsen the already difficult problem of meeting spare parts requirements for a multiplicity of tractor makes and models.

Another approach would be to resume private imports in 1980 but with restrictions on the number of different makes eligible for import--say, at most, three or four. This would avoid undue proliferation of spare parts requirements. Since NASCO per se is going out of tractor assembly in 1982 in any event, it could serve as "supplier of last resort" by scheduling only enough units to make up the difference between prospective private imports and the yearly schedule set out above.

Actually, this type of mixed strategy has much to commend it if ARE anticipates allowing at least some imports of assembled tractors after the domestic manufacturing facility begins operation. This would allow foreign manufacturers to establish dealership relations with the proposed Machinery Service Centers which would facilitate procurement of spare parts for both existing and new tractors and give farmers the benefit of competition among suppliers. This, of course, would not be feasible if manufacturers could anticipate dealership participation in Egypt for only two years.

Recommendations

As emphasized in several earlier contexts, the Study Team's principal concerns are that (a) the volume of tractors available for sale to farmers be large enough to press upon the market demand and (b) import financing arrangements include pre-conditions with respect to action toward significantly improving the system for tractor repairs and spare parts delivery. Specifically, it is recommended that:

1. Provision be made in the present project for financing the equivalent of 3000 65 hp farm tractors in 1980 and 1981, respectively.

2. The financing agreement contain a sufficiently definitive condition precedent to insure prompt and adequate ARE action, along the lines recommended elsewhere in this report, to remedy the critical repair facility/spare parts and machinery management situations.

3. ARE be strongly encouraged to assess the adequacy of loanable funds available to the Principal Bank for Development and Agriculture in the context of Egypt's national food security goal and the contribution which further mechanization of Egyptian agriculture can make toward fulfilling that goal.

4. ARE be encouraged to re-evaluate the decision to concentrate farm tractors in the 65 hp range with particular attention to the investment savings possible from shifting to 45 hp units. Should such a course prove impractical, the Study Team urges that AID employ all reasonable means to encourage MOA to find ways of getting farmers to use their 65 hp tractors so as to get 65 hp from them instead of the 35-50 they are now realizing.

5. USAID explore with MOA, at an appropriate time vis-a-vis establishment of the MF-NASCO private sector enterprise, the advantages and disadvantages of pursuing a strategy of restricted but sustained private sector imports of assembled tractors at a level sufficient to make a competitive price available to farmers yet not of such volume as to thwart the objectives sought by the MF-NASCO joint venture for domestic manufacture.

CHAPTER XI

LAND IMPROVEMENT

General Needs

Despite its inherent high fertility, waterlogging and salinity have deteriorated most of Egypt's cropland to such an extent that it is producing far below capacity. The detailed soil survey completed in 1973 after 16 years of intensive effort found that only six percent of the presently cultivated cropland could be classified as excellent, 45 percent as good, the remaining 49 percent as either medium or poor. Shifting to perennial irrigation without adequate drainage has led to a higher ground water table, varying degrees of soil salinity and alkalinity, subsoil compactness and hard pan formation. For severely waterlogged soils drainage is the only solution. With World Bank assistance, tile drainage is now being extended to cover 950,000 feddans in the Delta and 300,000 in Upper Egypt which are in the most serious need of drainage. Similar treatment of another area of 300,000 feddans in Upper Egypt is still under discussion.

Installation of a permanent drainage system--whether tile or open ditches--is both costly and time consuming. Fortunately, Egypt has found a way of temporarily restoring large areas to about their original productivity by a rather simple, inexpensive and rapidly applied process. Called "subsoiling" (actually a type of drainage) this process has been found to increase yields by 20-150 percent. How much yields are increased by subsoiling depends upon soil type, the present degree of deterioration and the crop involved. The more deteriorated the soil, the greater the yield increase from subsoiling. Tap root crops,

like cotton, naturally respond more to having their root zone freed of waterlogging and salinity than do shallow-rooted crops such as maize or wheat. When gypsum is used in combination with subsoiling, yield increases are even more impressive. Research indicates that yields on most of Egypt's three million feddans of class III and IV lands would benefit substantially from periodic subsoiling. One million feddans of those lands are seriously in need of such treatment, as their cotton yields have dropped to probably no more than half the national average.

A related kind of "waterlogging" problem severely affects another one million feddans of Egypt's prime cropland, mainly in Upper Egypt. It results from farmers not having leveled their fields adequately following completion of the High Dam at Aswan and the accompanying shift to perennial irrigation. Improperly leveled fields collect irrigation water in pools at low points. This condition not only drowns out a growing crop but progressively deteriorates the soil itself. Conversely, high spots tend to be underwatered, which results in both poor germination of seed and salt accumulation. Indications are that on the average, crop yields on the one million feddans most seriously affected by uneven terrain could be increased 10-15 percent by precision leveling.

Soil Amelioration Organization

Overall responsibility for all types of land improvement in Egypt rests with the MOA Soil Amelioration Organization (SAO) headed by an Undersecretary who reports directly to the Minister. The SAO is a major department of the Ministry of Agriculture. Its professional staff comprises some 50-60 engineers in various relevant specialties. Field-level workers (machine operators, mechanics, etc.) number several hundred. The Soils Investigations Department

has 20 laboratories, usually one in each Governorate, which test soil samples to determine the treatment needed at each location. Soils analyses are completed before any amelioration work is begun.

Expanding the Organization's staffing to take fuller advantage of opportunities for increasing agricultural production via subsoiling will have to be time-phased but overall should not pose a serious problem. SAO currently has dynamic and energetic leadership, eminently qualified in the technical aspects of land improvement.

On the equipment front the picture is far different. As indicated by Table XI.I, SAO presently has only a fraction of the number of most major items required to increase subsoiling field coverage to some 300 to 400 thousand feddans per year. This would roughly double the present rate. Such doubling of the current production rate over the next five years is believed to be feasible, if the organization had adequate equipment. SAO presently has only a very limited land leveling program. Here too, though, it has the organizational and technical capabilities for mounting rather quickly a service/demonstration effort of sufficient scope to lay the foundation for an energetic private sector activity.

Subsoiling

Soil amelioration services--subsoiling gypsum treatment where needed and some land shaping -- are provided to farmers in high-return areas on a custom charge basis by the MOA Soil Amelioration Organization.

Present program

Now in its fifth year, the program is based upon extensive research by Dr. Kassem A. Kassem, now Undersecretary for Soil Amelioration, at the Soil

TABLE XI.I

SOIL AMELIORATION EQUIPMENT FLEET AS OF NOVEMBER 1978 AND SAO ESTIMATES OF NUMBER REQUIRED FOR FULLY EFFECTIVE PROGRAM *

Item	Number On Hand	Additional Needed
130 hp tractors (subsoiling & ditching)		
Eicher (new), 4 x 4	24	150
Fiat (2 yr. old), 4 x 4	50	
65 hp tractors		
UTS (4-10 yr. old, 800 hr./yr.)	120	
Old tractors for hauling	50	70 (hauling)
70 hp digger-loaders		
JCB (6 months old)	25	90
Allis Chalmers (1 yr. old)	3	
Land planes, 14 ft. length	3	25
Doudi ditchers	52	90
Subsoilers, 2 time mounted	92	200
Subsoiler, 1 time trailed	100 (scrap)	
Trailers	25	50 (5-ton)
Gypsum spreader, 3 pt. hitch	18 (on order)	100
Track type tractors with dozer		10 (100 hp)
MF (100 hp)	2	
MF (160 hp)	1	
Trucks (available locally)		

*Data relate only to soil amelioration activities as SAO is yet little engaged in precision land leveling. In the Study Team's view the above equipment needs given by the Undersecretary appear to be less than required but may approximate SAO's ability to utilize additional equipment in the near term. Assuming 60 percent of 3.0 million feddans need to be subsoiled every four years, a fleet of 250 tractors could be required for a maintenance program only.

Salinity Laboratory, Alexandria. Begun in 1968 on an experimental basis covering 2000 feddans, Dr. Kassem's research was expanded to a large-scale pilot project on 15,000 feddans in 1969, then to 30,000 in 1970 and finally to 50,000 feddans in 1971.* Actual application of the soil amelioration process to farmers' fields has built up slowly over the past five years. Through October 48,000 feddans had been subsoiled during 1978 and an additional 18,000 feddans were expected to be completed by year's end. Plans for 1979 call for a total of 225,000 feddans to be "ameliorated," some 60 percent of which will be subsoiled.

Encouraged by farmer reception and success of its early years' experience, the SAO has developed a 5-year plan for extending services to 1.2-1.5 million feddans by 1985. The remaining 1.5 million feddans of Class III and IV lands are scheduled for subsoiling in the 1986-90 period.

Ambitious though it is, this program is not adequate to take full advantage of the opportunity which soil improvement affords for increasing crop production. Even at its projected 1980-85 rate of 300,000 feddans per year, SAO would still have ample room for expanded coverage, since subsoiling is by its nature a temporary expedient. Benefits from this process drop rapidly after the third year. Consequently, to achieve optimal yields the process should be repeated every 4-5 years. Considering the yield increases this inexpensive process can bring, it behooves Egypt to find ways of treating at least the Class III and IV lands at optimally spaced intervals.

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*For a comprehensive discussion of the genesis of the SAO program, field trial results and technical aspects of the soil amelioration process see National Project for Land Improvement and Soil Conservation, Report on Soil Amelioration in the Lower Delta, Vol. II, United Arab Republic, ministry of Agriculture and Agrarian Reform, June 1971.

The Process

Ideally, the full soil amelioration process includes surface drainage, subsoiling and gypsum application. Here the term "subsoiling" excludes surface drainage. Installing a surface drainage system is time consuming and produces considerably lower,though longer-lasting, benefits in terms of increased yields than does the subsoiling/gypsum treatment. Why, with its limited overall capacity, the SAO does not concentrate on subsoiling those lands that will yield high returns without expensive surface drainage is by no means self evident.

Subsoiling involves three interrelated steps: deep furrowing with a 2-tine chisel plow; clearing of field drainage ditches; and applying gypsum where soil tests indicate it is needed. The furrowing has to be deep enough to break up the underlying hard pan to at least the depth of the plant root zone (at least 55 and preferably 75 cm). This can be done efficiently only by a tractor of 100-150 hp. To clear ditches a 70 hp digger-loader is used. Mechanical ditchers are used to insure that the clearing does in fact get done and that it is done properly. If the drains are not properly cleared, the entire subsoiling process comes to nought. SAO has no practicable means of requiring a farmer to clear his ditches nor of providing technical supervision at whatever time a particular farmer finds it convenient to do his own clearing. According to SAO officials, even small farmers prefer to have them do the entire job. To complete the process, on soils with a pH exceeding 8.5, gypsum is applied at the rate of 3-5 tons per feddan. Produced in quantity in Egypt, gypsum is both readily available and relatively inexpensive.

Operations

Subsoiling is done at the request of individual farmers living within a preset geographic area identified by the SAO at the beginning of each year.

Limiting operations in any given year to an area of 150-200,000 feddans is essential to economizing machine time. As many farmers reportedly wait for subsoiling service, SAO presumably strikes a balance between soils likely to be most benefited and number of farmers seeking service.

Subsoiling costs are paid by the benefited farmer on a per feddan basis to cover SAO operating costs. The present charge to farmers is LE 2.50 per feddan, but this will be raised to LE 3.00 for 1979 to cover the Organization's increased costs. Gypsum is supplied at its actual cost, 81 piasters per ton and, as noted earlier, used at a rate of 3-5 tons where needed. Hauling of gypsum is subsidized and costs the using farmer LE 3.00 per ton. Ditching costs average about LE 15.00 per feddan. Therefore, the total cost to the farmer is roughly LE 22.00 per feddan. This cost is repaid by benefited farmers in 10 yearly installments beginning one year after the work is completed. No interest is charged. Subsoiling is done 120 days per year; ditching over a 5-month period six days per week.

Costs and Returns: Subsoiling

Whether considered from the standpoint of the Egyptian economy at large or that of farmers on lands which can be improved appreciably by the process, research and field experience alike show that subsoiling yields very high returns in relation to costs. This is apparent from the yield increases generally to be expected from a typical rotation over the 5-year period during which the subsoiling has been found to affect crop yields:

Crop	Yield Increase-Percent of Base Year 1	2	3	4	5	Total Increase as percent of Pre-Application yield
Cotton	50	48	40	30	15	183.
Maize	15	5	--	--	--	20.
Berseem	4.6	4.6	--	--	--	5.2

These data also illustrate two significant characteristics of subsoiling noted earlier: (1) cotton yields are enhanced far more than are those of shallow-rooted crops like maize or those like berseem which are more salt-tolerant than cotton and (2) even for cotton the yield-increasing effects of subsoiling decline rapidly after the third year and are lost entirely on maize and berseem after two years. Although the indicated increases in cotton yields may appear high, they actually are quite conservative compared to those that have been obtained on badly deteriorated soils. The above data assume no gypsum is added. Where that treatment also is needed, even larger yield increases result from the total soil amelioration process.

As subsoiling is performed only on poorly drained soils, it is reasonable to assume that crop yields before subsoiling are well below the national average. To illustrate prospective net returns from subsoiling without gypsum, base yields are taken here to be 50 percent of the 1977 national average for the respective crops as they are in the internal rate of return calculations in Chapter XXIV. Assuming the cropping pattern on such lands approximates that found by the Farm Management Survey to be characteristic of cotton farms outside the rice belt, 32 percent of the land treated would be used for cotton, 68 percent for maize, 63 percent for berseem, and 37 percent for wheat and other crops little benefitted by subsoiling. With such a combination of crops and with farm-gate prices at

their 1977 levels, subsoiling would increase the total value of production per feddan some nine percent over the five years during which it has some effect. To the family operating a typical two-feddan farm, this would mean an average increase in net income of LE 25 per year for that five-year period.

The family-sized farm operator's cost of having SAO subsoil and ditch all his land at the custom rate of LE 18.00 per feddan indicated above would be LE 3,600. As he pays no interest on the "loan" made by SAO to cover the cost of their services, that would be his total outlay for obtaining the LE 25 average income increase per year. Therefore he would, in effect, realize a return of 350 percent on his investment in subsoiling services. From a cash flow standpoint, his situation over the five years during which benefits are accruing would in reality be somewhat better than that. The reason is that repayment of the SAO loan is currently spread over ten years. As a result, during the first year after the subsoiling operation is performed, his family's net returns from crop production would be increased some 15 percent. Even though returns would decline in subsequent years, they would still exceed loan repayments by a wide margin in the fifth year, as loan repayments by a two-feddan farmer would be only LE 3.60 per year. However, under SAO's present extended repayment arrangement, during the succeeding five years an initially benefited farm family would still be making these loan repayments from a farm income which had returned to its relatively low presubsoiling level.

Longer Range Strategy

Virtually all subsoiling operations of the kind described above currently are performed by the Soil Amelioration Organization. For the next several years, Egypt's national interest probably will best be served by continuing to look predominantly to SAO for these services. The equipment required is large and expen-

sive. The initial investment required no doubt will deter private custom operators' entering this field. In addition to the equipment, considerable technical expertise is required for pre-application soil testing to determine prospective benefits and counselling with individual farmers regarding how and to what extent soil amelioration is likely to affect their crop yields. And, though the cost per feddan is small compared to the resulting increase in value of production, existing SAO policy of spreading the application costs over a ten-year period no doubt increases significantly the number of farmers seeking subsoiling services. Few small farmers would be able to make an immediate payment of LE 18.00/feddan for subsoiling and ditching. To a private custom operator with a scale of operation big enough to utilize his equipment efficiently, the cost of carrying the service charges for any length of time would be a heavy financial burden.

In due course, private contractors may be willing to take up custom operations in sufficient number to meet recurring needs for subsoiling services. To make this practical SAO would have to shift its role progressively from that of supplying services directly to farmers to one of providing supporting services to private custom operators. For example, SAO would need to make its soil testing laboratory facilities available to private entrepreneurs either on a charge or public service basis. Either SAO or the Agricultural Extension Department likewise would need to provide farmers with advisory and soil testing services (to determine the needed level of gypsum application) in conjunction with the operations of private contractors. If subsidizing the hauling of gypsum is to be continued, either SAO would have to stay in that phase of soil amelioration--again, in conjunction with private contractors doing the subsoiling work--or government would have to arrange to make subsidy payments to private haulers directly or through using farmers.

Given the general ARE policy of encouraging private enterprise, it would seem appropriate for MAO to consider the feasibility of shifting subsoiling operations to the private sector as circumstances permit. However, for the immediate future the priority should be to cover as quickly as possible all the lands where production could be increased significantly by subsoiling. In the Study Team's judgement, that objective could be accomplished by rapidly expanding SAO's service capabilities.

Precision Land Leveling

SAO presently has no program for precision land leveling. Some 50,000 feddans of State Farm lands in the Upper Delta currently are being leveled for sugar beet production, but that represents a special purpose operation rather than the start of a general SAO land leveling service. With limited equipment and budgetary resources, SAO has preferred to confine its activities to subsoiling and surface drainage where its leadership has had extensive prior experience. Under the circumstances the priority given the Delta areas' waterlogged and saline soils may have been warranted. However, not to begin to level land in Upper Egypt as it is needed is to leave that "neglected area of land improvement" without the attention land-short Egypt deserves. This appears not to be either an economically or socially advantageous strategy from this point onward.

The Need

Farmers tilling the one million or so feddans of Upper Egypt cropland particularly in need of leveling are well aware of what irrigating uneven fields does to their crop yields and their land. What research in other countries like Pakistan and Turkey has proved scientifically they have learned by painful

experience. In general, they have cut up their already small fields into several plots in order to reduce the unevenness of each area irrigated. Many have tried to improve the levelness of their fields by moving soil from the high to low points. Unfortunately, each has to rely on memory as to those areas when he is able to get to the land for leveling after the crop is harvested. If pursued long enough, this trial and error method will result in a fairly level field--if the area being leveled is not too large. But, with each passing crop season, even those trying this approach lose yield and see the quality of their land deteriorate. With the primitive equipment they now use, earth-moving is a slow process. While farmers in Upper Egypt do the best they can, getting their fields in shape for efficient irrigation will take a long time, with obvious consequences to their families' welfare and the nation's food production.

Field uneveness reduces the land available for crop production, yields, and soil quality while increasing production costs in various ways. For example, it is reasonable to presume that poor germination due to uneven soil moisture is reducing crop yields, in severely affected areas, by at least 10 percent. A third of the nitrogen used to increase crop yields is probably lost through leaching due to inevitable over-irrigation of some parts of unleveled fields. In under-irrigated high spots yield is reduced due to salt accummulation, and the cost of reclaiming badly affected areas is increased since reclamation relies mainly on leaching to remove the salts. While no reliable estimate can be made, considerable land must now be lost to crop production because uneven fields require an excessively large watercourse system with many irrigation units. And when fields are subdivided there are more corners, making for inefficient planting and

tillage even when the work is done with animals.

Egypt has had relatively little experience with precision land leveling. And as seems so frequently the case with matters relating to farm mechanization in Egypt, there are no Egyptian research data on land leveling. Fortunately, both the practical experience and research in Pakistan and Turkey appear applicable to the local situation. In Pakistan for example, precision land leveling was found to yield a cost-benefit ratio of 2.4 to 3.2. It seems reasonable to expect similar returns can be had in Egypt, since even in Upper Egypt only 200 to 300 cubic meters of earth per feddan must be moved to level reasonably large irrigation areas. In the Delta, movement of perhaps only 50 m^3 would be required. Pakistan's experience indicates that precision land leveling can be achieved under these conditions at relatively low costs.

The Technique

Precision land leveling consists of grading and planing land to a smooth level field to facilitate efficient irrigation and water use. With proper farm water management practices, efficient application can be made with surface elevation variation of .05 foot from the design level. The leveling process is carried out by trained technicians, who measure with inexpensive instruments the elevations of different points in a field. Earth is then moved from the high to low elevations until a uniform level is achieved. The earth moving itself can be done with a standard 65 hp tractor, which pulls a locally fabricated soil scraper and land plane.

Building upon his experience with Pakistan's land leveling program, N. A. Dimick has designed a simple low-cost soil scraper. A test model of this scraper has been fabricated locally. In volume production it would cost around LE 1000. The land plane also can be made in existing Egyptian plants at a

relatively low cost. Tractor costs run around LE 2.00 per hour at current prices. Dimick's field trials with the kinds of equipment noted earlier indicates that under Upper Egypt soil and terrain conditions a one-feddan field can be precision leveled in about two days. Counting all costs, this would make precision leveling come to about around LE 35.00 per feddan. A field once leveled will stay that way except for an occasional touch-up which farmers can do themselves.

Benefits of Precision Leveling

In summary, the principal benefits of precision leveling of uneven lands are:

--Improved irrigation application efficiency.

--Uniform soil moisture for germination.

--Improved fertilization efficiency.

--Higher yields.

--Lowered probability of salt accumulation.

--Increase in cultivatable land.

--Reduced delivery losses.

The gains in production and water-use efficiency actually achieved in any given situation naturally depend upon the condition of the concerned land before it is leveled. In general, though, the magnitude of benefits from the respective sources can be expected to be on the order of those indicated below.

Improved irrigation application efficiency: Generally the farmer will apply irrigation water until the entire field, including any high spots, is covered. This practice results in very little water covering the high areas while excessive amounts cover the low areas. Actual intake differentials may be even greater since differences in hydraulic head result in faster infiltration in low

areas, and possible salt accumulation can reduce infiltration on higher areas. The additional time required to cover the high areas is of major concern to the irrigator. He attempts to improve the levelness of his field by moving soil from the high to the low areas and by working smaller areas so that variations in level within an irrigation unit are minimized. Through trial and error he tries to create a fairly level area. However, this method is unlikely to produce much precision on fields of one-half to one feddan or larger in size. Therefore, irrigated fields are subdivided not only by inheritance, but as an attempt to improve field levelness. This is illustrated diagramatically in Figure XI.1.

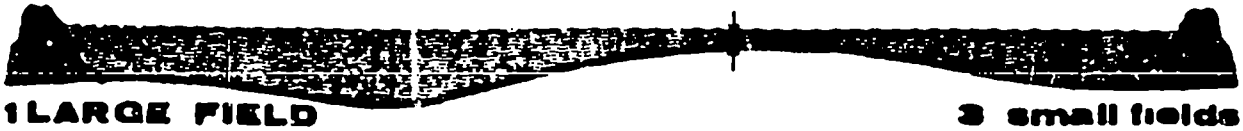
This Study Team was unable to find any research data on irrigation efficiency in Egypt. However, extensive field measurements in Pakistan's Mona Reclamation Experimental Project showed that the median irrigation application efficiency throughout most of the irrigation season lies between 20 and 30 percent. Only about one-fourth of the water applied during an irrigation is stored in the crop root zone; the remaining three-fourths penetrates to deeper levels, contributing to the rising water table. There is a strong supposition that from 10 to 60 percent of the fertilizer applied may be removed from the crop root zone by this water movement.

In many instances, early in the crop growing season or at planting time, there is need for only a light irrigation to replenish soil moisture. When fields are not level, the minimum depth of irrigation water applied to cover the surface is often four to five inches. Over-irrigation and low application efficiencies result.

Uniform soil moisture to promote better germination: Poor germination may result either from excessive moisture in low areas or loss of moisture in higher

EFFECTS OF UNLEVELED FIELDS ON IRRIGATION EFFICIENCY AND FIELD SIZE

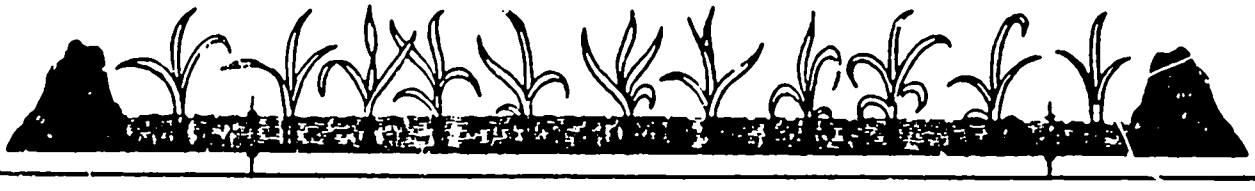
Unlevel Fields



1 LARGE FIELD		3 small fields
3 in	Application Required	3 in
3 in	Minimum Water Depth	3 in
14 in	Maximum Water Depth	9 in
7.5 in	Average Water Depth	5.5 in
39%	Application Efficiency	54%

Level Fields

EARLY SEASON IRRIGATION		LATE SEASON IRRIGATION
3 in	Application Required	3 in
67%	Application Efficiency	67%
3 in	Water Depth Applied	4.5 in



areas before the lower areas are dry enough to cultivate. No more than 5 or 6 cm difference in elevation may cause enough variation in field conditions so that soil preparation traffic and planting operations cannot be accomplished over an entire field at one time. The farmer must wait until the lower portions are dry enough for seedbed preparation. Uneven crop stands are a common result.

Evaluation of the effect of uneven soil moisture is difficult because of the lack of representative data on the incidence of poor stands. As a plausible example, if a poor stand reduces the yield by fifty percent on one-fifth of a given field, total yield is reduced by ten percent. The problem is undoubtedly more common in summer due to the high temperatures of Egypt.

Improved fertilization efficiency: Another benefit related directly to irrigation efficiency is the efficiency with which fertilizer is used. Over-irrigation such as occurs on unleveled fields most of the year leaches applied nutrients out of the root zone, resulting in lower plant recovery rates. It is estimated that from 10-60 percent of the applied nitrogen may be lost for this reason. Therefore, an important objective of improved farm water management is to prevent this loss. When two to four inches of excess water are applied each time a crop is irrigated, adequate nitrogen in the root zone cannot be maintained. Informed sources estimate that around 30 percent of the applied nitrogen is lost in this manner. Unfortunately, data are lacking to indicate how much of the over-irrigation is due to unlevel fields and how much to other factors. In any event, both are related to poor farm water management.

Higher yields: In some situations, reduced yields on both the high and low spots are found that logically cannot be ascribed to either poor germination or fertilizer leaching. The most important cause is the increased probability of moisture stress occurring in the underwatered high spots. This is the reason

behind reduced germination mentioned above, but it also affects per plant yields if moisture stress occurs during other important stages of growth.

At the same time some parts of an uneven field are not getting enough moisture, other parts of the same field may be getting too much. Low areas are prone to excessive ponding of irrigation water which can reduce yields in several ways: Lack of oxygen in the root zone, destruction of soil structure and an increased probability of lodging.

Reduced probability of salt accumulation: The combination of unlevel fields and farmer's typically irrigating until the high spots are covered frequently results in both over and under-irrigation occurring within the same fields. Under-irrigated high spots do not receive enough water to accommodate normal leaching of accumulated salts. In addition, shortly after irrigation the high spots are again exposed and evaporating, even while lower areas are still inundated. Consequently, even greater accumulations occur as salts are carried by capillarity from surrounding areas to the surface of the high spot.

To value crop losses due to these problems and hence the benefits possible from correcting them by leveling, data are needed that associated yield reductions with accumulated salinity and, in turn, with differences in elevation, soil type, water quality and water table depth. Unfortunately, these relationships have not yet been quantified in Egypt.

Application of uniform amounts of water of all parts of a farmed area becomes impossible if fields are not level, and reclamation based on leaching to remove salts becomes expensive. If a target for leaching is set, then reclamation must, under present conditions, apply sufficient water to cover high spots as well. Consequently, variations in level and infiltration rate may

result in applying two to four times as much water as necessary to low areas. Most of the excess is wasted.

Increased cultivatable land: Farmers subdivide unlevel fields to make smaller irrigation units where differences in level are minimized. As a result, few of these units are a feddan or larger in size; half and quarter feddan (or less) predominate. This irrigation unit size necessitates an extensive farm watercourse system.

While redesigning all channels in a water-course would be impractical, substantial benefits would accrue where this could be done. These benefits would include putting additional land into cultivation as fields are made larger making it possible to utilize animals for tillage by eliminating many field corners in each field.

Reduced delivery losses: A reduction in the total length of channels to serve a given area would also reduce the losses from seepage and spills. In fact, other than channel lining, this is the only method that could have a significant impact on decreasing seepage loss.

Costs and Returns: Land Leveling

Limited experience in Upper Egypt indicates that 200 to 300 m^3 of earth per feddan must be moved in order to level fields to improve water distribution. Fields in the delta are estimated to require the movement of perhaps only 50 m^3 of soil. The amount of soil that must be moved is therefore generally not excessive and consequently low in cost.

There are yet in Egypt no research data or field experience on which to base prospective cost/benefit estimates. Fortunately, relevant conditions in Pakistan are sufficiently similar to those in Upper Egypt to permit using data

from trials in that country as a guide to the results which could be expected from precision land leveling in Upper Egypt.

The technique developed and proved in Pakistan utilizes a standard farm tractor and engineering technology for effectively leveling irrigated lands. The farm tractor pulls a soil scraper and land plane. The soil scraper is locally fabricated in widths from 5 to 8 feet, capable of efficiently moving from 1 to 2 m^3 of soil per trip depending on tractor horsepower and soils. Pakistan's ongoing Precision Land Leveling Project was designed to teach technicians to engineer systems properly and to advise farmers on improved irrigation practices.

Soil Conservation Service personnel developed the cost structure of hypothetical contractor operations. It was estimated that a contractor can move soil for Rs. 3.00 ($0.30) per m^3, or approximately Rs. 600 ($60) per acre. This is a one-time cost as a field, once leveled, will remain in that condition provided proper cultural practices are used and periodic touch-up maintenance is done. These cost figures are well in line with U.S. figures of $100 per acre to level land for furrow irrigation. In turn, this indicates a probable cost of LE 35 per feddan in Egypt.

Illustrative costs and returns from land leveling under different combinations of basic conditions are shown in Tables 1 and 2. If five percent of initial costs were spent on annual maintenance at 1974-75 prices, this would pay for one or two days annually for a pair of bullocks pulling a scraper blade to maintain each acre. Total annual costs therefore, would be as shown in Table 1. The benefits for five typical watercourse cases and estimates of the benefit/cost ratios, assuming a 25-year life and 15 percent interest rate,are developed in Table 2. The benefit/cost ratios shown are based on the actual loss and delivery situations prevailing in unimproved watercourses.

TABLE XI.1

ANNUALIZED COSTS AND MAINTENANCE FOR PRECISION LAND LEVELING IN PAKISTAN (Rs./ACRE)*

Costs	15 years			25 years		
	10%	15%	20%	10%	15%	20%
Annualized Costs	79	103	128	66	93	121
Maintenance	30	30	30	30	30	30
Total Annual Cost	109	133	158	96	123	151

TABLE XI.2

BENEFIT/COST RATIOS FOR PRECISION LAND LEVELING WITHOUT WATERCOURSE IMPROVEMENTS (RUPEES PER ACRE PER YEAR)

Benefits	Watercourse Type				
	Case I	Case II	Case III	Case IV	Case V
Higher water value	133	125	164	210	180
Better germination	30	30	30	30	30
Fertilizer savings	73	73	73	73	73
Increased land area	43	43	43	43	43
Decreased delivery losses	15	18	23	41	31
Total	294	289	333	397	357
Costs**	123	123	123	123	123
Benefit: Cost	2.39	2.35	2.71	3.23	2.90

* Exchange rate is U.S. $1.00 = Rs 10.00 Pakistan
** Assumes 25-year life and 15% interest rate.

Source: "Water Management Technical Report No. 43, Pakistan Field Report No. 5", Echart, Dimick and Clymas, 1975.

Alternative Program Strategies

There are alternative strategies for managing the entire land improvement effort. One is simply to have SAO carry out the entire program; another to have that organization take the role of market developer for a few years with the expectation that as farmer demand for services builds up, private suppliers would enter the market. In that event, SAO would progressively phase down its program. Each approach has its strong and weak points. Those of particular relevance are highlighted in the succeeding critiques.

Depend on Private Initiative

For the near term, to depend solely upon private initiative probably would be to doom farmers in Upper Egypt and elsewhere to continuing their present ways of coping with uneven fields. With enough extension-type demonstrations and an active publicity campaign, this new technology might catch on in time. The history of technological innovation, however, suggests that such time would be years in coming.

Retain as Public Service

Notwithstanding its lack of experience in precision land leveling as such, SAO has the technical, managerial and organizational capacity for moving promptly and aggressively into a major land leveling effort. It would have to re-orient some of its technical staff, recruit and train some additional field technicians and give land leveling a far higher priority than presently accorded that activity. The priority aspect could be settled easily by ministerial action. However, that would not remove SAO's overriding constraint of insufficient equipment to do justice to both subsoiling and land leveling. Having been procured for subsoiling and surface drainage operations, relatively little of SAO's present equipment is the

type needed for land leveling.

With the necessary equipment and encouragement to restructure its program priorities, there is no reason to doubt SAO's ability to provide effective leadership on land leveling as it has done on subsoiling. The same cannot be said, however, with respect to that organization's assuming complete responsibility for all field operations. Cast in that role, the sheer magnitude and organizational complexity of the task almost certainly would overwhelm SAO early on, to the lasting detriment of both its subsoiling and land leveling activities.

A Mixed Strategy

For the longer run the entrance of private entrepreneurs' into custom land leveling seems as inevitable as it is desirable. The fields to be leveled are small. The equipment required is relatively small in size and has a cost well within the reach of many such operators. With one million feddans needing treatment in upper Egypt alone, and each feddan requiring two days of leveling work, SAO single handedly would be a long time getting the job done--as would any other public entity. Both Pakistan and Turkey among others have had quite successful experience with private land leveling services after the government first got the ball rolling. The same could be expected of Egypt, where shared use of capital items is traditional and purchase of other types of custom services is established. Egypt has the added advantage of pioneering efforts by cooperatives that laid the foundation for a system which brought tractor services within reach of even the smallest farmer.

For government to pursue successfully a two-phase strategy would require a great deal more than simply deciding to do it. For instance, SAO would need to direct their field operations specifically toward demonstrating to farmers and potential custom operators the benefits each could gain from rapidly expanding

land leveling services. As the market became established in particular localities SAO would need to be prepared to move on to new areas. Such a ground-breaking role is quite different from the all-inclusive operational one which SAO now plays with respect to subsoiling. In addition to SAO market development of service activities, government would need to actively encourage private custom operators to enter the field. Working out the soil testing and gypsum hauling arrangements noted in connection with the completely private-enterprise approach is a case in point. In the Study Team's judgement, it would be premature at this juncture to consider financial assistance to individual custom operators. This should prove unnecessary when the benefits of precision land leveling have been effectively demonstrated. If offered at the outset to stimulate contractor participation, such financial assistance might well set private custom services development on a path which all concerned would rue later on.

General Considerations

Whichever strategy is chosen, there are certain government support functions that appropriately could be channeled through SAO. High on this list are means for publicizing the opportunities offered by precision land leveling. With either of the strategies involving private participation, such educational efforts obviously would be directed toward potential custom operators as well as groups of farmers whose lands could be benefited by leveling. In addition to selective service operations to introduce land leveling in new areas, this activity could take any combination of the usual forms of extension work, including the organization of demonstrations around actual SAO field operations. An early effort by SAO to phase the Agricultural Extension Department program to keep it in line with the progress of SAO's field operations would go far toward meeting this priority need. Engaging the proposed Research and Development Center in laying a problem-

oriented research base would strengthen land leveling activities and at the same time heighten involvement of universities in Upper Egypt in local farm problems. Close coordination between SAO operational or/and demonstration/support activities and the AID-assisted Egyptian Water Use Project similarly would benefit both.

If payments for subsoiling services are to continue to be spread over an extended period, it would seem unreasonable to expect farmers to make immediate payment for land leveling services. Actually, the need for spreading the payments is greater in the case of land leveling than it is for subsoiling. The cost per feddan is higher, and near-term returns are lower. How the financing arrangements can best be managed depends heavily upon the operational strategy selected. With the function completely in the government sector, there would be no obvious reason why the sytem applied to subsoiling would not work as well for land leveling. Under either of the approaches involving private contractor participation, it would appear necessary for (a) SAO to carry the financing load on behalf of government (b) government to make direct subsidy payments to participating farmers or (c) special credit arrangements to be made through the Agricultural Credit Bank. Of the three, the first appears least undesirable. Subsidies cannot be recaptured. As the costs of leveling will be more than offset by increased yield, a subsidy would benefit participating farmers twice. Special bank credit arrangements create difficulties whether they involve subsidized interest rates or not. If credits for leveling costs were channeled through SAO, government would have a means of exercising some control over the quality of services rendered by private operators and, more importantly, could phase out governmental participation selectively, as circumstances warranted. The risk in this approach is that SAO participation as a financing agent might cause neglect of its other land improvement responsibilities and, worse yet, bureaucratize the essentially private process to the point of immobility.

Recommendations

AID-assistance strategy vis-a-vis subsoiling and land leveling can at this time most usefully be confined to (a) financing the expansion of the SAO's equipment fleet to permit a substantial expansion in services on both fronts and (b) encouraging MOA/SAO to reassess SAO program priorities in the context of comparative contributions of different land improvement activities to furthering Egypt's food security goal. No AID participation in SAO's gypsum treatment activities is proposed, since the gypsum is produced in Egypt and SAO could shift to private hauling services when their existing equipment is worn out.

Specifically the Study Team recommends:

1. AID finance the following equipment items to expand SAO performance capacity:

	Subsoiling*	
150	130 hp tractors	$ 2,084,000
90	70 hp digger-loaders	1,300,000
50	5-ton trailers	50,000
10	100 hp track-type tractors with dozer blade	139,000
200	subsoilers	111,000
50	14 ft. land planes	97,000
		$ 3,781,000
	Land Leveling	
150	65 hp tractors	750,000
150	1 M^3 scrapers	150,000
		$ 900,000

2. USAID encourage the Minister of Agriculture and SAO leadership to reassess current SAO priorities to reduce emphasis on surface drainage in favor of increasing substantially the attention given land leveling in Upper Egypt.

3. USAID also encourage MOA to forge a closer link between the programs of the Extension Department and SAO,with programmatic emphasis on land leveling in Upper Egypt,and to stimulate research on land and water use in that region--especially by the agricultural universities serving it.

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* In due course it is reasonable to expect that private custom operators will enter the subsoiling field. Considering the equipment investment and technical expertise required by the subsoiling process, however, the Study Team does not see private custom operations becoming available in significant volume during the next five years. While steps advantageously could be taken during that period to encourage qualified custom operators to enter this field,the Study Team concluded that overall advantage lies strongly on the side of equipping SAO now to carry out an impact program large enough to capture the production-increasing potential of subsoiling as rapidly as possible. In five years much of SAO's present equipment will be worn out. Consideration can be given at that time to the advisability of replacing that equipment in light of the then prospective volume of private custom services.

CHAPTER XII

REPLACING SAKIAS WITH MECHANICAL PUMPS

Setting

Some 400,000 sakias, the Egyptian water wheels, are currently used to lift water from canals to the level of surrounding fields. These are drawn by animals, either cows or buffaloes. In addition, farmers utilize man-powered tambours to lift irrigation water. Together, an estimated 70 percent of all farms use either sakias or tambours. A relatively small proportion have access to power pumps, either electric or diesel.

The Farm Management Survey indicated the following:

1. With respect to method of irrigation, only 20 percent of farms were irrigated by pumpsets. Sakias, tambours and gravity systems predominated (Table XII. 1).
2. By far the largest proportion of farms had shared (usually sakia) ownership of the irrigation equipment (Table XII. 2).
3. In the relatively small number of cases in which pumpset use was reported, these were most frequently on farms of one to three feddans and were usually rented (Table XII. 3).
4. Where irrigation was for farms that had no cows or buffaloes, the irrigation method was most frequently with sakias, either with rented or share-owned cattle (Table XII. 4).
5. Sakias were most frequently pulled by self-owned cattle (Table XII. 5).

TABLE XII. 1

METHOD OF IRRIGATION, BY CROP BELTS

Farm Management Survey, 1978

Method	Crop Belt[1]							
	1	2	3	4	5	6	7	Total
Sakia	58	64	30	42	1	--	12	207
Pumpset	11	4	7	7	--	14	36	79
Tambour	--	--	1	4	--	24	--	29
Gravity[2]	--	--	--	17	41	18	8	84
Total reporting	69	68	38	70	42	56	56	399

[1] Belts run generally north to south. Belts 1-3 are delta areas. Belts 4-7 are middle and upper Egypt areas. Raw sample data overweight belts 5-7 in relation to national total number of farms and feddans of cultivated area.

[2] Farms reporting all irrigation details except type of equipment. Belt 5 cases seem definitely to be gravity-irrigated. Some of those in other Belts may merely reflect incomplete responses.

TABLE XII. 2

METHOD OF ACCESS TO IRRIGATION EQUIPMENT, BY TYPE

Farm Management Survey, 1978

Method of Access	Sakia	Pumpset	Tambour	All Types
		Number of Farms		
Owned	17	20	4	41
Rented	20	55	1	76
Shared Ownership	161	2	24	187
Total	198	77	29	304

TABLE XII. 3

ACCESS TO PUMPSETS, BY SIZE OF FARM

Farm Management Survey, 1978

Size of Farm	Method of Access: Owned	Rented	Shared Ownership	All Methods
Feddans:	Number of Farms			
Less than 1	2	7		9
1 - 3	7	30		37
3 - 5	1	11	1	13
5 - 10	5		1	11
10 - 15	2	1		3
15 - 20	1			1
20 and over	2			2
Total	20	54	2	76

TABLE XII. 4

MEANS OF IRRIGATION ON FARMS WITH NEITHER COWS NOR BUFFALOES

Irrigation method	Number
Sakia with rented cattle	19
Sakia with share-owned cattle	10
Pumpset	1
Tambour	4
Gravity	6
Total	40

TABLE XII. 5

ACCESS TO ANIMALS USED FOR PULLING SAKIAS

Farm Management Survey, 1978

	Number Reporting
Owned	144
Rented	26
Share-owned	24

TABLE XII. 6

DAILY COST OF RENTED ANIMALS[1]

Piasters per day	Number Reporting
40	6
50	56
60	17
70	18
80	11
90	--
100	64
Over 100	9
Total	101
Average daily cost	74.8 pt

[1] Respondents not renting animals were asked to give their best estimate of going rate in their village.

6. Where animals were rented, the most frequently cited cost was 100 piasters a day; 50 piasters was next most-frequently reported (Table XII. 6).

All told, sakias use about 80 percent of all the draft work done with animals. Female cows and buffaloes do virtually all of the sakia pulling, some two-thirds of which comes during the heaviest lactation period, with accompanying serious reductions in their milk production. In addition, extensive use for draft work significantly lengthens a cow's calving period, hence reducing the annual calf crop.

Consequently, if sakia work could be mechanized, there would be a "saving" of the milk and meat now lost. Replacement of sakias with pumps is one of the most significant opportunities available for mechanization to increase Egyptian agricultural production. It is important to note that small farms have a higher proportion of Egypt's cows and buffaloes than do larger ones. Consequently, if it were no longer necessary to work animals to pull sakias, a direct increase in farm income would result. In the longer run, removing cows and buffaloes from their age-old role as work animals would open the way to improving their performance as meat and milk producers. Even without herd improvement, the direct economic benefits from relieving cows of sakia work could easily exceed an estimated LE 30 million per year.

Later sections of this chapter develop a detailed analysis of the costs of lifting irrigation water by animal-drawn sakia compared with diesel and electric motor-driven pumpsets. These data indicate that mechanizing water lifting can cut irrigation costs in half where the area served is large enough to use a pumpset efficiently. Notwithstanding this evident economic advantage, however, the changeover from sakias to motor-driven pumpsets is proceeding slowly. The reason

for this appears to lie in a combination of custom, lack of farmer understanding of comparative costs and organizational difficulties in developing an irrigation area big enough to utilize efficiently the smallest practicable motor-driven unit. In addition, difficulties in financing the purchase of a motor-driven pumpset discourage most farmers from taking action on their own. This is particularly true of small farmers who are by far the most numerous participants in existing "sakia rings". Relatively few small farmers can qualify for medium-term loans under present bank requirements.

In light of the above, it is little wonder that an integral part of the Government's farm mechanization policy is replacement of animal-drawn sakias with mechanical pumps powered by diesel or, where feasible, electric motors. Incentive for that policy originally stemmed mainly from the expectation that farmers would reduce the number of their cattle which, it was thought, would then free land now used to grow fodder for the production of other crops.

However, the economics of cattle-keeping are such that Egyptian farmers are not likely to dispose of animals freed from draft work. Rather, they will likely keep them for milk and meat production. This being the case, the question is whether or not changing from sakias to motor-driven pumpsets is economically advantageous to farmers and the nation. The answer to this question can be found in the value of milk and meat lost from working cows and buffaloes as compared with the cost of lifting irrigation water by mechanical means.

Whether to expedite replacement of sakias with motor-driven pumpsets revolves mainly around several basic facts and a number of interdependent factors. On the factual side: (1) MOA has no operating program to give effect to government policy for sakia replacement; (2) Only 20 percent of the farmers interviewed in the 1978 Farm Management Survey reported using motor-driven pumps and the bulk of these

were in the sugar cane growing area (Table XII. 1); and (3) Agricultural Credit Bank loans for intermediate-term production inputs by pumpsets have terms that most farmers, particularly those with small acreage, cannot afford. The questions to be examined in the remainder of this chapter are:

-- Is one-for-one replacement of sakias by a motor-driven pumpset economically attractive to farmers? If not, are economies of scale, such as to make adoption of this improved technology profitable when two or more existing "sakia rings" are combined into an irrigation area large enough to utilize a powered pumpset efficiently?

-- Would the existing sakia rings organize themselves formally or informally into larger "water user associations" to gain the benefits of mechanized water lifting? If so, what advisory assistance and/or encouragement is required?

-- What organizational obstacles to enlarging irrigation units would need to be overcome? What supportive assistance would be helpful in this process?

-- Would financial incentives by government in the early-year encourage water-user groups to buy pumpsets collectively or on a use-charge basis and in sufficient quality to have a meaningful impact upon Egyptian agricultural productivity? If so, could this demonstrate the advantages of mechanical water lifting enough to stimulate progressive replacement of sakias without the aid of incentive loans?

This analysis first examines each of the above separately. Subsequently, the several components are brought together in an overall appraisal of the feasibility of the Study Team's recommended approach.

In addition, the present analysis considers four types of mechanical pumpsets: 6 hp diesel engine with 615 gpm 6" pump; 7.5 hp diesel engine with 1113 gpm 8" pump; 3 hp electric motor with 615 gpm 6" pump; and 7.5 hp electric motor with

1113 gpm 8" pump. A report on the "Technical and Economic Feasibility of Electrifying Tertiary Pumping Means in Middle and Upper Egypt" indicates that this range of equipment provides an adequate basis for comparing lowlift pumpsets with sakias as alternative means of lifting irrigation water.* In the suceeding discussion, these alternatives are appraised in relation to irrigation areas of 15, 30 and 60 feddans.

Comparative Costs

Comparative costs of lifting irrigation water by alternative means have particular significance: profitability to farmers, economy of scale and impact on cash flow. For the immediate purpose of this section, only the direct costs of irrigating a given number of feddans are considered. Such unit costs are by no means the only, or even the most important, factors to be considered in judging the comparative advantages of alternative means of lifting water. Estimated costs of irrigating an average feddan of cropped land with respect to the factors indicated above are summarized in Tables XII. 7-9. The basis for the respective estimates are summarized below.

Costs by Alternative Methods

A sakia typically is owned jointly by five to ten farmers whose holdings make up an irrigation unit of about 15 feddans, the maximum area that realistically can be irrigated with one sakia. Survey results indicate that each farmer-member of "sakia rings" usually provides his own cow or buffalo to do the draft work required to turn the sakia. In effect, sakia rings are informal "water

* Louis Berger International. Inc. May 1978.

TABLE XII. 7

ANNUAL COST OF IRRIGATION WITH ANIMAL POWERED SAKIA[1]

Item	15 feddans in LE per year
Machine Costs	
Depreciation[2]	21.90
Interest on investment[3]	23.00
Insurance[4]	2.30
Repair and maintenance	10.00
Labor Costs[5]	57.60
Animal Costs[6]	
Milk loss	151.20
Meat loss	43.50
Total Costs	309.50
Cost per feddan	20.60

[1] 15 feddans is the maximum capacity of a sakia. Costs reflect weighted average number of irrigations for all crops.

[2] Based on LE 460 purchase price, 20-year economic life, LE 23 salvage value.

[3] Reflects standard cost estimating practice in Egypt; one half purchase price x 10%.

[4] 0.5% of purchase price.

[5] Assumes all family labor. Total requirements for sakia tending and water control x 45% of total that occurs during peak seasons x 1977 average wage rate of pt 76. of man-day and pt 35.5 per boy-day.

[6] Losses by 3 cows due to sakia-pulling work valued at 1977 average prices per unit.

TABLE XII. 8

ANNUAL COSTS OF IRRIGATION WITH DIESEL POWERED LOW-LIFT PUMPSETS OF SPECIFIED CAPACITY WHEN APPLIED TO VARYING SERVICE AREAS [1]

In LE Per Year

Item	6hp Diesel Engine 615 gpm 6" pump		7.5 hp Diesel Engine 1113 gpm 8" pump	
	15 feddans	30 feddans	30 feddans	60 feddans
Machine Costs				
Depreciation[2]	46.80	57.20	64.80	79.20
Interest on Investment[3]	44.30	44.30	56.50	56.50
Insurance	4.30	4.30	5.70	5.70
Fuel	53.30	106.60	100.80	201.60
Oil	17.70	35.40	33.60	67.20
Grease	6.50	7.90	13.50	16.50
Repairs & Maintenance[4]	45.90	56.10	68.60	83.80
Labor Costs				
Pump Operation[5]	2.40	7.20	2.40	4.80
Water Control[6]	16.50	33.00	15.00	30.00
Total Costs	237.70	352.00	360.90[7]	545.30[7]
Cost per feddan	15.85	11.75	12.05	9.10

[1] Machine costs derived from "Technical and Economic Feasibility of Electrifying Tertiary Pumping Means in Middle and Upper Egypt" by Louis Berger International, Inc., May 1978.

[2] Based on LE 887 purchase price for 6 hp unit and LE 1180 for 7.5 hp unit with 10% salvage value. Average economic life of equipment: engines 10 years, pumps 20 years.

[3] See footnote 3, Table XII. 7.

[4] Engines 10% of purchase price, pumps 5% adjusted for hours of use.

[5] Assumes fixed-site unit except 6 hp pumpset serving 2 irrigation areas of 15 feddans each. Labor charge includes total irrigation time plus moving set between locations valued at 1977 average man-day wage rate.

[6] Assumes all family labor. See footnote 5, Table XII. 7.

[7] Excludes cost of any necessary rearrangement of existing delivery systems.

TABLE XII. 9

ANNUAL COSTS OF IRRIGATION WITH ELECTRIC POWERED LOW-LIFT PUMPSETS OF SPECIFIED CAPACITIES APPLIED TO VARYING SERVICE AREAS

In LE Per Year

Item	3 hp motor 615 gpm 6" pump	7.5 hp motor 1113 gpm 8" pump	
	15 feddans	30 feddans	60 feddans
Machine Costs[1]			
Depreciation[2]	22.40	27.50	33.70
Interest on Investment	28.30	39.30	39.30
Insurance	2.80	3.90	3.90
Repairs & Maintenance	28.30	35.40	43.20
Electric Power[1]	136.20	258.30	516.60
Labor Costs[3]			
Machine Operation	2.40	2.40	4.80
Water Control	16.50	15.00	30.00
Total Costs[4]	236.90	381.80	661.50
Cost per feddan	15.80	12.75	11.00

[1] See footnote 1, Table XII. 8. Electric powered units can only be used at fixed-sites. Data assume availability of transmission lines for hook-up at sites.

[2] Based on LE 566.70 purchase price for 3 hp unit and LE 785.80 for 7.5 hp with 10% salvage value. Average economic life of equipment: motors 30 years, pump 25 years.

[3] See footnotes 5 and 6, Table XII. 8.

[4] Excludes cost of any necessary rearrangement of existing delivery systems.

user associations" operating within sharing principles long set by custom and tradition.

A sakia is a primitive machine with a relatively low purchase price. For this equipment, "machinery costs" make up a comparatively small part of the total cost of lifting irrigation water. Labor saving, likewise, is a much less significant factor in comparative costs than is true of most other types of farm mechanization. What looms large in the cost of irrigating by sakia is the value of milk and meat lost as a result of using female cows and buffaloes for the draft work.

Typically, a sakia is turned by three cows or buffaloes working one at a time in two 3-hour shifts. Thus, one day of irrigation by sakia results in milk and meat loss by three animals. Detailed explanations of the milk and meat loss calculation and other aspects of the cost of animal labor are given elsewhere in this report. Without repeating those calculations here, let it be said that a working baladi cow produces only 65 percent as much milk and 75 percent as large a calf crop as does one not used for draft work. In the case of the female buffalo, the percentages are about the same, but the value of milk lost is much higher since a buffalo produces more and of a richer quality, hence higher priced, milk than does a cow. Survey results indicate that whereas buffaloes are little used for field work they provide about half the draft power used for turning sakias. Overall, about 60% of a cow's work time and virtually all of a buffalo's goes to the sakia.

At 1977 farm gate prices, the combined cow/buffalo milk and meat loss comes to LE 64.90 per animal per year. As each sakia requires the work time of three animals, this means an average, in terms of milk and meat loss alone, of LE 194.70 per sakia per year.

As indicated by Table XII. 7, fixed and variable costs of the sakia per se are derived in the standard manner. The value of man and boy labor required is imputed on an opportunity cost basis on the assumption that family labor has an opportunity value meaningful to the average Egyptian farmer only in periods of peak labor requirements.. Irrigation labor, predominately by the family, used during such periods is valued in Table XII. 1 at the 1977 annual average wage rate per man-day and per boy-day respectively. The number of man- and boy-days required per feddan is the weighted average of requirements for the respective crops since different crops are irrigated a varying number of times during their growing season, e.g., wheat 6, permanent berseem 14, cotton 12, etc. These labor requirement data were based on the non-mechanized component of the composite labor and power requirements at Egypt's present stage of mechanization. Referring to the time distribution of irrigation labor requirements for the respective crops, the Study Team estimated that 45 percent of all irrigation labor requirements came during peak periods (See Chapter V). Thus, 45 percent of the days of mainly family labor required per 15 feddan irrigation unit is included as a labor charge in estimating the total cost per feddan of lifting irrigation water by sakia.

Economies of Scale

Per feddan costs of irrigating land with different types of equipment depend heavily upon how fully the equipment is utilized (Table XXII. 10). Fixed costs of machinery use are nearly as high for watering a few feddans as they are for larger acreages up to the physical capacity of the particular equipment involved. And, as noted previously, the faster the water is pumped, the less time the man spreading it on his field has to wait for a particular parcel

TABLE XII. 10

COST PER FEDDAN FOR IRRIGATION BY ALTERNATIVE TYPES OF EQUIPMENT

In LE per Feddan

Type of Equipment	Irrigated Area 15 Feddans	30 Feddans	60 Feddans
Sakia	20.60	20.60	20.60
Diesel-powered pumpset			
6 hp engine/615 gpm pump	15.85	11.75	9.30
7.5 hp engine/1113 gpm pump	17.05	12.05	9.10
Electric-powered pumpset			
3 hp engine/615 gpm pump	15.80	15.80	15.80
7.5 hp motor/1113 gpm pump	15.45	12.75	11.00

to be covered. Water loss in transmission also is a function of the rate of flow, particularly on sandy soil. While this loss is recognized by Egyptian farmers and others concerned with irrigation systems, the Study Team could find no data definitive enough to warrant factoring this item into comprehensive costs estimates.

The particular equipment types and sizes of irrigation unit combinations illustrated in Tables XII. 7-9 by no means exhaust the range of possibilities. They will suffice, however, for considering economies of scale and for subsequent analysis of trade-offs between equipment costs and those of overcoming organizational constraints. Fifteen feddans represents the maximum capacity for both the animal-drawn sakia and the 3 hp electric motor. Consequently, to irrigate, say, 30 feddans, would require two sakias or two 3 hp electric powered pumpsets at the same cost per feddan as one unit irrigating 15 feddans.

The 6 hp diesel engine/615 gpm 6" pump unit could irrigate up to about 200 feddans per irrigation cycle at some further reduction in cost per feddan compared to those shown for 15 and 30 feddan irrigation areas. Similarly, the 7.5 hp diesel/1113 gpm pumpset obviously could be used with either a 15 or 30 feddan irrigation area as well as with the 60 feddan area for which cost data are shown in Table XII. 8. It is equally self-evident, however, that costs per feddan on such smaller areas would be much higher than those indicated for the 60 feddan area, as any acreage smaller than 60 feddans would not utilize the capacity of 7.5 pumpset efficiently. These same relationships hold for electric powered pumpsets of comparable size. It will be noted from the respective tables that irrigation costs per feddan range from a low of LE 9.10 to LE 20.60 for the particular combinations shown. From these data, it would appear that a 7.5 hp unit would be preferable to the smaller engine. As will be seen from subsequent discussion, however, portability is a limiting factor with that size machine.

Impact on Cash Flow

Replacing sakias with low-lift pumps directly increases the cash income of benefited farmers by making available for sale the milk and meat otherwise lost by working cows and buffaloes at the sakia. As indicated by a comparison of Tables XII. 7 and 8, this saving is, on the average, considerably more than enough to pay a reasonable custom rate for irrigating the same acreage by mechanical means where the irrigation area is large enough to utilize a diesel-powered pumpset efficiently. Particularly benefited by low-lift pump technology would be the farm families tilling comparatively small acreages. Sales of milk, milk products and calves make up an important part of the cash income from such small farms, a much higher percentage than on larger size units. This is because the ratio of cattle to crop land is significantly higher on farms of 1-2

feddans than on those with 10 or 15 feddans of cultivated area.

Whether cash income benefits would actually increase in direct proportion to the number of cattle is hard to say. Having fewer feddans to be irrigated, it would appear that small farmers would need to use their animals fewer days per year for sakia work. No research data were found on this subject, however. Informed opinion indicates that members of a sakia ring contribute to the animal power requirements for irrigating the group's combined acreage on a per member basis. If indeed this is the prevailing practice, the operators of very small units stand to gain about as much in cash income per family as do those with larger acreages, hence considerably more as a percentage of total cash income. Also, a sakia ring generally comprises farms of different sizes. With draft requirements shared on a per member basis, small farm operators would be subsidizing the cost of water lifting for larger operators to a greater or lesser extent. Custom charges for mechanical water lifting almost certainly would be on a per feddan basis. Consequently, to whatever extent the smallest farmers in existing sakia rings are now bearing more than their share of irrigation costs, shifting to low-lift pump irrigation would remove these inequities.

Technical Considerations

Capacity differences among types of equipment and their effects on water lifting costs were covered by the preceding section. Other primary technical considerations concern (a) mobility and (b) technical feasibility.

Electric motors are essentially not mobile since they can be used only at fixed sites where there is electrical power. As few rural areas have transmission lines, electric motors are not at present a technically feasible means

of lifting irrigation water for the vast majority of Egyptian farmers.

The 6 hp and 7.5 hp diesel powered pumpsets can be used either at fixed sites or as portable units. The larger engines are heavy and considerably harder to move. Indications are that most diesel pumpsets now used outside the sugar cane growing area are 6 hp units. A number of these reportedly are portable units operated on a custom hire or charge per feddan per year basis. Study Team members observed some pumpsets being moved by donkey along canal banks from one site to another.

Sakias are not portable. However, this imposes no additional constraint upon their technical feasibility as they are limited by capacity to watering about 15 feddans and existing irrigation areas are designed around that capacity. In passing, it is worth noting that, in some areas, the limited water flow generated by a sakia essentially precludes effective irrigation by that method of fields distant from the canal source. For example, many farmers in the Cairo area interviewed for the "Attitudes Toward Mechanization" survey complained that they could not get enough water to grow a decent crop because their fields were too far from the canals.

An on-site 615 gpm pump powered by a 6 hp diesel engine can irrigate 15 feddans in about 2 hours. Even where there are non-contiguous service areas, moving the equipment from one site to another should not require more than 1-2 hours. If 2 hours transit time is assumed, a single 6 hp pumpset could irrigate 30 feddans per day or 420 feddans in the same number of days now required to irrigate 15 feddans by sakia. However, as a fixed-site machine, the technically feasible area for a 6 hp unit probably is not more than 60 feddans. While no research data were found on the subject, it appears likely that even if all other problems related to enlarging irrigation areas could be over-

come, transmission losses and difficulties with system design would make irrigation of more than 60 feddans by a fixed-site 6 hp pumpset generally impractical. With its much faster discharge (1113 gpm vs. 615 gpm), the feasible area covered by a 7.5 hp diesel engine/8" pump unit would be less restrictive. Even there, however, it might not be much over 100 feddans since a low-lift pump can only irrigate land on one side of a canal. This inevitably makes for relatively long delivery channels per feddan compared to, say, tube well irrigation in India or Pakistan.

Concern has been expressed in some quarters that mechanical pumps will worsen alleged over-irrigation from the abundant canal water generated by the High Dam. No research data could be found comparing present pump and historical sakia practices in this regard. Cogent arguments are heard on both sides of this issue. In the Study Team's judgement, the more persuasive of these favors pump irrigation. Its logic is that the faster flow of water from a pump reduces seepage from delivery channels and hence contributes less to water logging than does slow irrigation by sakia.

An additional consideration is that sakias are owned and operated by a group of farmers whereas mechanical pumps are usually owned by one member of an irrigation group and "rented" to other members to meet their needs. For the first time, many farmers are clearly paying a charge for water pumping. As this fee-for-service system appears likely to be continued as mechanical pumps become more numerous, especially where portable units are employed, costs should tend to discourage farmers from drawing more water than their crops actually need. An extension effort should also be envisaged as a vital part of a sakia-replacement campaign to educate farmers as to negative effects on current crop yields as well as on longer term soil deterioration from too much water

Organizational Aspects

The earlier analysis of comparative costs showed irrigation of a 15 feddan area by low-lift pump to be only a few pounds per feddan less costly than by sakia. So small a potential gain is not likely to encourage many water users groups to replace their sakias with low-lift pumps. The small margin results from the fact that 15 feddans do not use even the smallest diesel-powered pumpset to anything like full capacity. When capacity is more fully exploited, the cost advantage of low-lift pumps over sakias increases rapidly. Enlargement of irrigation areas, however, poses organizational problems. The question thus becomes the feasibility of surmounting organizational obstacles involved so Egyptian farmers and the nation could benefit from adoption of the improved technology.

From its analysis of alternatives to sakia irrigation, the Study Team concluded that the probable organizational obstacles to enlarging irrigation units stemmed from the following main sources:

1. Tradition: Sakia rings typically involve only 5 to 10 farmers who have shared water lifting facilities and duties for years. Combining two or three such water user groups into a larger unit to utilize a low-lift pump efficiently involves forming new interpersonal relations, arrangements for establishing irrigation schedules, and various other operating details. Difficult and time-consuming initial organizational problems exist. Experience in other countries indicates that these are particularly hard to overcome when major changes have to be made in a water delivery system.

These considerations suggest that the sakia replacement strategy most likely to succeed is one that would least alter traditional practices. Taking all of this into account seems to suggest that a strategy built around pumpsets that are portable is likely to fare much better than one aimed primarily at adoption of fixed-site units.

While portable pumpsets theoretically could be jointly owned and used by several sakia rings, organizing such an arrangement would likely prove quite difficult. Where farmers in contiguous irrigation areas prefer to join together in the purchase and use of a low-lift pumpset so much the better. That would facilitate subsequent redesign of the delivery system for irrigation by relatively more efficient fixed-site equipment. More generally, however, advantage appears to lie strongly on the side of persuading farmers to shift from ancient traditions of joint ownership to more recent joint usage through custom hire, now a standard practice with tractors and other mechanized farm equipment.

How much of a factor tradition would prove to be in the face of a concerted action program is hard to say. Until fairly recently, traditional farmers everywhere were presumed to be quite resistant to technological change. In his landmark work, Schultz argued persuasively that what was thought to be resistance to change was in fact the unavailability of new technology that was profitable for farmers to adopt.* Subsequent success of the Green Revolution based on new and highly profitable wheat and rice production technology proved him right and effectively laid the myth to rest. There is no obvious reason why irrigation water lifting in Egypt should be an exception.

* Transforming Traditional Agriculture, Schultz, T.W. (New Haven, Conn. Yale University Press, 1964).

2. Lack of Knowledge: For any new technology to gain acceptance, it is essential that potential users understand (a) what it can do for them and (b) how to go about putting it to use. Rapid development of custom tractor services in Egypt in the mid-1960's is a case in point. The Study Team became convinced that if farmers better understood the advantages of low-lift pumps and how to organize themselves into larger groups to use them efficiently, replacement of sakias would spread more rapidly than it has over the past several years. The Team likewise concluded that a well-designed extension effort aimed at producing such understanding could be mounted in Egypt with the same effectiveness as similar campaigns in other countries. Success of the Green Revolution, dependent on much more complex technological change than does the substitution of one water lifting device for another, is a highly pertinent precedent.

At present, Egypt has neither an extension program on sakia-replacement nor personnel trained in techniques of organizing groups of farmers to carry out joint activities. Train-the-trainer methods widely used in other countries have proven highly effective means of quickly developing specialized program-oriented capabilities in agricultural personnel already in service. Basic to success of a sakia-replacement program considered later in this Chapter are two assumptions: (1) Egyptian agricultural personnel at the government, district and village levels will be made available for short-course training and for participation in furthering the program and (2) AID will provide technical assistance advisors skilled in train-the-trainer and farmer-organization techniques to help organize and implement an educational campaign. The validity of these assumptions ob-

viously turns heavily upon the will of Ministry of Agriculture leadership to give effect to government policy to introduce improved irrigation technology. The Study Team has confidence that an appropriate training and extension effort can be successfully mounted and carried out.

3. Scarcity of Innovators: Change of whatever sort invariably requires that some individuals bear the risk and responsibility of taking the lead. In the case of low-lift pumps, the adoption process is further complicated by the necessity for group action. With portable units, the critical innovator becomes the pumpset owner/custom operator. This assumes that for reasons indicated previously, group ownership generally will not be practical except in isolated instances. Whether the initiative for introducing a low-lift pump in a particular locality comes from custom-hire entrepreneurs or from potential users of water-lifting services is incidental, albeit a consideration of critical significance to planning an operational strategy. In the end, some individual has to buy the pump set and operate it in a manner satisfactory to members of present sakia rings who opt for the improved technology.

Two principal factors convinced the Study Team that with the supportive program recommended later, generating sufficient custom hire innovators will not pose a major organizational problem. One is the prospective profitability of pumpset custom services once a market has been established. The scope for economic incentive to such innovators while making irrigation by low-lift pump cheaper for farmers than it is by sakia is evident from Table XII. 4. In that table, no attempt is made to divide overall net benefits between pumpset owners and water-using

farmers. Scattered data available to the Study Team, however, indicate that present custom rates for water lifting are on the order of LE 15.00 per feddan per year. Such annual rate data require interpretation, however, as they manifestly depend upon the particular combination of crops grown in the area.

Nonetheless, data suggest that, at prices farmers reportedly are willing to pay, there is an attractive margin for operators who have enough customers. At the outset, pumpset owners may not be able to utilize their equipment to full capacity. An incentive-loan program is therefore recommended to supplement an educational/motivational approach to encourage replacement of sakias with low-lift pumps. Without a financial incentive, organizational obstacles for adoption of pumps unquestionably would be much harder to overcome.

The second factor alluded to is the economic advantage to water users of shifting to low-lift pumps. While, for various reasons, most members of an existing sakia ring would not be willing to undertake responsibility for owning and operating a pump, they could become persuasive agitators for someone to take on that role. An enlightened user group consequently can go far toward creating the conditions necessary to economical custom operation of a pumpset in the process of themselves gaining the benefits of lower cost irrigation water.

The Study Team concluded that, with reasonable MOA/USAID effort, organizational obstacles to widespread introduction of low-lift pumps could be overcome, but the magnitude and complexity of that task cannot be minimized. In broad outline, it involves the following functional aspects:

a. Purchase of equipment by one member of an enlarged irrigation unit,

several members as partners or by another member of the local community acceptable to potential users. If more than one person owns the equipment, it would be critical that there be, at all times, one individual responsible for maintaining, running and moving the unit according to a prearranged schedule.

b. Determine fees, to whom and when they are to be paid and how collection records are to be maintained.

c. Arrange for any necessary work on canal banks to facilitate moving pumpsets from one location to another, a particular problem where a user association comprises non-contiguous areas some distance apart.

d. Motivate, advise and assist members of existing sakia rings to join into informal or formal water user associations and to organize themselves for group decision-making for scheduling irrigation time, changing delivery schedules as circumstances warrant, fees and correcting any inequities that may develop with experience.

In the Study Team's judgement, the organizational obstacles to enlarging irrigation areas could best be overcome by establishing a Joint Task Force. Members would have no responsibility other than developing and guiding a campaign to encourage and assist groups of farmers to replace their sakias with low-lift pumps. The Task Force might be comprised of two senior Egyptian agricultural engineers and two American technical assistance advisors. The Egyptian members would be selected for their knowledge of farm irrigation and demonstrated effectiveness in working with groups of farmers. The American members provided by AID would bring to the Task Force a background of training and experience in group extension and training methods. Administratively attached to the Agricultural Extension Department, the Task Force would function as a semi-autonomous unit, concentrating on sakia-replacement; it would work closely

with the Ministry of Irrigation and Reclamation; it would also coordinate its activities with other elements of the Ministry of Agriculture concerned with on-farm water use. The Task Force would also draw on results from experimental work in the Manshuria area by the Egyptian Water Use Project and the IBRD-assisted pilot farm mechanization project to be established in the Sohag and Minufia governorates.

Operationally, the Task Force might initially focus on developing in a cadre of MOA and Agricultural Credit Bank personnel, at the governorate, district and village level, competence in group motivation and other techniques essential to success of the sakia-replacement effort. This could be done fairly quickly by employing the train-the-trainer system which has proven successful for similar purposes elsewhere. All told, it is anticipated that some 500 to 600 "key trainers" and other agricultural personnel would participate in initial and follow up short courses. The Joint Task Force would operate for at least a 3-year period.

The Task Force, operating in two 2-man teams, would work directly with farmer groups to: enrich their training efforts with first hand experiences; demonstrate to village agricultural personnel techniques of organizing farmers for group action; and to counsel farmer groups on ways of overcoming difficulties experienced in making changes in irrigation technology.

Three years of participation by American advisors should be sufficient to lay the foundation for a continuing Egyptian program. By that time, MOA would have sufficient experience to decide whether to retain the Task Force principle by enlisting participation by designees from other concerned departments or/and ministries or to carry forward the sakia-replacement activity as part of the Extension Department's overall program. During the Task Force's 3-year life span, the Study Team should expect that some 10,000 informal or formal

water user associations be formed around portable low-lift pumpsets. There should then be sufficient momentum for progressively increasing adoption to proceed with less and less government participation.

Financial Considerations

For the replacement of sakias with diesel powered pumpsets to proceed at an optimal pace, it is imperative that financial constraints of two different types be anticipated and effective means provided for removing them. One concerns timely availability of pumpsets as the demand for them increases as a result of the proposed program's operation. The second concerns the character and availability of credit to pumpset purchasers.

Insuring Adequate Supplies

Low-lift pumpsets in an adequate number to meet the present meager demand are assembled in Egypt from domestically fabricated pumps and imported 6 hp diesel engines. With plant modernization, Egypt should have the capability for domestic production of entire pumpsets by 1982. Meantime, however, financing must be available to ensure importation of an adequate number of engines, appropriate models of which are produced in India and in other less developed countries. Unless special financing arrangements are made for bulk purchase of assembled pumpsets, it is unlikely that a sufficient number will be produced during the next 3 or 4 years to meet the demand the Study Team anticipates can be generated by a vigorous sakia-replacement program. Consequently, AID financing through the Agricultural Credit Bank for both the purchase of locally manufactured pumps and imported diesel engines might be considered. Whether the Bank procures the engines or arranges for import through Egyptian

assembly plants depends on mutual convenience and on comparative costs. Either way, the Bank would have to arrange for final assembly locally of the full pumpset. The Bank would them make completed units available to eligible custom operators or farmer groups as "in-kind loans".

Given adequate financial resources, neither function should tax the agricultural credit system's existing capabilites. The Agricultural Credit Bank (i,e., Principal Bank for Development and Agriculture) and its subsidiaries at the governorate, district and village levels already carry out large-scale in-kind lending operations with respect to fertilizers and certain other production inputs (See Chapter XXII on agricultural credit system). These banks also now make intermediate term loans for the purchase of pumpsets, tractors, and other farm implements. They are experienced with both in-kind lending processes and financing of durable farm production requisites. They therefore seem to be the appropriate organization to meet the requirements described here.

While there may be reason to question the desirability of the agricultural credit banks continuing to act as commodity merchants over the long run, they now have that responsibility. Reportedly they are discharging it with fewer farmer complaints than most cooperatives received when they performed those functions. At any rate, there is no obvious purpose to be served in singling out pumpsets for handling by some other agency, especially since in the opinion of the Study Team, is equipped to assume the responsibilities involved. Further, handling the number of pumpsets visualized by the program recommended later would not appreciably increase the credit system's current volume of activity.

Financing Pumpset Purchases

In the Study Team's assessment, there is no real prospect for replacement of a significant number of sakias unless:

(a) means are found for at least removing the disincentive to pumpset purchases posed by the relatively harsh term loans and

(b) adequate loan funds are available to the Agricultural Credit Bank. Intermediate term loans presently require a 25 percent down payment, repayment of the full loan in 3-5 years and bear a 10 1/2 percent interest rate. Few Egyptian farmers are able to meet such terms; fewer still would assume this much cash flow load for investment in a pumpset having a low yield during the first several years. Since this would effectively foreclose access to the impr technology by the vast majority of Egyptian farmers, retention of present terms would preclude otherwise qualified small farmers and farm laborers from becomin custom pumpset operators. Further, small farmers and farm laborers seem the mo likely source of custom operators. With Egypt's year-round growing season and complete dependence upon irrigation, water lifting is a continuous activity, except for the period when canals are closed for cleaning. Since the upper limit of irrigation areas will require pumping for only a few hours a week, operation of a custom pumpset should be most attractive as a part-time activity.

In the summer and fall of 1978, village banks generally deferred action on tractor loan applications due to a shortage of loan funds. Given Government's understandable concern with controlling inflation, capital rationing to the agricultural sector appears likely to continue. This problem could be met by AID's augmenting the Agricultural Credit Bank's total loan resources sufficiently to meet all legitimate credit needs. However, this would require a large assistance input and involve consideration of many aspects of the system's operation. The Study Team believes a more appropriate near-term approach might be a special-purpose augmentation of the Bank's loanable funds. Provision of such assistance could then be integrated with adjustment in terms applicable only to loans for replacement of sakias with pumps.

After considering various alternatives, the Study Team concluded that both types of financial constraints upon optimal adoption of pumps could be met most advantageously by establishing an Incentive-Loan Fund in the Agricultural Credit Bank system. To be meaningful, this fund would have to be large enough to finance sufficient pump purchases to demonstrate their advantage throughout the country. The $15 million AID assistance proposed later in this chapter for this purpose would meet that objective. Assuming low-lift pumpsets would cost farmers about as much when fully manufactured domestically as they do today, plus inflation allowance, the recommended Fund would finance about 10,000 pumpset loans. As technology innovations are adopted slowly at first and at an increasing pace as experience becomes more widespread the Study Team concluded that the following represents a realistic off-take schedule:

500	units	in year 1
2,000	"	in year 2
3,000	"	in year 3
3,500	"	in year 4
1,000	"	in year 5

The drop off in the fifth year reflects the Team's expectation that the Incentive-Loan Fund will be largely exhausted by the end of the fourth year. Repayments would support a continuing volume of pumpset loans but are not considered part of the present project. Repayments would be earmarked by the Bank for loans to further pumpset financing on terms deemed appropriate to circumstances at the time. The Study Team believes it should not be necessary to continue the incentive feature beyond the first 5 years. Repayment terms for intermediate credit in general, however, should be made much more realistic than at present, as indicated earlier. In the event they are not, MOA should consider the possible advantage of retaining the incentive principle for pump loans from previous loan repayments.

Borrower Considerations

From the individual borrower's standpoint, the loan process is seen working out as follows:

1. Assume the pumpset purchaser borrows the full purchase price (LE 890) on the proposed Incentive-Loan Fund terms.

2. Repayment schedule:

Year 1 -	interest only	LE 53.50
Year 2 -	interest only	LE 53.50
Year 3 -	principle + interest	LE 209.00
Year 4 -	" "	LE 209.00
Year 5 -	" "	LE 209.00
Year 6 -	" "	LE 209.00
Year 7 -	" "	LE 209.00
Seven-year total		LE 1152.00
	Interest	LE 262.00
	Principal	LE 890.00

3. From a custom operator's standpoint, the feasibility of borrowing from the Incentive-Loan Fund to purchase a pumpset depends on the number of feddans to be served per year and the custom rate users are willing to pay. As an illustration:

a) Current income from machine use during the seven-year loan period must at least cover interest and principal payments; depreciation; and cash costs of operating the machine less the equity built up by principal repayments. Referring to the preceding section and Table XII. 2, these totals for the entire seven-year loan period assuming a 30 feddan area are:

Principal and interest payments	LE 1152.00
Depreciation	394.00
Variable machine costs	1470.00
Total	LE 3016.00
Less owner equity at end of 7 years (purchase price minus 7 years depreciation)	LE 496.00
Net cost	LE 2520.00

b) Users would be willing to pay water lifting charges at least as high as the value of milk and meat lost by lifting water by sakia with their own animals as indicated in Table XII. 1, i.e., LE 13.00 per feddan x 30 feddans x 7 years (LE 2730.00).

c) On this basis, a custom operator could slightly more than break even during the entire loan repayment period if he were able to use his pumpset for irrigating only 30 feddans per year. He would have a seven-year net return of LE 210 or LE 30 per year for his labor in moving and operating the machine and for taking the risk of not actually having enough customers to provide 30 feddans of pump use per year. Disregarding the risk, this would mean a net return of roughly LE 1.00 per day while operating the machine.

d) In cash return terms, the machine owner would just about break even during the seven-year loan repayment period if custom rates were no higher than those assumed above. At the end of seven years, however, he would fully own a pumpset with more than half of its useful life remaining.

The preceding calculations illustrate three significant points in the sakia-replacement strategy:

-- Incentive loans are essential to encourage individual custom operators or groups of farmers to buy pumpsets to provide water lifting services to two or more existing irrigation units. With principal repayment deferred the first 2 years, an owner could meet his cash requirements with a service area of only 15 feddans.

Some might be willing to do this in the expectation of expanding their service area in subsequent years. In this way, the Incentive-Loan Fund becom an important means of demonstrating the low-lift pump technology in different localities.

-- The tradeoff between custom rates, adoption of the improved tec nology, willingness of operators to purchase pumpsets and the area serviced b one pumpset is critical.

-- Custom operators will have to expand their service areas, hence to encourage additional sakia rings to shift to low-lift pump irrigatio once they had made the initial decision to buy a pump. With such economic in· centives, the organizing effort of the Task Force and other participating gov· ernment workers can be focused upon gaining acceptance by initial purchasers in different localities. As their service areas expand, custom operators can afford to reduce their rates which, in turn, will benefit their original cus- tomers and facilitate adoption of the improved technology by additional sakia rings.

Viability of the System

Preceding sections of this analysis have led to three significant conclu- sions with respect to sakia-replacement strategy planning:

-- Custom-operated portable 6 hp pumpsets offer the best opportunit for gaining widespread adoption

-- Given the proposed loan terms, custom operators, particularly small farmers and landless laborers, should find the prospective returns suffi ciently attractive to purchase pumps if they and existing sakia ring members

are assisted and encouraged to enlarge irrigation areas to at least 30 feddans.

-- Economic incentives of serving more than 30 feddans with one pumpset are such as to encourage both custom operators and farmers using the pumps to become active promoters of the low-lift pump technology.

These and several other critical aspects of the system in operation are illustrated by the hypothetical case summarized in Table XII. 11. The indicated benefits over sakia irrigation could, of course, also be gained if two or more sakia rings jointly purchase and operate a pumpset. Nothing in the preceding discussion is meant to imply that joint ownership should be discouraged. However, given added organizational problems in forming such groups, the Study Team concluded that a strategy built around custom operations would yield higher returns to government assistance efforts.

Note from the final two columns of Table XII. 11 that the proposed deferral of principal payments for the first 2 years gives the pumpset owner a modest additional cash flow margin over that which reasonably can be expected when princiapl repayments begin. This seems highly desirable to encourage operators to enter this essentially new field. It also provides a margin to hold down custom rates at the outset to attract users. The difficulty with that approach lies in negative user reaction to later increases in charges needed by the custom operator to meet costs - unless his service area were to expand much more rapidly than seems realistic. These matters will necessarily be considered carefully by those advising local farmer groups and custom operators.

Recommendations

A three-part AID assistance strategy is proposed to help Egypt cope with the financial, informational and organizational constraints upon the replacement

TABLE XII. 11

ILLUSTRATIVE IRRIGATION COSTS AND PUMP OWNER RETURNS UNDER ALTERNATIVE ASSUMPTIONS REGARDING CUSTOM RATES

In LE

			Cash Requirements of Pumpset owner		Custom Rate Per Feddan	
Year	Feddans per pumpset	Cash cost per feddan by sakia[1]	Loan Interest and Principal[2]	Cash Machine Costs[3]	Minimum[4]	Feasibl
1	30	13.00	71.20	217.30	9.05	12.00
2	30	13.00	71.20	217.30	9.05	12.00
3	45	13.00	219.47	287.70	11.05	12.00
4	45	13.00	219.47	287.70	11.05	12.00
5	45	13.00	219.47	287.70	11.05	12.00
6	60	13.00	219.47	365.10	9.55	11.25
7	60	13.00	219.47	365.10	9.55	11.25
8	75	13.00	--	445.60	5.95	9.50
9	75	13.00	--	445.60	5.95	9.50
10	90	13.00	--	519.90	5.75	9.35

[1] Cash income from milk and meat lost by working animals. See Table VII. 1.

[2] See Text.

[3] Based on Table XII. 8. Total machine costs minus depreciation and interest on investment.

[4] (Col. 4 + Col. 5) divided by Col. 2. Assumes pumpset purchaser must cover out-of-pocket expenses each year even though in years 3-7 he will be buildin equity in pumpset.

[5] Assumes (1) equal division between pumpset owner and water users of differenc between their respective cash costs after owner begins making principal repa ments and (2) raising rates after 2 years is not feasible (3) incentive at ou set is necessary to encourage pumpset purchase and (4) users would be willin to pay even the full cash savings if necessary, due to time saved and other non-cash cost reductions.

of sakias with motor-driven pumpsets. This consists of the following:

-- Create a financing capability to provide groups of farmers incentives to organize themselves into informal or formal "water-user associations" for efficient use of portable 6 hp diesel-powered pumpsets.

-- Provide technical assistance through a Joint Task Force to help mount a concerted motivational/informational campaign to encourage farmers to organize efficient-size user groups to take advantage of improved water-lifting technology.

-- Arrange financing on a step-down principle for local costs of the farmer education/organization advisory services aspects of the total sakia-replacement effort to facilitate early impact and progressive institutionalization of the activity.

Incentive-Loan Fund

Purpose: Efforts to educate farmers to the economic benefits of forming water-user groups large enough to make efficient use of motor-driven water lifting equipment cannot succeed unless custom operators and/or groups of farmers are able and willing to finance the purchase of pumpsets. Under existing bank terms, only relatively large farm operators can qualify for such medium-term loans. In addition, the requirement of loan repayment in 3 years on top of a 10 1/2 percent annual interest rate puts the purchase well beyond the financing capabilities of small farmers and landless laborers who otherwise seem the most likely source of custom operators. Collectively, a group of small farmers might be able to arrange to meet present bank lending requirements if they took the necessary legal steps to qualify as a borrowing entity. As the agricultural credit system has had little experience with group lending, it seems safe to predict that in the early stages only a persistent farmer group would stay with the negotiations long enough to actually obtain a loan.

Amount: To accelerate the pace of sakia-replacement, the revolving fund must be large enough to reach several thousand water-user associations countrywide. An AID input of $15 million is recommended as the minimum necessary. The average 6 hp diesel-motored pumpset today costs approximately $1270 (LE 890).

Allowing for price inflation, the proposed $15 million AID contribution would enable the Egyptian agricultural credit system to make loans for roughly 10,000 diesel pumpsets over the next five years.

Since there are 400,000 sakias and tambours in Egypt, the 10,000 pumpsets financed by a $15 million revolving fund would still represent only a small percentage of the total irrigation units. With effective organization of the effort, farmer demand could be expected to reach an average of 2,000 pumpsets over the next 5 years. Once the benefits and organizational techniques become widely understood by farmers, effective demand might exceed that volume. When it significantly exceeds 2,000 units per year, incentive funds would be reserved for neediest cases. Other borrowers would be channelled to the regular agricultural credit system. Anticipating that the adoption of low-lift pumps will follow the characteristic pattern of technological innovations in general, the proposed $15 million Incentive-Loan Fund would have the following projected off-take schedule: 1st year, 500 units; 2nd year, 2,000; 3rd year, 3,000; 4th year, 3,500 and 5th year, 1,000. The drop off in acceleration rate between the 4th and 5th years merely reflects the Study Team's conviction that farmer demand will exhaust the initial fund early in the 5th year unless some reserve arrangement is introduced in the meantime.

Duration: The revolving fund will be set up with a 5 year assured life span. This corresponds with the duration of the over all AID agricultural mechanization assistance program under consideration. Five years also is sufficient to permit the incentive fund to reach a substantial number of farmer groups throughout Egypt. At the same time, it is a rather short period to institutionalize technological innovation. Only by building on the long Egyptian tradition of shared use of water lifting facilities could the water-user association con-

cept be expected to take root so rapidly. Actually, what is required is simply to increase the size of the traditional "sakia ring".

At the end of the initial 5-year life span, the assets of the revolving fund could either be (a) merged with the other resources of the agricultural credit system or (b) maintained as an incentive fund to assist particularly deserving groups of small farmers who even collectively cannot gain access to mechanical pumpsets through agricultural bank credit. Notwithstanding the awkwardness of earmarked funds in any banking system, the Study Team recommends this approach. Facilitating the access of small farmers to mechanical irrigation by making the lumpy investment in pumpsets divisible would promote the welfare of farm families at the low end of the economic scale.

Loan terms: The terms of the loans must give borrowers an incentive to form and serve larger irrigation groups around motor-driven pumps. It is recommended that this incentive take the form of (a) 100 percent loans for pumpset purchase, (b) repayment over approximately one-half the expected life of the equipment and (c) deferral of principal repayments for the first 2 years with a borrower option to prepay any of the subsequent 5 yearly installments. Interest charges would be based on a "cost of money" principle. This would enable the AID assistance to directly benefit the farmers using the pumpsets and encourage energetic small farmers and landless laborers to become custom operators. If the AID assistance is provided to the ARE as a grant, the cost of money principle would result in an interest charge to borrowers from the Incentive-Loan Fund of around 6 percent. This assumes the usual 2 percent Central Bank charge plus a 4 percent fee for services payment to the Agricultural Credit Banks. Should the AID assistance be on a development loan basis, interest costs to the ARE presumably would be added to the otherwise feasible 6 percent charge to bor-

rowers. Interest payments would become due annually from the outset.

Roughly half of all Egyptian farms have less than two feddans of cultivated land. In Upper Egypt, this figure runs to 60 percent. In both cases, half or more of the small farms are less than one feddan in size. Regardless of the size of his operation, the Egyptian farmer must have some means of lifting irrigation water from the canal for his crops. In many communities, all the farms are quite small; in others, small units are interspersed among larger ones. It follows, therefore, that regardless of where the pumpsets are located, the greatest number of beneficiaries will be small farmers.

In the Study Team's view, the most promising strategy for encouraging sakia replacement would combine the concept of custom operation with that of water-user associations. Unlike tractors or other mechanized equipment, where custom operations can function on an individual farm basis, custom operation of a pumpset requires cooperation between the machine owner and a group of users. While group ownership is feasible, group operation of a service seldom works well. In the end, one person has to be responsbile for running the equipment and maintaining delivery schedules. Whether the initiative for forming or subsequently expanding a machine-owner/water-user combine comes from one party or the other is not material. Given these circumstances, the time and effort required to organize farmer groups to utilize a pumpset efficiently and the contribution which sakia-replacement can make to Egypt's national food security goal, the concessions in loan terms proposed are quite modest.

Eligible borrowers: Loans will be made to any group of farmers with authority to borrow money and to carry out loan agreement terms or to individuals who agree to provide water pumping services to two or more existing sakia rings on a fee basis. Ideally, loans would be made only to legally constituted water-u

associations. But such a precondition almost certainly would defeat the purpose of creating the Incentive-Loan Fund. Consequently, it would be much more expedient and less disruptive of traditional practices to permit individuals also to borrow from the Fund. In either case, a condition of eligibility would be firm user agreements from members of sakia rings to assure sufficient irrigated area for use of a 6 hp pumpset. Group borrower agreements would specify arrangements for sharing use of the pumpsets. If the borrowers are individuals, the supporting agreements would specify fees for water pumping services not exceeding the standards set by the MOA unit responsible for administration of the sakia-replacement program. Loans normally would not be made to applicants who would serve fewer than ten farmers and in no event to an individual farmer for his own exclusive use.

Usually, an individual borrower, hence pumpset owner, would himself be a farmer member of the group to be served by this equipment. However, realism argues strongly against making that a condition of eligibility. Organizing a water-user group will take considerable time and leadership. To operate a contract water pumping service will take part of a person's time most of the year. Village residents who themselves may not be farmers thus should be eligible for pumpset loans. This would open the way for some landless laborers of ability to have additional employment opportunities for themselves and their families.

Use of loan funds: Only in-kind loans for the purchase of diesel (or electric) powered pumpsets would be made from the Incentive-Loan Fund. With the existing lay-out of irrigation water delivery systems, pumpsets normally would be portable. Stationary units would be financed, however, where local conditions warranted. The number of feddans that could practicably be served by

a pump at one location would automatically determine the preferred type of unit In all instances, the area would have to be large enough for the investment to be economically viable.

Fund Administration: The sakia-replacement loan funds would be administered by the Principal Bank for Development and Agricultural Credit. The Bank would be expected to keep these earmarked funds separate from its other financial resources. Otherwise, the Bank's established practices would be followed for the earmarked funds as well. The Bank currently makes in-kind production credit loans for fertilizers, seed, custom tractor hire and other types of production inputs.

Since it would be making in-kind loans to borrowers, the Bank necessarily would draw upon the revolving fund to purchase locally manufactured pumps and to either directly or through arrangements with Egyptian assembly plants import suitable engines (from underdeveloped countries such as India or Korea). Pump manufacturers, for example, Tanta Motors, already follow the practice of importing engines to attach to their pumps, as few of the appropriate size are manufactured in Egypt. When Egyptian-made engines become available in volume, the Bank would buy these as well as the pumps locally, assuming they are priced competitively with imports.

To cover administrative costs, the Bank would receive a one-time two percent fee from the revolving fund for the amount of loans actually made. During the 5-year program period, the Bank also would be entitled to four percent cent of the interest collected. Together these two charges approximate the four percent difference between the loan rate discussed above and the cost of money to the Bank (considered necessary to its viability). The Bank also would cover from the revolving fund, the normal bank handling charges for local and im-

port procurement. These charges would be passed on to borrowers in the pumpset purchase price, just as commercial firms do. Thus, these handling charges would not become a net cost to the revolving fund.

Technical Assistance

Joint Task Force: To change traditional patterns of cooperation built around the limited delivery capacity of the sakia, farmers have to believe that the change will benefit them individually and collectively. Experience has abundantly demonstrated that enlightened motivation to adopt improved technology can be fostered most expeditiously be a campaign tailored to adoption of new technology. Experience also has shown that action-oriented campaigns are most effective when planned and carried out by special staff units created or assembled for a particular purpose. It is recommended, therefore, that a small, temporary special-purpose unit be created and charged specifically and solely with an impact campaign to encourage and assist groups of farmers to shift from sakias to motor-driven pumpsets. To blend U.S. experience in extension methods with Egyptian expertise in local agricultural conditions and custom, it is recommended that this special unit be constituted as a four-man Joint Task Force comprising two Egyptian and two American specialists.

Organization: The Ministry of Agriculture would provide the two Egyptian Task Force members from among qualified personnel of some appropriate department or by outside hire for the 3-year duration of the sakia replacement activity. These individuals would be freed of all other responsibilities to devote full time to the Task Force program. AID would provide two technical assistance advisors to serve as the American members of the Task Force. They, too, would serve for 3 years and have no other responsibilities.

For administrative purposes, the Joint Task Force would be attached to the

MOA Extension Department. It would, however, function as an autonomous unit with specific responsibility for maintaining close liaison with relevant departments of the Undersecretariat for Engineering and Farm Mechanization and the Ministry of Irrigation and Land Reclamation. The Task Force likewise would maintain close contact with the IBRD-financed pilot farm mechanization projects in Minufiya and Sohag governorates and the AID-assisted Egyptian Water Use Project.

The American members of the Task Force would be an integral part of the overall Technical Assistance Advisory Group (TAAG) discussed elsewhere in this report under the general guidance of the TAAG team leader. Like their Egyptian counterparts, however, they would have no TAAG responsibilities other than to the sakia-replacement task force.

Functions: The main functions of the Task Force would be to: (1) inform groups of farmers about the advantages of collective action to replace sakias with motor-driven pumpsets serving economic-sized areas; (2) assist farmer groups to organize water-user associations and groups or individual custom operators to obtain loans, if needed, from the Incentive-Loan Fund; and (3) develop a cadre of trained, local-level personnel capable of working effectively with farmer groups and others to carry out these objectives. In actual practice, a substantial start would be made on the training objective before any significant progress could be made on the information/organization front. It would be futile for a small, Cairo-based task force to try to do much work directly with farmer groups except for gaining first-hand experience with the problems with which local personnel will have to cope. To build a Cairo-based contingent large enough for substantive direct work with farmer groups undoubtedly would prove counterproductive.

Training Program: The personnel training activity would comprise two sequential steps. First, the Task Force itself would conduct a series of "train-the-trainer" short courses for agricultural staff and key agricultural bank employees in each governorate. Those selected for participation in these courses then would be responsible for conducting similar training sessions with village level extension or other appropriate agricultural workers and Agricultural Credit Bank personnel. These are the personnel who would carry the campaign to farmer groups in their respective areas.

Substantively, the training at both the governorate and village levels would include:

-- A thorough explanation of both the direct and opportunity benefits that will accrue from replacing animal-powered sakias with motor-driven pumpsets.

-- Case illustrations designed to familiarize trainees with the economies of scale and proximity in deciding an optimum size of irrigation area.

-- How to organize formal or informal associations of water users around the pumpset technology.

-- Terms, eligibility and other conditions concerning credit available from the Incentive-Loan Fund at the village agricultural banks.

-- How to cope with problems of rearranging canals for efficient use of mobile or stationary pumpsets.

Follow Up: After the first round of train-the-trainer sessions is completed, two-man teams of Task Force members would maintain first-hand contact with former trainees to ensure that what they had learned in training was being effectively passed on to colleagues in the villages. They would also remain in close contact with village level personnel and with farmer groups organizing associations to give professional advice and identify strong and weak points in campaign performance.

It does not appear necessary at this time to provide the Task Force with a special evaluation staff. The possibility that such a staff might make a contribution to program performance should be reassessed, as the sakia-replacement program progresses. Much would depend upon how much attention the overall Mechanization Planning and Evaluation Unit proposed in another part of this report and the Evaluation Unit to be created in the Extension Department as part of the Minufiya - Sohag project find it feasible to give the sakia-replacement effort.

Local Cost Financing: Although administratively attached to the MOA Extension Department, the Joint Task Force will be essentially inter-departmental and inter-ministerial in character. Assurance of adequate, regular financial support always is difficult under such circumstances. To minimize financial constraints upon Task Force effectiveness, it is proposed that the AID Technical Assistance grant cover the full local costs of its operations on the step-down principle proposed in the overall TAAG section of this report. Under that formula, the AID grant would cover all local costs the first 2 years of operation of the sakia program and 70 percent of those in its third and final year. This arrangement would facilitate MOA budgetary provision for building the Task Force functions into the regular extension department organization program by the beginning of the fourth year or continuing an inter-departmental or inter-ministerial task force by co-opting representatives from MOA departments and/or other Ministries concerned with on-farm water use.

A summary of the costs associated with the sakia-replacement subproject follows.

Estimated Operating Costs
Sakia Replacement Subproject

Personnel	3-year Total
2 Egyptian Task Force Members	$ 27,200
2 American Task Force Members	792,000
Secretarial and clerical aides	15,900
Local transport and per diem[1] Task Force members	19,100
Key Egyptian Trainers[2]	4,800
Project Support	
2 small pick-up trucks	15,000
2 demonstration portable pumpsets with 5 hp diesel engines	2,400
Spare parts ($500 for vehicles, $240 for pumpsets)	1,700
Vehicle repair and maintenance	2,400
Fuel, oil and lubricants	4,200
Training aids and equipment	1,000
Office equipment and supplies	2,000
Total	$ 887,700
20% contingency	177,500
Grand Total	$ 1,065,200

[1] All Task Force local travel performed by project vehicles. Per diem for American members is included in overall technician cost per year. Consequently, cost estimate refers only to per diem of Egyptian Task Force members.

[2] Assumes 4 in each of 17 governorates will attend 15 days of training during the 3-year period. Cost estimate thus assumes 1020 days of per diem plus transport costs for travel to central locations averaging 100 km per round trip.

CHAPTER XIII

MACHINERY MANAGEMENT EXTENSION

Agricultural Extension in MOA

Organizational History

Agricultural extension began in Egypt in September 1953 with some U. S. assistance and support (such U.S. aid was discontinued in 1967). The extension organization was enlarged in 1963, in 1968 received additional emphasis and was then made into an extension department within the Ministry of Agriculture. The government approved a reorganization plan in 1976 to provide for expanded services to farmers. This plan is still in the process of being implemented.

The operating head of the organization at the central level is a General Director with assistants to help him carry out planning and supervisory responsibilities. He has a High Advisory Council but this group has not always been active. Administration is divided among four supervisors. The headquarters organization develops extension programs and activities and sends these down to the local governorate level for action. The extension organization depends on research personnel to make national recommendations and to assist in training. Programs are developed by central level extension staff from recommendations made by senior personnel from research institutions. Some current extension educational techniques used are: publications; a monthly farming magazine sent to extension workers, cooperative leaders, and village leaders; radio and television programs; and field demonstrations. All programs are developed

centrally with minimal input from the local level and essentially no input from farmers or industries related to farming.

Locally, the extension operates at the governorate and at the district (equivalent to county) and village levels. Local extension personnel are supervised, under the existing governing system in Egypt, jointly by central level extension and the Director General of Agriculture at the governorate level. On this level there are two or three extension workers who are supervised on the governorate level by a Chief Extension Officer, assisted by two or three deputies.

Egypt has some 4,000 villages grouped into 123 districts of varying size. As an average for the whole country, a village would have an average area of some 1,500 feddans, and a district would include some 33 villages and have an area of about 48,750 feddans. Where there are no village extension workers, two or three district-level extension workers are the only agricultural educational contacts for 33 villages.

There is one agricultural extension center, which is often called the agricultural unit, in each district. This system was initiated in 1944 but was not completed until the late 1960's. This agricultural unit is headquartered in a building for agricultural extension staff as well as all personnel of other agricultural services serving the district. Attached to this building is usually an eight or ten feddan farm that is mainly used for demonstration purposes and for conducting field trials at the local level. On some of these, field trials are conducted by agricultural research staff stationed at nearby experiment stations.

At the village level where there is no extension agent, a representative of the Ministry of Agriculture has some responsibilities for extension. This

representative interprets and enforces the rules and regulations of the MOA. Because in his enforcement role he sometimes must impose a fine on farmers, it is difficult for him also to act in an educational role.

The reorganization of 1976 called for creating a cadre of workers to carry out extension educational programs at the village level. Progress in implementing this reorganization and improving the effectiveness in the extension program has been slow. Many of the positions still remain to be filled. Salary and allowances for extension officers are low and less than salaries for equal level government posts in research. This results in less competition for the extension posts, and agricultural graduates entering extension often do so because they are unable to find alternative employment.

Mechanization Program Lacking

The Agricultural Extension Department does not now have an education program on mechanization, has no programs planned, lacks experience in this area and employs no personnel experienced in this subject.

The extension function has been described as "existing more on paper than in the field." Extension is trying to expand its services to farmers but has problems arising from: unfilled positions, inadequate professional development for recently added officers, transportation and an inadequate budget. Communication and links between extension and research are very poor. Extension officers have little contact from which to gather first-hand information on recent research. Researchers too often work in isolation from production problems; consequently, extension workers are handicapped by lack of solutions to current problems.

The Extension Department in the Ministry of Agriculture recognizes the need for a machinery management educational program. However, that department has a broad range of educational responsibilities to agriculture. If machinery management remains undifferentiated from the several areas that need improvement, it will not receive the allocation of resources required.

The Egyptian farmer is currently blending modern technology with ancient traditions and practices. He bypasses many of the steps taken in more develop countries. In this process, he has not gained the experience and skill development required to maximize the benefits of mechanization. With a limited history of mechanization, much of the information he requires to solve his mechanization problems must come from outside sources.

An aggressive educational program to supply current, unbiased information to farmers, professional workers in agriculture and agriculture-related business on all phases of agricultural mechanization should be an essential component of an agricultural mechanization program for Egypt.

Magnitude and Character of the Problem

By Study Team estimate, the effective output of tractors and related equipment now on Egyptian farms could be increased 17.5 percent through efficient machinery management*. Achieving such an increase would be equivalent to adding another 4,375 tractors. At a price of $5700 each, these would have a value of at least LE 25,000,000.

As used here, the term "Machinery Management" spans the range from equipment selection and tillage practices to the use and maintenance of

* See Chapter IV for the basis of this estimate and other aspects of the analyses underlying the Study Team's conclusions and recommendations with respect to machinery management.

tractors and other types of farm equipment. Evidence of poor management practices has diverse forms. For instance, roughly 40 percent of all tractor-use hours are spent on threshing, another 7-8 percent on lifting irrigation water. Using a 65 hp tractor to power a drum thresher, when a 10 hp stationary engine and improved type of threshing equipment could do an even better job, is scarcely making efficient use of farm machinery. The same is true of tractor-powering a sakia for water lifting when a 5-6 hp diesel motor and modern pump would deliver more water faster. With Egypt's presently low tractor density, such non-field uses of tractors take a direct toll of crop production. This is particularly noticeable in the case of maize where seed-bed preparation competes for tractor time with the wheat harvest. Having experienced the benefits of custom tractor plowing and no doubt for other reasons as well, many farmers apparently delay maize planting until a custom tractor operator gets to them. After a point, yields plummet precipitously as planting is delayed.

Today, use of tractors and related equipment in field operations is limited to seedbed preparation. Even there they lose efficiency by not having the right kinds of attachments. Substituting a disc harrow and a spike-tooth harrow for the board drag now used for smoothing the seedbed after plowing would eliminate one plowing and produce a much better seedbed with no more tractor hours. In fact, use of such ancillary equipment would reduce overall tractor requirements. The reason is that in present practice, fields generally are plowed at least twice, a method that is partly a carryover from traditional animal-power cultivation, where plowing both ways with a baladi plow was necessary to break up the soil.

Significant opportunities also exist to increase farm production with reduced production costs by extending tractor usage to operations other than seedbed preparation. As indicated elsewhere in this Study Team report, mechanical planting of maize, cotton, sorghum and soybeans can increase yield ten percent over present hand-seeding methods. Inter-row cultivation of such crops can increase yields both directly and indirectly as well as eliminate the need for laborious hand hoeing and weeding. The indirect yield gains stem directly from reducing the roughly ten days per feddan currently spent on hoeing and thinning maize or the fourteen days per feddan hoeing cotton. Requirements for these functions come at the peak labor season. At some point, even small farmers who need additional seasonal labor find they cannot cope with a shortage of workers and rising wage rates. The result is a reduction in hand cultivation of row crops. When that happens, yields drop significantly.

Of more immediate concern are the use and maintenance of machines. Results from a large-sample survey carried out as part of the present study indicate that nearly one-fourth of all tractors owned by co-ops were inoperable. In contrast, only three percent of those owned by individual farmers were out of use. All told, another 41 percent of all farm tractors were considered by informed local reporters to be in only "fair" condition. To be sure, most of the inoperable tractors and many of those in fair condition were well along in years. Many others, however, were not, which suggests poor maintenance and/or lack of repair facilities and spare parts. That co-ops do not compare favorably with private owners suggests co-ops represent a prime opportunity for efforts to improve machinery management. Another opportunity is found

in the State Farms developing the New Lands. Idle cropland and idle machinery in the New Lands bear mute evidence that better machinery management could contribute significantly to Egypt's food security and New Lands Development policy objectives and at the same time produce a better return on machinery investments on those large farms.

Given the marked seasonality of crop production requirements in Egypt, 300 to 400 hours of tractor use per year for field operations is about all that can be expected until farmers learn to use the motorized equipment for work in addition to seedbed preparation. Today co-ops get about 280 hours of field work out of an annual average use for all purposes of 560 hours. Private owners average some 345 hours in the field out of 850 total hours. The competition from threshing, some water lifting, and largely off-farm transport for available tractor time is a factor in both instances. So is down-time due to lack of repairs and spare parts, a particularly critical factor with older machines. However, these do not explain why, with Egypt's low tractor density conditions, the field use of these machines falls well below what is feasible. In particular they do not explain why co-op tractors are used less than half as many hours a year as privately-owned ones.

By no means are all the opportunities to improve machinery management immediately within the grasp of the Egyptian farmer. Provision of some facilities, such as those for repair and spare parts, depend on private entrepreneurs and/or government. An economical alternative to the tractor-powered drum thresher is simply not available on the market. Motorized water lifting equipment is available, and highly economical compared with the usually animal drawn sakia, but wider use of this machine awaits organization of larger irrigation units. No companies are found with the capacity to manufacture a

volume of new types of equipment for increasing Egyptian agricultural output so that tractors can be freed for more field work. Further, Egyptian manufac lack a tradition oriented to innovation or to market developments for such equipment.

Each of the preceding four areas for improved machinery management is treated in detail in other sections of this report. Here, concern is directe to aspects of machinery management which farmers can do something about themselves, if necessary with some guidance and encouragement through government effort. Encouragement and assistance to MOA to mount the necessary effort deserves priority attention for assistance by AID.

Recommendations

Strategy for Improvement

Special problems require special treatment. As an interim solution to the pressing problem of quickly activating a machinery management education program, a Task Force approach is recommended as the most promising by a wide margin. By reason of experience with agricultural extension programs and methods, participation by American professionals can go far toward making suc a Task Force effort effective quickly. Consequently, the Study Team proposes that a Joint Task Force be set up to initiate and carry out an information/motivation/training program targeted to priority aspects of machinery management. In broad terms, this Task Force would deal with removing constra on the inefficient use of farm machinery for increasing Egyptian agricultural production. Specifically it would:

1. Act as a problem solving group to change those factors that currently restrict the effectiveness and growth of mechanization.

2. Conduct an agricultural implement introduction program.

3. Develop teaching skills revelant to mechanization in the agricultural colleges.

4. Conduct an advisory and development program for small local manufacturers of agricultural implements.

If the Task Force is blended in with the present organization, its effectiveness would be reduced by the same restraints now facing the Extension Department. It would work closely with the Department especially at the village and district level. For technical guidance, it would look to educational institutions, research stations and the Undersecretariat for Engineering and Farm Mechanization. The administrative arrangements of the unit should be flexible and highly mobile with freedom to develop and implement a nationwide mechanization educational program.

A separate and unique unit of this type should, at the end of a recommended five year period, be integrated into the Agricultural Extension Department. One or more of the Egyptian specialists would then be assigned specifically to continue the mechanization education program, while other specialists would be assigned the responsibility of integrating mechanization into other ongoing commodity programs. For example, the cotton program could have, advantageously, a mechanization component in its educational program. The Task Force would consist of subunits specializing in different aspects of machinery management but functioning as an integrated whole in identifying and attacking specific problems.

Primary audiences for the Task Force program would naturally be: farmer-users of custom-hire tractors and other types of motorized farm equipment;

private custom service operators; predominantly farmers who do custom work for their neighbors as well as using the equipment on their own farms; and the 4000 village co-ops that are major owners and operators of custom equipment like sprayers as well as tractors. Also included in the "farmer" audience would be the State Farms developing the New Lands. Their special characteristics of size and organization may require specially-tailored approaches and perhaps assignment to them of a more or less full-time Task Force sub-unit. At this juncture, however, it appears feasible to accommodat the New Lands farms within the framework of the overall Task Force mission.

At the outset, the Task Force would plan and develop a comprehensive program. They would take into account suggestions from farmers at the village level as to the desired content so that it would be realistic in character. Priorities might change over time, but areas that currently appear to warrant immediate attention include:

1: Tillage and seed bed preparation: Adopt better seedbed preparation techniques which have the potential to improve yields 10-25 percent and reduce production costs. Likewise, sizing the tillage tool for the tract methods to control tractor wheel slip, plowing at the proper soil moistur condition, etc., offer attractive opportunities for improving machine efficiency. Demonstrations on the 10-feddan demonstration farms could be an important segment of this program.

2. Costs and return evaluation: The adoption of mechanization by an indivic farmer must be based on expected net returns. This information is not available to farmers at the present time. Group meetings and individual consultation on farm record keeping, evaluating custom-service charges and individual ownership, cost and returns of group ownership of field machin

or irrigation pumps, etc. could put the growth of agricultural mechanization on a sound financial basis.

3. Operation, maintenance and repair of equipment: Tractor owners, drivers, cooperative managers, and others should have a source of information on how to use and care for their tractors and implements properly. Machinery operation and daily care workshops would be components of this program.

4. Machinery and implement selection: Strengthening the tractor testing station in Alexandria and broadening its scope, as proposed elsewhere in this report, would help that organization to generate vital information on both tractors and implements. Although the station has done only a limited amount of work in this area in the past, such information as it has developed has not been made available to potential tractor or implement buyers. The new program would encourage dissemination of information. Extension-sponsored demonstrations would be utilized to introduce new implements to farmers and to provide unbiased information on machine specifications and optimum size.

5. Assistance to small manufacturers: In addition to the main farmer/co-op audience, this mechanization extension effort also would extend to small manufacturers of farm equipment. One sub-unit of the Task Force would be devoted exclusively to providing them with advisory assistance.

Lest emphasis on tractors and related equipment in the situation description and proposed AID strategy above be taken to imply that only big farmers would benefit, a brief comment on the data set out in Chapter IV will help put the proposed action into perspective.

The data show that small farmers, even those with less than one feddan

of cultivated land, use custom-hire tractors for seedbed preparation and threshing to nearly the same extent as operators of larger areas. This finding was also supported by the Team's Farm Management Survey. Even more surprising is the relatively high percentage of tractor owners who are small farm operators and use them mainly for custom work. Assuming that the smallest of Egypt's small farmers, as in other countries, are the ones most in need of reliable extension information and advice, it follows that this group will be among the principal beneficiaries of the Task Force efforts.

AID Assistance

AID assistance strategy for furthering the machinery management program should center on:

1. Technical Assistance in the form of:

   (a) American specialists to function as members of a six-unit Joint Task Force.
   (b) An exposure-type, short-term participant training program to create awareness of opportunities to improve machinery management and how they can be realized.
   (c) A limited longer-term training program to develop especially promising young personnel for future mechanization program leadership.

2. Financing the local costs of the Task Force operations on the step-down principle proposed in the TAAG section of this report to:

   (a) Relieve financial constraints endemic to inter-departmental activities of the kind proposed.
   (b) Enhance the prospect of attracting well-qualified and highly-motivated Egyptian personnel as Task Force members.
   (c) Facilitate progressive institutionalization of the mechanization extension concept and methodology in the program and organization of the MOA Agricultural Extension Department.

Task Force Strategy

The proposed Task Force is considered the best interim means of providing the specialized expertise to help solve the machinery management problems that restrict Egypt's agricultural productivity. The task force envisaged would be a semi-autonomous unit functioning interdepartmentally between the Undersecretariat for Engineering and Farm Mechanization and the MOA Agricultural Extension Department. It would be problem-solving in character and highly mobile to cope with priority problems wherever and whenever they arise.

The Task Force would be "joint" in organization and staffing in order to combine Egyptian specialists' intimate knowledge of local agricultural conditions and American experience with farm machinery management extension methods and programs in a concerted effort. It would be "interim" (five years) in design because machinery management should in time become an integral part of the Agricultural Extension Department's regular program and staffing. That recently-reorganized Department is not yet ready to give machinery management the impetus that the investment in farm equipment warrants.

Organization and Staffing

Administratively attached to the Agricultural Extension Department, the Joint Task Force would be an operationally autonomous unit with its own budget and staffing. It would look mainly to the Undersecretariat for Engineering and Farm Mechanization for technical guidance and the Extension Department for guidance on ways of bringing its program to farmers and other relevant audiences. It would also maintain close liaison with the university research establishment and draw heavily upon experience of the IBRD-assisted pilot projects in Minufiya and Sohag. The Joint Task Force would work closely with the evaluation unit to be set up in the Extension Department in connection with the pilot projects

and the Planning and Evalulation staff of the Undersecretariat for Engineering and Farm Mechanization proposed in another section of this report.

Organizationally, the Joint Task Force would comprise Egyptian-American "teams" representing expertise in various aspects of machinery management and would function as an integrated group in identifying and attacking specific problems. One team would concentrate on the sakia-replacement effort described in another part of this report. A second would work mainly with small farm equipment manufacturers to help them understand better how to meet and enlarge the market for their products. A particular focus for this team's efforts would be on product quality improvement and standardization. The other five sub-units of the Joint Task Force would have multi-purpose missions and comprise paired Egyptian and American specialists in:

a. Agricultural engineering, concentrating on field machinery.

b. Agricultural engineering, with particular emphasis on irrigation, land leveling and drainage equipment, hence deeply involved with the subsoiling/landleveling subproject outlined in a preceding section.

c. Agronomy, with an orientation toward field crops and soils as they relate to mechanization.

d. Farm management, combining expertise in farm cost-and-returns analysis and credit.

e. Extension methods, relating to bringing machinery management information effectively to farmers and others concerned.

Qualifications for the American specialists are outlined in the Technical Assistance Advisory Group (TAAG) Chapter. As noted, qualifications of the Egyptian members of the Joint Task Force should approximate those of their American teammates. A high level of skilled personnel is recommended since the value of the Task Force's output inevitably will depend on the quality of its staff. Not only should the American and Egyptian staff be well qualified,

but all personnel should be freed of all other responsibilities during their Task Force assignments.

A major reason for proposing the task force approach is to facilitate MOA's recruiting to Joint Task Force duties the best qualified Egyptian professionals available from wherever they may be found, whether in government, the Universities or private industry. Toward this end the Study Team urges that MOA take fullest feasible advantage of the incentive-pay policy already in effect.

Local costs

Although administratively attached to the MOA Extension Department, the Joint Task Force would function interdepartmentally. To minimize financial constraints, the Study Team recommends that the AID grant cover full local costs of Task Force operations on the step-down principle proposed in the Chapter on the TAAG. Following that formula, the AID grant would cover all local costs the first two years of operation, 70 percent the third year, 50 percent the fourth year and 20 percent in the fifth and final year. Budgeting for Task Force functions would be built into the regular Extension Department organization program by the time American participation is completed.

Budget

Estimated personnel and other costs for the proposed 5-year operation of the Joint Task Force are detailed in the following table.

Estimated Costs

Machinery Management Subproject*

Item	5-Year Total
Personnel	
6 Egyptian Task Force Members	$ 149,000
6 American Task Force Members	4,320,000
Secretarial and Clerical	
1 secretary (Egyptian)	20,600
2 typists	20,200
4 clerks	20,600
Office equipment and supplies	14,800
Local transport (normally by Team vehicles)	
Per diem	
6 Egyptian Task Force Members	104,400
6 American Task Force Members (covered in "Personnel" above)	
Project Support	
6 pick-up trucks	51,000
spare parts	5,100
Vehicle Maintenance & repair	18,000
Fuel, oil and lubricants	14,400
Gooseneck implement trailer	6,000
Cameras, projectors & screens (6 sets)	7,000
Other audio-visual equipment	2,000
Film and other audio-visual supplies	1,000
Total	4,754,100
20% contingency	950,800
Grand Total	$ 5,704,900

* Excludes sakia-replacement subunit shown separately

Note: 5-year total includes full funding of local costs. For the effect of applying the proposed step-down principle see Chapter on Technical Assistance Advisory Group.

CHAPTER XIV

SERVICE FACILITIES FOR AGRICULTURAL MACHINERY

Background

All tractors are imported into Egypt. NASCO, a public sector plant located at Helwan, has assembled approximately 17,000 tractors. Spare parts for these tractors are imported by NASCO.

NASCO, which has sales offices in downtown Cairo, sells these tractors through one of several distributors or directly to farmers. Some of the major distributors are: Tractor Engineering (public sector), General Company (public sector) and Saad Aguizy (private sector). Persons buying a tractor direct from NASCO, buy it at the Cairo office and then take the necessary papers to the assembly plant at Helwan to collect the tractor purchased. The warranty is provided by the importing agent representing the manufacturer through a contract with NASCO. For Massey Ferguson tractors this agent is Saad Aguizy.

With respect to prices, those of Massey Ferguson for the Model 265 tractor, are fixed, whereas NASCO, which sells the tractors directly to buyers for LE 5,750, discounts the price of the tractors to distributors. The range of these discounts is as follows:

No. of tractors purchased	Discount per tractor
1 - 20	50 LE
21 - 50	100 LE
51 - 100	150 LE
101 or more	200 LE

The contract with Saad Aguizy provides that the distributor receive LE 50 per tractor on the Massey Ferguson 265 for warranty service on new machines, approximately 0.9% of the tractor selling price. The parent company provides needed replacement parts, and the distributor or local agency furnishes labor, travel and related items.

NASCO imported 2400 MF 265 tractors through an AID financed contract in 1977. Approximately 25% of these have been sold. NASCO has reported 3800 unsold tractors at the plant. This includes the AID financed MF 265 tractors and a number of Romanian and Yugoslavian tractors as well. Other companies both in the public and private sector also import tractors and act as dealers. Some of the same companies also act as distributors for tractors assembled at NASCO and have one or more workshops that can perform major overhauls. Some also have stations in outlying areas that represent the importer, carry a limited supply of spare parts and can repair or make arrangements for repair with local private repair shops.

Tractor Engineering, General Company, Tanta Motors and others, in both the public and private sectors, import tractors and essentially act as dealers for them in Egypt. Most have one or more major workshops that are reasonably well equipped and can perform major overhauls. Some of these have stations in outlying areas that represent the importer. Tractor Engineering, for example, is a public sector company that imports International Harvester tractors and acts as both distributor and dealer. It has large workshops able to repair tractors in both Cairo and Alexandria. It also has about 20 branches that have a limited supply of spare parts for sale and the capability to repair tractors.

General Company is a public sector company with a substantial workshop in Cairo to service Eastern Bloc tractors. Although it carries a large supply of spare parts, most do not fit current models. Mechanics search private shops for "will fit" parts and often several days or more are required to fi a part. The shop repairs approximately 100 tractors per year. For Russian tractors alone this represents less than 30 percent of the expected number of overhauls. Survey results reported elsewhere in this report show approximately 10 percent of the tractors owned by cooperatives and private individuals are inoperable.

Tractor distributors normally sell most of their tractors in the headquarters office of the distributor, although tractors can be purchased through some branch offices. However, most buyers apparently prefer to deal with the headquarters office. Distributor's spare parts sales offices and workshops are frequently not at the headquarters office, but instead at separate sites. Tractor sales are also completed through banks and cooperatives. Presale checkups, operation, care and maintenance information, and after-sale service are either provided by importer-dealers or not at all.

Local manufacturers of agricultural implements typically do not maintain a spare parts inventory. Implements are relatively simple in construction and spare parts are manufactured as needed. Some parts, such as chisel points which wear and require replacing on a regular basis, are manufactured in some larger plants and local shops but usually on a demand basis. Buyers of agricultural implements normally buy the implements directly from the factory.

When repairs are needed, either a local repair shop or the original manufacturer is contacted. Much of the repair work is done by private

mechanics who have learned by trial and error rather than through formalized training by equipment manufacturers. Many of these mechanics are quite good, but are limited in their ability to handle specialized problems, work shop facilities, testing equipment and in procurement of spare parts.

In summary, manufacturers and importers operate through central sales offices and a few large repair facilities. From the above description, it is clear they lack local outlets for parts or service. The extent of the problem, resulting from the paucity of local servicing facilities in the context of the number of tractor and repair needs in Egypt, is examined next.

Local Machinery Repair Situation

In general, it may be said that lack of local repair facilities and a chronic shortage of spare parts takes a heavy toll of Egypt's farm tractor stock potential. The machinery inventory survey carried out as part of the present study obtained detailed information on the condition, age, make, annual usage and various other characteristics of 5,800 individual tractors in 1,584 Egyptian villages. Survey results indicated that seven percent of all farm tractors were completely inoperable. To be sure many of the inoperable units were at least 10 years old. In contrast, however about two percent were in the 1-6 year age range. By Egyptian standards the fact that a tractor is older does not necessarily imply it is ready for the junk yard. This is indicated by the fact that roughly one fourth of the machines reported to be in good or fair condition also were past 10 years of age and reportedly turned out a respectable number of hours of work during 1977. In fact, a surprising number of privately owned older units were in their 20's

and 30's and still going strong.

Applying the survey percentages to Egypt's total farm tractor stock of some 25,000 units, an estimated 500 tractors less than 15 years of age are inoperable, due presumably or primarily to lack of spare parts and/or to the fact that repair facilities capable of putting them in working order are simply too far away. These units represent roughly 425,000 hours of potential tractor power annually, which, if replaced by new machines, would require an investment of LE 2.5 million or more at current prices. Of course, the actua loss to the Egyptian economy and owners of the inoperable tractors is not nearly so high as this figure implies. Repairs are by no means costless even if available and new machines would last longer than those now in need of repair. Nonetheless, the tractor hours lost each year due to temporary down time or because machines have gone completely out of service, represent a significant loss to the economy. The loss takes the form of reduced crop production due to late planting, lower yields due to poorer tillage than otherwise would be possible and other undesirable effects - not to mention losses to tractor owners from having their equipment out of service for extended periods.

It must be noted that the number of inoperable tractors alone does not tell the whole story. While systematic data are not available on "temporary" down time due to lack of spare parts and/or the distance to repair facilities, field contacts by Study Team members suggest the aggregate of lost tractor usage each year is staggering. Farmer reports of waiting 3-6 months for spare parts are by no means uncommon. Needless to say, while a tractor owner is looking for parts he is not doing his other farm work. Even the cooperative system, which maintains its own spare parts inventory and supply facil-

ities, experiences delays in repairing co-op owned machines equal to those faced by private tractor owners. Much, but not all, of the difficulty appears to lie in the cumbersome and time-consuming procedures required of the village co-op manager to get parts. Simplifying those procedures would help. However, this alone would not remedy the larger problem, namely that of bringing repair services closer physically to the co-ops where the inoperable tractor is located.

Another dimension of the repair services/spare parts problem is seen in the large number of tractors reported as only in "fair" condition. That so many younger machines are in this category suggests poor maintenance. This no doubt reflects in part the owner's lack of appreciation of the importance of preventive maintenance. Lack of convenient access to service facilities and the difficulty of finding even such simple items as oil filters contribute to the problem.

With respect to other farm machinery, the repair/spare parts situation apparently is not nearly so critical as it is for tractors. Except for a comparatively few diesel and electric powered pump sets and some sprayers, tractors are the only motorized machines currently found on Egyptian farms. Sakias, plows, sprayers, and even the water pumps used with imported engines are fairly simple in construction and are locally manufactured. Additionally, farmers know how to repair these implements themselves; village blacksmiths can make parts or even entire pieces of equipment; and, if necessary, the manufacturer can be reached in a few days. At worst, complete replacement of these types of farm machinery if they become totally inoperable does not require major investment.

That service facilities are so inadequately able to provide for self-evident needs is attributable in no small part to lack of initiative on the part of machinery dealers. Even though it has tried, NASCO, long the predominant supplier of farm tractors in Egypt, does not have an effective dealership system in place. Their mainly private outlet dealers, like Egyptian dealers in general, prefer to keep their offices in the major cities and let customers come to them. This practice stemmed no doubt from several years of a strong sellers market when relatively few tractors were imported. When the Open Door Policy of 1973 freed the importation of tractors and many individuals suddenly became "dealers", there developed no spirit of dealer outreach and service to local communities. Still today with in-country tractor supplies pressing hard upon the market, a farmer from Upper Egypt who wants to buy a tractor has to journey to Cairo and make his purchase in a dealer's office. For all practical purposes this is a catalogue store, not a place where equipment can be inspected or operated. Needless to say, this view of proper dealer/customer relations does little for either the accessibility or quality of after-sales services.

While the parts/service problem today relates mainly to tractors, it will grow in both volume and complexity as farm mechanization in Egypt becomes increasingly sophisticated. Water lifting will become more motorized. Self-powered thresher-winnowers will replace tractor powered drum threshers and release tractors for field work. New-type threshers will require more attention by skilled mechanics than do the drum thresher and hand-turned winnowers now in use. These and other technological advances will perforce increase farmers' dependence upon repair, service and spare parts supply

facilities outside their own villages.

Discouraging as the repair/parts picture is today, there are some bright spots. Plans have been developed in several quarters for coping with the problem, and some remedial action has been started. Thus, the climate is unusually favorable for directed action to bring competent repair facilities and an assured supply of spare parts within convenient reach of tractor owners. And the plans themselves, though largely paper at present, provide a valuable body of informed Egyptian judgement on which to build a remedial strategy.

Bringing repair, maintenance and dealer services much closer to local communities than they are today is a central focus of Egyptian planning and action. In this area the MOA plan, still in the incubation stage, visualizes a network of privately owned and operated service-dealer facilities with Ministry monitoring to assure that farmers get dependable service and can find spare parts when they need them. As a stop-gap, the Ministry also pools procurement of major spare part items on behalf of the cooperatives, private dealers and the two quasi-private corporations that are extensively engaged in the farm machinery business. NASCO has for some time operated a system of small mobile teams to work their own dealers in providing after-sales service during the tractor warranty period. They also maintain a stock of spare parts for the types of tractors they assemble. These are available through dealers to purchasers of NASCO tractors. Massey-Ferguson has tried the mobile-van repair service approach on a limited scale and has evolved a plan much like the Ministry's for area dealer-service centers in connection with the prospective MF-NASCO private sector joint venture for manufacturing tractors in Egypt.

Although differing in detail, all the plans and trial approaches the Study Team encountered shared two basic objectives: (1) to make competent repair and maintenance services easily accessible to equipment owners and (2) to provide for private ownership and operation of repair facilities. The latter is established government policy in keeping with the more generally applied Open Door Policy. It also reflects the conviction of MOA farm mechanization leadership that only through private initiative will Egypt develop an efficient network of farm machinery repair and maintenance facilities.

Recommendations

Given the preceding complex of considerations, a three part AID-assistance strategy is recommended which in the main would serve to energize MOA and private sector plans already in the making. In general:

--Create an Incentive-loan Fund to encourage private and semi-private entrepreneurs to develop a network of competent service centers throughout Egypt with outreach to local communities through arrangements with local repair/maintenance facilities.

--Provide expert assistance in getting the presently inoperable tractors back into use either as rehabilitated units or as spare parts for other machines. Beyond its immediate purpose, this phase of the strategy would contribute directly to facilitating development of the proposed service center system.

--Assist the Engineering Department of the MOA Undersecretariat for Engineering and Farm Mechanization to develop,(a) performance standards for farm machinery service facilities/dealerships to insure

farmer-users of reliable repair services and easy access to spare parts and (b) the Department's capability to monitor the performance of service/dealer facilities without intervening in the operation of the facilities themselves. As this Department would also have responsibility for the tractor rehabilitation activity discussed above, the same technical assistance advisors would serve both functions.

More detail on these and related program elements are discussed in the following sections.

Incentive Loan Fund

Purpose: An incentive-Loan fund would make loans on an attractive basis to encourage qualified private or quasi-private operators to develop the capability to promptly and reliably service farm machinery and supply spare parts as needed to equipment owners and small repair shops serving rural communities.

Amount: An AID grant of $5,000,000 is proposed for establishing the Fund. This would cover (1) the estimated financing required for establishing 20 Area Centers (average $145-150,000) by building new facilities or upgrading existing ones, (2) assist about 50 local repair shops (average about $30,000 each) to upgrade their facilities to acceptable standards, (3) cover the costs of Fund administration and (4) leave a small margin for contingencies such as increasing the density of upgraded local shops where experience demonstrates their need.

Duration: Resources of the Incentive-Loan Fund would remain available until exhausted, but not to exceed 10 years. It is anticipated that the

Fund will be largely loaned out during the first 2-3 years. Allowing any balances to remain available after the requirements for Area Centers and their principal satellite shops were met would permit increasing the density of local shops somewhat in areas of particular need.

Eligibility: An applicant's eligibility for a loan would depend upon which of the two categories of service facility development he proposed to undertake:

1. Applicants considered eligible for loans for financing the establishment of an Area Service Center normally would be private or quasi-private companies already licensed as farm machinery service operators and/or dealers at locations where such Centers optimally should be sited. Loans also would be made, however, to applicants desiring to enter the service/dealer field if they had demonstrated the necessary technical and managerial abilities in other types of endeavour. Where there is choice between equally well-qualified applicants preference would be given to private over quasi-proviate operation and to a resident of the community concerned over a non-resident company. In particular it is not intended that this Fund be used to enable a single large firm to turn the Area Centers into a chain of machinery dealerships.

2. Only private individuals now operating successfully small-shop repair facilities would be considered eligible for Fund loans for upgrading local farm machinery repair shops. In addition to the preference and qualification criteria outlined above, location of the proposed facility vis-a-vis an Area Center and the size, composition, etc. of the shop's prospective service area would be prime considerations. Willingness and ability to establish working arrangements with the nearest Area Center for supplying spare parts would be mandatory.

Technical Capability Certification: Certification by the Minister of Agriculture of an applicant's eligibility from the standpoint of technical and managerial qualifications would be a necessary prerequisite to granting a loan to any prospective borrower. Such certification would be based upon prior site inspection and review of the applicant's proposed development plans by that department of the Undersecretariat for Engineering and Farm Mechanization responsible for setting standards and monitoring the perfor-

mance by repair/service facilities assisted by Fund loans. In these pre-qualification reviews, the prime focus would be upon assessing the interest and capability of an applicant to develop and manage the kind of service center that will meet the objectives of establishing the Fund. Particular consideration would also be given to the applicant's proposed approach to establishing effective Area Center/satellite arrangements.

Uses of Loan Proceeds: Area Center borrowers from the Fund would be permitted to use loan proceeds for any reasonable purpose they deem necessary to developing a high quality farm machinery service business such as: shop equipment, hand tools, spare parts inventory sufficient to serve as a wholesale and retail outlet for the area to be served, remodeling and expanding physical facilities, purchase of land as an operations site, new construction for reasonable spare parts and repair shop needs, and operating expenses during the first three years. Loans to small-shop operators also would be made for the above purposes with the exception of wholesale spare parts supply. Ordinarily, there would be no need to include purchase of land or building construction unless the business were being relocated or minor construction were necessary to provide better service to farmers. Loans would not be made to refinance debts of the applicants.

A "line of credit" would be authorized for Area Center operators to cover possible first and second year needs to add shop equipment inventory and other items not foreseen in the original loan planning.

Loan Terms: Terms would be concessional to encourage entrepreneurs to undertake an essentially new kind of business which might show little profit in the beginning. Also, Area Center borrowers would be epxected to help local shops upgrade their services and local parts fabricators to improve

the quality of their products. Specific contributions by these Centers to furthering the national mechanization effort would include providing special training for local repair shop mechanics at cost, counselling with spare parts fabricators to encourage them to produce all spare parts to high quality standards, providing periodic machinery use and maintenance demonstrations and performing other public activities to help maintain a high level of interest in machinery management. For their part, borrowers for local shop upgrading would be expected to accept apprenticeship trainees whenever possible and to send some of their employees for training at the Area Center with which they are associated.* Although it is not contemplated that specific activities of these types would be written into borrower agreements, applicants' attitudes toward undertaking such extracurricular responsibilities would be assessed in the course of pre-loan discussions and would play a part in loan decisions. Developing a mutual understanding of how this part of the service improvement program would be handled in each respective case, would be one of the prime purposes of the pre-qualification team's site visit. Needless to say, evaluating performance on this front and counseling with operators on future activities would be an important part of such a team's follow-up inspection.

Loans would be written to cover a 13-year period. Terms would include forgiveness of interest and deferrment of principal payments during the first three years. Starting with year four interest would be charged at a rate reflecting the cost of money to the Fund. Assuming the AID funds are made available to ARE as a grant - as seems appropriate for the type of activity involved - the "cost of money" principle would result in an interest charge

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* Also see Chapter XVIII on Apprenticeship Training.

to Fund borrowers of around seven percent. This assumes the usual Central Bank charge of two percent and that the cost of Fund administration, including collection of both principal repayments and interest, would be in the order of five percent. Payments on principal and interest would be made monthly until the loan is repaid. Prepayment would be permitted at any time.

Borrowers would be required to make an initial investment of at least ten percent of the loan requested in either cash or assets directly used in the operation of the service facility for which the loan is sought. This poli would help screen out any who might otherwise simply come along for the ride, yet should not be burdensome to serious applicants. All local-shop applicants and no doubt a preponderance of those seeking Area Center loans would, though other candidates would not be ruled out, already be engaged in the farm machinery servicing business, hence able to meet the pre-loan requirement without additional investment. A "line of credit" would be included with the original loan to be used if necessary to add to the spare parts inventory or to cover operating costs that might develop in the early stages of the operation. This credit would be authorized to cover operating deficits, providing evidence indicates the operation to be improving financially and efficiently, the spare parts inventory is maintained, and management salaries and cash "take out" are with approved limits.

Another loan condition that might be considered is to permit Area Service Centers to extend credit for spare parts to small local shops on open accounts up to a maximum of 30 days. If necessary in order to get service facilities started in low volume areas, the Fund Administrator would be authorized to waive the ten percent cash or asset requirement or make other adjustments in loan terms within limits set by Fund operating policies.

Complete annual audits would be required including inventory and finance matters as well as compliance with the terms of the loan agreement.

Administration: The Fund would be administered by a qualified banking institution, such as the Development Industrial Bank, Bank Misr (The Bank of Egypt) or the Nasr Social Bank. From the Study Team's observations, the Bank Misr appears best equipped to handle this Fund. It has an agricultural department which on surface inspection appears capable of performing the necessary functions. (For obvious reasons there have been no discussions with Misr Bank nor any of the others mentioned with respect to willingness to serve as Fund Administrator, fees or other specifics which would be explored in the process of deciding which financial institution to select to administer the Fund.)

The bank administering the Fund would receive fees negotiated before finally selecting it as Administrator. One reasonable approach would be to pay the administering bank a set percentage on each loan made and allow it to keep a percentage of all interest collected. This would keep the fee arrangement within the framework of normal banking practice. More importantly it would give the Administrator an incentive to get the Fund resources into use promptly and to take initiative in seeing that interest payments are made when due. Authority should be given for the bank to place reserve holdings in interest bearing accounts or in sound short term investments. It would not, however, be permitted to make money on the Fund for itself. Any earnings from interest on outside investments would become part of the Fund capital. To ensure that use of assets be directed specifically toward achieving the original objectives, policies set for operations would make clear that the Administrator's mission be to make loans to farm machinery service operators,

not to make money on other types of investments. Additionally,

1. Loan repayments and net receipts from borrower interest payments will be channeled into Egypt's agricultural mechanization research and extension programs under arrangements mutually agreed to by MOA and USAID at the time such resources start becoming available.

2. The Fund would not be co-mingled with the bank's own resources. This would keep the Fund intact with debits and credits to it that pertain only to the Fund, thereby minimizing the possibility of improper use and providing the basis for more accurate accounting.

Center Network

As indicated by the preceding discussion of the proposed Incentive-Loan Fund, the complex of repair-maintenance-dealer envisaged would form a network of major Area Centers and local shops destined to bring essential services within easy reach of farm machinery operators throughout Egypt. All told, it is anticipated there would be 20 Area Centers - counting those in Minufiya and Sohag Governorates expected to be developed through the IBRD-assisted pilot project.

These Centers would themselves: provide services directly to farmers, co-ops and others in their immediate vicinities, be available to more distant machinery operators in their respective territories who require repairs more sophisticated than local shops can service, stock spare parts for sale to local shops or others as needed and function as equipment dealers to their entire territories. In addition, each Area Center would have specific "satellite" arrangements with a number of local shops strategically located throughout its area. This arrangement would help insure that reliable services were conveniently available to all farm machinery owners throughout the country. Details of the network system and a financial analysis of prospective Area Center operations appear in a later section of this chapter.

Location: Service Centers should be located in areas where they are readily accessible to tractor owners throughout Egypt. In Upper Egypt, centers should be located in natural trade centers with distance between centers dictated by convenience for tractor owners, present tractor and implement populations and areas of potential tractor and implement growth.

In Lower Egypt, centers should be located in normal trade centers. It is anticipated there will be overlapping territories with the density of the Centers related more toward machinery population than distance.

Service Centers

Suggested Locations

Kom Ombo	Eliaiyat
Armant	Zagazig
El Minya	Salmib
Fayum	Sherbin
Beni Suef	Asyut
Damanhur	Ismailia
Kafr-El-Sheikh	Cairo*
Tanta	Alexandria*
Mansoura	Sohag**
Faqus	Shibn el Kom**

Physical Arrangement and Staffing: Each Center should have:

1. Storage for spare parts. All parts should be in organized storage, catalogued, with a current inventory listing.

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* Present centers for spare parts distribution. Repair shops available but upgrading needed.

** World Bank Project expected to develop facilities at these locations.

2. Spare parts counter should be manned by trained competent parts salesperson.

3. There should be a display area for selected spare parts and machine attachments.

4. The workshop area should have specialized areas or stalls for specific operations and/or makes. The original workshop area should include at least four specific working areas with space and plans for expansion.

5. There should be an area in the workshop area for records. This should include a desk or small bookkeeping area.

6. There should be an inside display area for one or more tractors or implements.

7. There should be offices for the owner-manager, for secretaries, areas for filing, and a conference room or conference area for discussion with farmers.

8. There should be an outside display area for new and used tractors and implements.

9. There should be adequate space for expansion. A two thousand square meter area or larger is recommended.

10. The Center should develop and implement a plan to maintain a staff of competent mechanics and spare parts specialists. Evidence of an acceptable program might include:

    a. Employing persons with formal training and/or experience.

    b. Employing formal military personnel who have received training or experience in mechanization while in the service.

    c. Employing secondary agricultural school graduates and adding on-the-job practical training to their formal training.

    d. Maintaining an on-going program to improve the competency of employees on a continuing basis. This could include on-site formalized training or arranging with machinery manufacturers for employee to attend specialized schools.

Operating Guidelines

Spare Parts: The center should have a warehouse or storage area with a stock control system that assures an 85% off-the-shelf availability. A

competent, efficient staff that would maintain the stock control system and provide immediate service for persons or firms requesting spare parts. To assure an adequate inventory of spare parts, the Center would take the following action:

1. With the aid of the MOA Undersecretariat for Engineering and Farm Machines and the Service Technical Assistance Advisors, determine the inventory of tractors and other agriculture machinery in the area, evaluating both machine numbers and condition. Using this information, the Center would estimate spare parts needs as a basis for the spare parts inventory.

2. Contract with importers and in-country manufacturers to maintain a parts supply in the Center. It is assumed the MOA would adopt and and firmly follow a policy of allowing only those firms that are serious contenders for the Egyptian agricultural machinery market to import tractors or other machinery. This would, in effect, force all importers to either sign contracts with the Centers or develop other service-dealer networks.

3. With the assistance of the MOA Undersecretariat for Engineering and Farm Machines and the Technical Assistance Service Advisors, investigate all possible sources of spare parts including original equipment manufacturers, manufacturers specializing in producing "will fit" parts, junked tractors or persons specializing in the sale of used parts and distributors or dealers specializing in the sale of spare parts. Also, the Centers would have for their use a list of all spare parts in storage or warehouses in Egypt prepared and kept current by the MOA Undersecretariat for Engineering and Farm Machines.

4. Work through the MOA Undersecretariat for Engineering and Farm Machines to purchase confirmed orders of spare parts to obtain volume discounts and obtain other assistance in obtaining spare parts and maintaining an adequate inventory.

5. Offer spare parts individually as requested by tractor owners. Spare parts would also be available to small sales and/or repair shops in the area on a wholesale basis for resale.

Workshop

The workshop should be equipped for complete overhauls of tractors and other agricultural equipment, including irrigation pumps and engines. The workshop should be equipped with a PTO dynomometer to check tractor engine performance.

It is assumed small private workshops in the area would look to the Center for specialized work. The Center would negotiate with NASCO to provide before delivery checks, advisory assistance in operation and maintenance, new machine warranty service and spare parts or repair work needed on the machine.

Centers would be encouraged to contract with local co-ops to provide the same services to any owner of a tractor purchased through this source. The Centers would be encouraged to contract with local cooperatives to repair all tractors now inoperable or salvage tractors beyond repair for spare parts. They would also make contracts or agreements to provide maintenance and repair services to the co-ops.

Distribution or Sales

The Center should become a complete mechanization center either offering any needed service or assisting tractor owners or potential tractor owners to obtain that service. Through agreements with tractor distributors it should offer for sale at least three but not more than five tractor makes. The tractors should be on display at the Center where there should be full authority to complete sales of machines. The Centers should provide full service: before delivery checks, advise on operations and maintenance, new machine warranty service, a complete supply of spare parts and a well-equipped shop with mechanics trained to repair specific makes of machines.

As a matter of policy, the Centers should not become franchised dealers for one machinery company excluding all others. They should also make agreements with implement manufacturers to offer the same complete service for implements as for tractors.

Mechanization Related Sales and Other Activities

1. Centers should sell various farm supplies related to mechanization.
2. Agriculture fuel sales stations ideally should be located near the Center but preferably should not be under the same management.

Small Service Shop Development

Numerous small shops are currently struggling to service the agricultural machinery industry. It is in the interest of the Service Center network to include these shops in the facilities offered to the areas and to offer loans and advice on upgrading them.

Persons now operating small shops would be encouraged to upgrade their facilities and to utilize the major Centers for local supply of spare parts and for work requiring specialized equipment.

After they are developed, the major Centers would provide training and Advisory services to smaller shops as part of their concessional agreement.

Major Centers would be well equipped to completely overhaul tractors and alter agricultural machines. They would also have a supply of spare parts for both wholesale and retail sales.

Beneficiaries

Ultimately, the beneficiaries of improved farm machinery maintenance will be the Egyptian public. Keeping tractors and other equipment in operation implies greater farm production and reduced imports of machinery to meet agricultural needs. The immediate beneficiaries would, of course, be the farmers and cooperatives who have machinery in need of repair and/or spare parts and the small local shop operators who now have a difficult time finding spare parts to keep their repair businesses going. Also benefitting directly would be farmers who want to buy tractors or other equipment from a local

dealer where they can see the machine before buying and have reliable after-sale service conveniently at hand. By no means are all tractor owners big farmers. According to the Farm Machinery Inventory Survey carried out as part of the present study, owners of one-third of all privately owned tractors ha land holdings of less than five feddans; nearly half have holdings of less than 10 feddans. For several years prior to 1977, farm size was used by Government as the criterion for rationing scarce tractor imports. The sizeable number of 1-3 year old machines owned by farmers with less than five feddans of cultivated land suggests that many relatively small farmers are now getting into the custom-hire business. They would, of course, benefit directly from improved repair and maintenance facilities as much if not more than the operators of larger farms who use their tractors more extensively on their own holdings.

Although derived second hand, the principal benefits of this proposed subproject would go to the users of custom tractor equipment. Currently, less than one-fifth of all tractor hours used for plowing and threshing, which make up the bulk of farm tractor usage, go to the machine owners' own farming operations. Surprisingly, about the same proportion of very small farms now use custom tractor service as do larger ones. Farms of less than two feddans today make up at least half of all Egypt's roughly 3 million farm operating units, those of less than 3 feddans about two-thirds. Thus, numerically the principal beneficiaries of improved farm machinery repair and maintenance facilities would be small farmers who would have a more dependable supply of custom tractor service, hence could get their farm work done in a much more timely fashion.

Tractor Rehabilitation

Of all tractors in the hands of private owners and cooperatives,

nearly one out of 10 is inoperable. More than 20 percent of all those owned by co-ops are in that condition. And according to an MOA report the figure for State Farms developing the New Lands is even higher: 55 percent. All told, this means that a total of 5,000 tractors currently are out of service for one reason or another. An operational plan for getting these tractors back into use either as rehabilitated units or as parts for other machines is presented later in this chapter. In addition to its direct benefits, the rehabilitation effort would contribute significantly toward helping the Area Center-satellite local shop aspect of this overall subproject get off to a fast and financially sound start.

To facilitate the tractor rehabilitation process, it is proposed that AID provide two Technical Assistance (TA) Advisors, each to work for two years with the Engineering Department. They would function as members of two-man Egyptian-American teams which would carry out the actual field work involved in the tractor rehabilitation program. The Engineering Department now has general responsibilities for farm machinery maintenance throughout Egypt and discussions with the Undersecretary confirm that this Department would be made responsible for the tractor rehabilitation program. While teams would function as a joint task force it is not proposed that in this instance they be constituted as set teams for the duration of the tractor rehabilitation activity. Rather, it is visualized that different members of the Engineering Department would rotate as team members to provide opportunity for more individuals to profit from the experience afforded by the field work and the participation with the American Advisors. The same two TA Advisors would service both the tractor rehabilitation and "Standards" components of this subproject.

Performance Standards and Monitoring

To insure that farm machinery repair and maintenance facilities throughout the country provide reliable services and spare parts when they are needed, it is essential that Government set standards of acceptability to guide them and effectively monitor their performance as a guide to such remedial action as individual situations may require. Neither standards nor an effective monitoring system exist today. Consequently, it is recommended that AID:

1. Provide technical assistance to the MOA Engineering Department, which already has general responsibilities in this area, to help that Department develop performance standards and develop the capability to carry out an effective monitoring/counselling program to help Area Center and local shop Incentive-Loan Fund recipients to maintain an acceptable quality of services to their communities. The Engineering Department staff would explicitly refrain from intervening in Center or local-shop operators' business. Their role would be fact-finding and counselling, not supervision. If remedial action were called for beyond professional coun selling which the monitors themselves could provide, it would be taken by means other than intervention by those monitors.

   It is anticipated that in due course the MOA monitoring system would extend beyond Incentive-Loan Fund participants as a means of upgrading farm machinery repair and maintenance facilities in general. Such expansion might be several years away, however, as the Engineering Department would need the experience of working extensively with Fund participants before undertaking the much larger and more difficult task of bringing local shops in general up to an acceptable quality of performance.

   As indicated previously, the two Technical Assistance Advisors proposed for assisting the standards preparation/performance monitoring

aspects of the Engineering Department's overall activities also would participate with members of the Engineering Department staff in carrying out the tractor rehabilitation program. This dual approach should strengthen both activities. When participating in the monitoring of Center and local-shop performance, the American Advisors would play a strictly advisory role vis-a-vis both the Engineering Department staff conducting site inspections and the operators of the facilities being inspected. Especially in the early stages, the primary purpose of such participation would be to develop an understanding of kinds of performance standards best suited to the Egyptian environment.

2. Include in the financing arrangement for the entire facility-improvement subproject that the Fund contain at least a covenant -- preferably a condition precedent -- so worded as to give reasonable assurance of prompt and effective Ministry action on the standards setting and performance monitoring activities before any AID funds are released for service facility improvement. Without these collateral capabilities developed, and judiciously yet effectively applied, creating the Incentive-Loan Fund could result in little more than adding to the number of repair/service facilities offering services to rural communities in the same inadequate manner as before.

Technical Assistance Input

The two American Advisors alluded to above constitute the only direct TA proposed for the entire Service Center Development subproject. In addition, some of the participants proposed in the Participant Training section of the overall Study Team report should come from the Engineering Department staff or be selected with a particular view toward their joining that Department upon completion of their

AID-financed training. Also, some part of the TAAG Team Leader's time would be devoted to the Service Center activity. However, that cost is shown in toto in t TAAG proposal rather than arbitrarily allocated among component parts.

To insure effective mobility of the American Advisors and their Egyptian tea mates, the Study Team recommends that AID assistance to the Service Center/tracto rehabilitation activity include provision for the purchase, maintenance and opera tion of two pick-up trucks and an initial supply of spare parts. The Engineering Department has several functions other than those proposed for AID participation. Also, that Department is a key part of the Undersecretariat's organization, so fa as farm mechanization is concerned. Consequently, local cost financing appears neither necessary nor appropriate in this particular instance.

Technical Assistance Team Qualifications

The two U.S. personnel who serve on the machinery services team should have the following qualifications:

1. Service technician. BS in agricultural mechanization or equivalent. Experience as service manager or equivalent at distributor level with major farm machinery company.

2. Agriculture engineer. BS in agricultural engineering, agricultural mechanization or Vo.-Ag. Experience in working with machinery. Experience in AID type work in a developing country.

Estimated technical assistance costs for the entire two-year period for whic direct AID participation is proposed are summarized in Table XIV. 1.

TABLE XIV. 1

ESTIMATED OPERATING COSTS
SERVICE CENTERS SUB-PROJECT

Personnel		2-year Total
2 American Advisors		$252,000
Local transport and per diem[1]		--
Project Support		
2 pick-up trucks		17,000
Spare parts		1,700
Maintenance and repair		2,000
Fuel, oil and lubricants		1,600
	Total	$274,300
	20% contingency	54,900
	Grand Total	$329,200

[1] All local travel performed by project vehicles. Per diem for American Advisors is included in overall technician cost per year; that for participating Egyptians covered by regular MOA financing.

Service Center Financial Analysis

Since the proposal for service centers essentially suggests these be privatel owned and operated, a financial analysis was prepared by the Study Team. Capital and operating costs, returns to owners, and bank repayments, are included.

Purchase Costs

It is assumed the costs below and the following costs and return estimates ar to be used as guidelines. Each Center would be considered individually by the lending agency, following recommendation by the MOA Undersecretariat for

Engineering and Farm Mechanization, assisted by the technical assistance team for service and spare parts. The costs follow:

	Dollars	Pounds
Land 2,000 sq. meters or more	$ 14,000	10,000
Roads, landscaping, fences, etc.	2,100	1,500
Tools & Equipment	35,000	25,000
Building	42,000	30,000
Vehicles & Implement Trailers	23,800	17,000
Spare parts inventory	28,000	20,000
	$144,900	103,500

Estimated Operating Costs

	LE/MO.
Labor:	950
1 Shop foreman	
1 Parts manager	
7 Mechanics	
2 Clerks	
2 Demonstrator-Salesmen	
1 Maintenance	
1 Security	
6 Helpers	
Utilities and misc. operating cash:	325
Phone	
Water	
Electricity	
Office supplies	
Advertising	
Building Maintenance supplies	
Vehicles:	50
Monthly cost for operating and owning service vehicles and one implement trailer	
Shop equipment replacement	100
Employee training expenses	150
Interest:	
Shop equipment	220
Spare parts	175
Land and buildings	350
Total monthly cost	3,020

Returns to Center Owners

	LE/MO.
Spare part sale:	
Wholesale: 60% for resale (cost plus 10%)	150
Retail: 40% (50% selling margin)	1,000
Labor returns:	
No estimated return	
Labor charges to reflect labor costs	0
Machinery sales:	
80 tractors per year equivalent (includes tractor, pump sets, implement, etc.) 9% markup 5750 x 9% less 8,000 LE after sales	
Services, demonstration costs, etc.	2,800
	3,950
Less costs	3,020
Less Manager/Owner salary	750
Return	180

Repayment to Bank

	IN LE
Assume 103,500 investment	
Less down payment	10,350
Loan	93,150
Amortized monthly repayment factor is 0.0135 percent of loan per month for 10.5%, 10 year repayment.	
Concessional terms, first three years forgiven interest and no principal payment.	
Assume payments for interest plus principal to be set up for 10 year repayment.	
Average income after owner/manager salary	
Income above operating cost, monthly	180
Concession on interest for shop, spare parts and building	745
Monthly return	925
First three years total net income	33,300

At End of Three-Year Period

Assume loan is reduced to 60,000 LE (or center business is expanded and a higher income anticipated).
60,000 x 6.0135 = 675 LE/MO.

During the three-year period it is assumed tractor sales would increase about one-third. (Based on predicted trends). Implement and pump set sales are expected also to increase. Assuming the Center sells 50 percent or more of the tractors sold in the area and a corresponding share of spare parts, gross returms should increase one-third or more while operating expense would be expected to increase 15 percent or less putting the Center on a sound business basis.

The costs and returns from the small shops would be highly variable. It is assumed the lending agency would evaluate each situation to assure it would develop into a sound business while serving the needs of the local farmers.

Returns from Service Center

The machinery inventory survey indicated that about 500 tractors presently inoperable could be restored to service. The value of these tractors, based on recent prices, is approximately 2,500,000 LE. Approximately 12,500 are reported in "fair" condition. Some of these are simply inefficient; others have faulty components that either render them unusable or severely restrict their effectiveness for agricultural and related purposes. If the effectiveness of these tractors is reduced by 25 percent the equivalent value of lost horsepower is about LE 15,500,000. Irrigation pump engines, sprayer and sprayer pumps as well as implements are often not in operating condition or are operated at less than full effectiveness.

An aggresive educational program on machinery operation, care and maintenance coupled with a net work of Service Centers could be expected to have a dramatic impact on the effectivesness of agricultural mechanization in Egypt. Estimates of actual returns are difficult and immediate results cannot be expected. It appears, however, that Egypt cannot expect agricultural mechanization to be effective until the majority of the machines are in good operating

condition and are properly operated. If LE 15 million worth of tractors were put back into effective use at a cost of LE 5 million and only a 10 percent return was obtained from this 10 million, the annual return would be LE one million. Additionally, with a national tractor fleet of some 25,000 currently, one can expect that a substantial quantity of repair work on an annual basis would be required to maintain it in full, efficient operation.

CHAPTER XV

RESEARCH AND DEVELOPMENT

Situation

Egypt has an abundant supply of graduate students, recent PhDs, and senior scholars in agricultural engineering and related disciplines. Many have been trained abroad at substantial public expense. Despite existence of this skilled manpower pool, there is but a trickle of research which contributes significantly toward furthering progressive farm mechanization because resources for field investigations are lacking. As a result, graduate students typically turn to library research for their dissertations. The same is true for senior researchers at universities and in government who, for want of support, have had to fall into a pattern of repeated paraphrasing of their earlier work or that of others. They rarely have the opportunity to work at pushing back the horizons of knowledge by first-hand practical research.

Little systematic attention is given either by government or university research to development of new types of farm machinery or to modification of prototype imports to meet Egyptian farm conditions. Such efforts as have been initiated by individual researchers in recent years have largely withered and died for lack of financial resources to carry them through to production. For example, modification of the IRRI thresher-wi[illegible], which could significantly reduce both the labor and tractor bind during [illegible] peak summer season, has been under way for four years. Another seemingly practical thresher was developed at Cairo University several years ago but has gone no farther than a prototype

model. Farm machinery manufacturers have displayed little interest in going beyond fabrication of commonly-used implements.

Until quite recently most of the space and facilities of the MOA Tractor Testing Station at Alexandria were occupied by a military unit. Consequently, work at that Station was confined to testing machines proposed for import, mainly tractors. If that orientation were maintained, little could be expected of the Station beyond import testing.

On both the research and development fronts, the primary barriers to more productive service to Egyptian agriculture are lack of funds and lack of systematic focus upon practical problems. Modest financial resources, judiciously applied, coupled with expert advice on shaping research and development efforts to meet priority production needs can greatly increase the volume, quality and relevance of research output from the qualified personnel already at work.

Recommendations

A four-part approach is proposed to mobilize Egypt's largely latent research and development capacity so that it could make significant contributions to farm mechanization.

1. Transform the Tractor Testing Station at Alexandria into a Research and Development Center charged with broad responsibilities to stimulate and coordinate applied farm mechanization research and machinery development nationwide.

2. Establish an Applied Research Fund to encourage and assist problem-oriented research by Egyptian scholars and institutions on priority aspects of farm mechanization, broadly defined to include the social and economic as well as engineering aspects of the subject.

3. Provide a technical assistance advisor on research administration and one on machinery development to help the new Center get an effective program under way quickly.

4. Arrange a modest Egyptian-American collaborative research exchange to give impetus to and an experience base in both countries for applied research on Egyptian farm mechanization.

For several years, leaders of the farm mechanization community in Egypt, the Ford Foundation, the Federal Republic of Germany (FRG) and others have discussed the creation of a multi-purpose Farm Mechanization Institute. The training component of that concept was separated from research and development by a decision in the summer of 1978 to apply the limited FRG funds originally earmarked for the Institute to strengthening mechanization training at Alexandria University rather than spread them thinly over the full range of functions conceived for an Institute.

The approach above builds on the original Institute concept with respect to those elements not covered by the FRG-assisted project at Alexandria University. Use of the facilities of the existing Tractor Testing Station as Center headquarters avoids losing time and the costs of constructing the new buildings visualized for the Institute -- without loss of functional efficiency. In fact, if the proposed Center is not a separate self-contained entity, has an outreach program and works closely with the training program at Alexandria University and the new IBRD-assisted pilot mechanization projects in Minufiya and Sohag Governorates, it should be able to avoid the isolation from corollary activities which so often beset research institutes.

Each aspect of the research and development program is discussed in some detail in the following pages.

A. Research and Development Center

1. Location

As indicated earlier, the Center would be headquartered and housed at the present facilities of the Tractor Testing Station at Alexandria. The present buildings are conveniently located with respect to Alexandria University and the Behera Company for cooperative undertakings. The floor space is adequate since the weather is mild. As the research program develops, a covered outside work area would be desirable. Considerable repair and upgrading would be required to put the facility into operating condition

2. Functions

a. Carry out field and laboratory research to meet priority agricultural production needs for the development of new machines, tillage practices, crop processing and storage facilities and the like. In short, it would be concerned with the development of ways that equipment of any type can be used advantageously on Egyptian farms. This entails both in-house development of new prototypes and modification of imported prototype machinery items. In its machinery development activities, the Center would enlist participation by MOA Agricultural Research Stations throughout Egypt and carry on cooperative research with the Agricultural Engineering and other relevant departments of the Faculties of Agriculture of Alexandria and other universities. By reason of proximity,

the Center could be expected to have especially close liaison with the Alexandria Faculty of Agriculture. For example, the Center logically would serve as a facility for research by Agricultural Engineering graduate students of that faculty; Agricultural Engineering Department faculty might well have joint appointments for research at the Center. The Center also would relate its machinery development planning to experience of the Minufiya-Sohag projects and utilize those areas insofar as feasible for field trials of newly-developed machines.

b. Arrange with the Behera Company and/or other equipment manufacturers for production and market development for proven new prototype machines.

c. Perform the usual services of a machinery testing station, especially field tests of tractors that have undergone laboratory certification and, in addition, run dynamometer tests of tractors as necessary to certify their power take-off output and fuel consumption.

d. Coordinate the planning and conduct of applied mechanization research carried out by individuals and institutions under grants-in-aid from the Applied Research Fund (see Section B below). Administer the Fund itself in accordance with its intended purpose.

e, Coordinate the in-Egypt part of the collaborative Egyptian-American graduate research program (see Section C below).

f. Publish results of the Center's own research in a form suitable for extension use with farmers; ensure similar publication of other research carried out with Fund assistance.

3. Local Staff

The local staff arrangements recommended for this subproject are shown below:

Director

Assistant Director

4 Senior Engineers

6 Assistant Engineers

1 Senior Machinist

1 Instrument Technician

4 Shop Mechanics

1 Shop Custodian

1 Publications Specialist

1 Publications Technician

Each of the four senior engineers would cover a specified field, such as tillage, irrigation and drainage, harvesting, and crop drying and storage.

B. Applied Research Fund

1. Purpose

The central purpose of the Farm Mechanization Research Fund is to mobilize Egypt's largely latent research capacity to support farm mechanization program objectives. More specifically, this Fund would be used to encourage and assist problem-oriented research by

Egyptian scholars and institutions on priority aspects of farm mechanization. Operationally this would be accomplished through grants-in-aid for well-designed project proposals for applied research in predetermined areas. Limited financial assistance from the Fund to selected subjects would focus both research attention and use of resources on areas particularly in need of further research from the standpoint of the mechanization program as a whole. Priorities - hence eligible areas - may well change as the mechanization program progresses. However, such changes in emphasis would not be allowed to abort previously approved projects which have not run their intended course or to become so episodic as to discourage research interest on worthwhile topics that require some time to produce meaningful results.

2. Financing

Initial financing would be by a 5-year AID grant of $1 million. Drawings upon the Fund should become heavy by the second year of operation and the AID grant largely committed to specific research undertakings by the end of the fourth year. As the expanded and focused research effort demonstrates its value, the Study Team anticipates that ARE would make increasing contributions to the Fund. In that way, its annual financing capability will at least maintain the level of research acitivity generated by the AID grant. It is also recommended in another section of this report that interest on and principal repayments of loans made from the Service Center Development Fund be channeled into mechanization research and development. These repayments should be peaking the time

the applied Reserach Fund is fully committed. Given these two sources of financing, there should be no need for AID financing beyond the initial 5-year project period. Either this collaborative research activity establishes itself among Egypt's budgetary priorities during the 5-year period or it should be allowed to go out of existence.

3. Administration

Primary responsibility for administering the Fund and, therefore, for guiding the research effort it stimulates and supports would rest with the Director of the proposed Research and Development Center. In defining mechanization program research priorities -- hence areas eligible for grants from the Fund -- and in evaluating individual project proposals, the Study Team recommends that the Director be assisted by a five-man committee appointed by the MOA Undersecretary for Engineering and Farm Mechanization. At least two members of this committee would be drawn from the academic community and at least one from the farm machinery manufacturing industry. The committee membership should include specialists in the social sciences as well as in agricultural engineering and well might include representation of farm workers' interests or those of urban consumers.

4. Priority Areas

The fields in which research project proposals would be considered for Fund support should be identified and publicized as far in advance as possible. To set them once and for all at the outset for the entire five year project period, however, would be counterproductive. New opportunities for research contributions to the mechanization

effort would be certain to emerge as farm mechanization and research progress. Thus, it is anticipated that following committee review of ongoing research and newly identified problems, the Director would announce eligible areas about one year in advance of any financial year.

For the Fund-financed research program to make an optimal contribution to furthering progressive farm mechanization, it is essential that the director and committee take a broad view of what constitutes the mechanization arena. Potential contributions from the social sciences deserve particular consideration in this regard. Additionally, and despite the danger of spreading Fund resources too thinly, particularly relevant research undertakings in crops, soils and livestock may emerge that would contribute significantly to farm mechanization objectives.

5. Research Proposals

Proposals would be accepted for consideration from individual researchers and institutions alike. In addition to evaluating the merit of individual proposals and the competence of the proposed implementer(s) the committee and/or R&D Center staff would counsel prospective researchers on specifics of research designs. It is possible that poorly designed proposals may be offered. Some would contain the germ of a potentially productive idea. To provide the needed guidance in the initial stages at least, the counselling load would likely be quite heavy, but its potential contribution to the quality of the research may be correspondingly high. Staffing of this component of the Center must make provision for meeting this

need either with full-time personnel or through ad hoc arrangements with qualified senior researchers in universities, government or business. The need for counselling assistance may decline after the first year or two. In that case, the flexibility of an ad hoc counselling arrangement, one that may also provide highly qualified counsellors, may commend itself as an alternative to hiring full-time staff for this purpose.

It is likely that researchers seeking grants would maintain an adequate flow of competent research proposals. On occasion, however, important areas might not be covered. Where circumstances warrant, the Director should be free to solicit proposals from especially well qualified sources. Given the potential of solicited proposals for real or imagined abuse, this technique obviously should be used judiciously and as a last resort.

Needless to say, the quality of fund-financed research output would depend principally upon the competence of the individuals conducting the research. The review committee consequently would be particularly diligent in this aspect of its pre-approval process.

Priority Research Areas

Fertilizer response to tillage practices.

Relation between power and labor availability and cropping intensity on farms with greater than 10 feddans of cultivated area.

Economics of land leveling under varying terrain and soil conditions.

Feasibility of alternative means of increasing forage production with and without mechanization.

Effects of working female cows and buffaloes upon milk and meat production.

Feasibility of increasing milk and meat production of cows and buffaloes freed from draft work by mechanization.

Feasibility of mechanizing berseem harvest.

Economics of machinery management on State Farms developing New Lands.

Availability and quality of machinery repair services in rural areas.

Factors affecting availability and annual hours of tractor use in different parts of Egypt.

Economics of mechanization by size and type of farm.

Impact of migration on farm production.

Impact of mechanization on hired workers incomes.

6. Duration

Research proposals requiring more than three years for completion normally would not be considered for Fund support. Projects of longer duration typically involve "basic" research, better left to other channels, and financing. While rigid adherence to a set duration might prove counter-productive over time, adherence to a publicized policy emphasizing short and middle-term applied research would focus Fund-financed research upon the most pressing problems.

To ensure that approved projects are not aborted due to financial shortages, all Fund-supported projects would be fully funded from the outset on a "reservation" basis with periodic payments made to grant recipients on a mutually agreed schedule. Such a "life of project" approach inevitably would find the Fund with substantial resources in the reserve account in the beginning. This would limit the number

of new projects it could otherwise initiate. Once regular ARE budget allocations to the Fund become routine, however, both these problems would evaporate.

C. Technical Assistance

Two members of the overall Technical Assistance Advisory Group (TAAG) would be assigned full time to the Center for the entire 5-year mechanization-assistance program period. One would be advisor on overall research administration, with particular emphasis on developing the Center's outreach program. The second would serve as machinery development advisor, hence be more concerned with the Center's in-house R&D activities.

D. Egyptian-American Collaborative Research

1. Purpose

This collaborative research activity, small in scale, is designed to give impetus to interests in applied farm mechanization research in both Egypt and the United States. This would build an experience base in both countries to further the role of mechanization in increasing Egyptian farm production. In the process, a number of Egyptian graduate students would receive valuable research training and their professors would have opportunities for enriching professional exchange with American colleagues.

2. Method

Participation in the collaborative research program would be determined by the R&D Center Director on the basis of invited proposals. Proposals would be required to identify an agricultural engineering faculty member and one or two graduate students on the Egyptian side and an agricultural engineering faculty member and one graduate

student on the U.S. side. For the first year, two proposals would be funded. Each approved proposal would, with the concurrence of the Center Director, be extended for one year with the same or new graduate students. U.S. graduate students would be expected to devote up to nine months in Egypt for M.S. thesis research and a minimum of twelve months for doctoral dissertation research. Two proposals would be funded in years two and three, each extendable for one year. In the fourth year, one proposal for a two-year flexible format research program would be funded. Year five would be devoted to completion of the work in progress.

Overall the scheduling is conceived as follows:

Year	Proposals		Egyptian		U. S.	
	New	In Progress	Faculty	Students	Faculty	Students
1	2	0	2	4	2	2
2	2	2	4	8	4	4
3	2	2	4	8	4	4
4	1	2	3	6	3	3
5	0	1	2	4	1	1

The number of both Egyptian and U.S. faculty would be reduced if a faculty member were successful on concurrent proposals or if successful proposal time periods overlapped.

3. Financing

Full AID funding is proposed for the five year program. The component cost items for the 5-year period are:

a. Local research project operating costs.

b. Equipment items required and not available from Research and Development Center.

c. Travel, living costs, and research assistant stipends of U.S. graduate students.

d. Travel expenses of Egyptian faculty.

e. Travel expenses of U.S. faculty.

U.S. faculty members would be expected to make two trips to Egypt per year for a total of one month in Egypt. Egyptian faculty would supervise all graduate student activity in Egypt and would make one trip to the U.S. per year to confer on research plans and to serve on the U.S. student's thesis examination committee.

E. R&D Center Establishment Requirements for Facilities, Equipment, Costs

A detailed list of facilities, equipment and dollar costs has been prepared so that the Center will have a realistic basis for extablishing the physical conditions essential to its activities. This information follows:

1. Machine Shop Equipment

1	Lathe, 43 cm (17 inch) swing, 160 cm (63 inch) bed, 8.25 cm (3 1/4 inch) spindle, 10 HP	$ 10,000
1	Drill press, 2.54 cm (1 inch), 3 HP	2,000
1	Turret Mill, 48 x 10	5,400
1	Surface Grinder	5,000
1	Grinder, rough grinding	200
1	Bench grinder, tool sharpening, 6 inch wheel	80
1	Power hacksaw	550
1	Reciprocating saw	75
1	Metal cutting bandsaw	800
1	Electric sheet metal nibbler/shears	100
1	Belt - disc sander with emery cloth belts	300
1	Sander - polisher (9 inch sander/7 inch polisher)	140
1	Anvil	60

2	Work benches with vise	500
1	Arc welder	600
1	Metal top work table	150
1	Acetylene welding outfit	200
1	Power pipe threading outfit	150
1	Parts cleaning tank	100
1	1/2" hand electric drill, variable speed, reversible	100
Miscellaneous hand tools, socket sets, chisels, etc.*		

2. Wood Shop Equipment

1	10" table saw	400
1	Band saw	400
1	10" radial saw	400
1	Drill press	400
1	Jointer-planer	400
1	Belt disc sander	300
2	Hand electric circular saw	160
1	Hand electric scroller	90
2	3/8" hand electric drill, variable speed reversible	150
1	12" wood lathe	200
2	Work bench with vise	500
	Miscellaneous hand tools, wood chisels, wrench sets, etc.	*
1	Saw blade sharpener	40
1	Portable press, hand operated with attachments	350

3. Instrumentation & Electrical Shop

1	Instrument test bench	600
2	Volt-ohm milliameter	300
2	Amprobe units	120
2	Soldering guns with assortment of tips and supplies	60
	Assortment of remote motor starter switches, motor controls, and common light switches	*
	Assortment of motor winding wire, lighting wire, etc.	*
2	Sets of electricians tools - wire strippers, etc.	120
1	Motor test bench	400

4. Research Laboratory Equipment

1	Overhead trolley crane with chain hoist	1,400
1	Floor jack, hydraulic	250
2	Tachometers	280
10	Stop watches	150
1	Soil moisture meter	200
1	Soil density determination equipment	500
4	12 ft. shop measuring tapes	60
2	100 ft. measuring tapes	40
1	Drawbar dynamometer	1,000
1	Power take-off (PTO) dynamometer	4,000

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* Pooled estimate

1	Stroboscope	200
1	Fuel flowmeter	300
1	Wheel revolution counter for slippage measurement	50
1	3000 g digital top loading balance	3,500
1	500 kg platform scale with dial	3,000
1	Set of sieves and pans for grain sample analysis	50
1	Tarpaulin (to collect threshing machine samples)	50
1	MF 265 row crop tractor with:	28,000
	Chisel plow — 4 row planter	
	Disc harrow — Spike tooth harrow	
	Reversible — Ditcher	
	Moldboard plow — Mower	
	Ridger-Cultivator — Seed drill	
1	Forklift	5,000
1	50 m steel surveying tape with reel	100
1	Surveying level and rod	500
1	Diesel fuel storage tank and pump	600
1	Oven, 0-180°C for sample drying	600
2	Pitot tube set (30,61,122 cm lengths) with manometer	300
1	Battery charger	80
1	Hydrometer set	40
1	Electric dynamometer for small motors	2,000
1	Variable speed motor - to 6 hp	1,000
*	Hand tools and stock of shop misc. supplies	2,000

5. Transport Equipment

1	Sedan for travel to universities & other cities	6,000
2	3/4 ton pick-up trucks equipped for trailer	17,000
2	5 ton gooseneck trailers, with brakes, for transport of equipment for field testing	12,000
1	Closed van for protected transport of reasearch instruments and personnel	10,000

6. Library

Machinery handbooks	
Agricultural engineers handbook	
Marks mechanical engineers handbook	
ASAE microfich file of technical papers	
Microfiche reader	
ASAE monographs	
SAE references	
John Deere FMO (Farm Machinery Operation Series)	
Reference textbooks	5,000

7.	Reproduction Equipment	3,000
	Total Center Establishment	139,545

8.	Building Renovation	70,000
9.	Farm Machinery Imports	
	Prototype equipment for testing and modifying to Egyptian conditions (5-year total)	200,000
10.	Center Operating Expense	
	(See attached budget summary)	

F. Funding

Effective performance by the professional project staff and progress toward the project goals within the time frame of the project demand that personnel, equipment, and money be available as required. Local professional staff must be able to devote full time to their project duties. It is therefore proposed that the project be fully funded by AID for the first two years at a decreasing level for the remaining three years. First year funding would include the costs for facilities and equipment. Starting with the third year, local costs would be 70% funded by AID, reduced to 50% for the fourth year, and to 20% for the fifth and last year. This approach would stimulate initial program activity and will also lead to planned institutionalization of the organization. The estimated cost for the R&D subproject follows on the next page.

Estimated Cost

Research and Development Subproject*

Item		5-Year Total
Center Staff		
2 American Advisors		$ 1,440,000
Egyptian professional staff		136,800
Secretarial and Clerical staff		90.000
Office equipment and supplies		8,000
Local transportation		(project vehicles)
Vehicle maintenance and repair		12,000
Fuel, Oil and lubricants		9,600
Per diem (Egyptian professionals only,- per diem of American Advisors presumed covered in their all inclusive budget base)		33,400
Center equipment (See Section E of text)		140,000
Spare parts		14,000
Building renovation		70,000
Prototype equipment imports		200,000
	Center Total	2,153,800
Collaborative research program		204,800
	Total	2,358,600
	20% Contingency	471,200
Applied Research Fund		1,000,000
	Total RAD Subproject	$ 3,829,800

* All cost estimates include 10% allowances for inflation

CHAPTER XVI

LOCAL MANUFACTURE

Setting

When the Massey Ferguson/NASCO private sector plant is completed in 1981, Egypt will have the capacity for domestic manufacture of tractors with a progressively higher percentage of locally-made components. All types of commonly used farm implements such as chisel plows and trailers are made domestically, mainly by small shops producing a few units a year. Some larger plants are now manufacturing more modern farm equipment such as irrigation water pumps, a limited number of small diesel engines and a few test models of the IRRR-type thresher-winnower. For the most part, though, motors and other types of modern equipment have to be imported.

For all its overall volume, even the manufacture of commonly used farm implements is essentially a made-to-order operation. Plants typically are little more than bigger workshops; few have any modern equipment. Even the Behera Company--the largest and best equipped plant coming to the Study Team's attention--uses an overhead belt-pulley system for powering individual machines and has no production line in the modern sense.

From Study Team observation, Egypt appears to have no tradition of manufacturers moving ahead of immediate demand to build a stock of implements for take-home delivery to buyers. Nor was any instance found of a manufacturer agressively engaged in market development. From lack of information about prospective demand, inadequate capital, or lack of

experience which would build motivation for pressing supplies upon the market, individual plants seem willing to let the flow of cash-in-hand customers dictate the volume of their production. With most implements made only after firm orders are placed, there inevitably is delay in farmers getting into use any new or replacement item they may need.

Roles of Local Manufacture

Elsewhere in this report, the case is strongly made that efficient use of machinery for increasing farm production requires that available tractor power be used for more land preparation operations than plowing; that freezing the tractor time now spent powering drum threshers is the most economical means of relieving the summer peak power shortage which results in late planting of maize and rice; that replacing animal-drawn sakias with motor-driven pumpsets is an efficient way of increasing Egypt's production of meat and milk. Achieving these objectives requires that new types of equipment be introduced in volume into Egyptian agriculture. Imports, of course, provide one means of obtaining such production-increasing implements. There is reason to doubt, however, that primary dependence upon imports would be an optimal long-range strategy.

The extensive studies underlying the decision to begin domestic manufacture of tractors suggests that Egypt has the basic capabilities to also produce economically the other new types of equipment needed as they are technologically much less complicated than tractors. Beyond comparative economics, there are two prerequisites of progressive farm mechanization which, in the Study Team's view, probably would be met more effectively by

local manufacture than by imports. One is the role which an adequate and an uninterrupted supply of equipment plays in encouraging adoption of new technology. The second is the urgent need for a reorientation of manufacturer and dealer attitudes toward stock-building and market development. Only if the supply of the new types of equipment needed for optimal mechanization press upon market demand can Egypt expect to gain the production-increasing benefits which mechanization has to offer. Supplies and market development reinforce one another in this regard. Market development efforts would come to naught if buyers and dealers could not be certain of the timely availability of the machines. Conversely, making supplies available without supporting market development likely would prove counterproductive in the long run. Both of these prerequisites could be met through a positive import policy accompanied by extensive in-country participation by foreign manufacturers. However, past experience leaves reason to doubt that such an approach would provide as unwavering a basis for meeting Egypt's farm machinery requirements over time as would one founded upon government-encouraged local manufacture.

The present study provides a substantial basis for anticipating the numbers of the recommended new types of machinery that advantageously could be utilized. On the production side, however, it was possible to do little more than survey existing production capacity and form some general judgments about what would be involved in creating the capability for domestic manufacture to meet those needs. Even this modest appraisal left little reason to doubt that for Egypt to meet its requirements for modern farm machinery through local manufacture would require: (a) substantial investment in plant modernization, (b) some expansion in capacity and (c) participation

for several years by an experienced farm machinery manufacturing firm--under a technical collaboration contract or other mutually acceptable arrangement--to help participating Egyptian manufacturers with product design, production management, establishing licensing arrangements and evolving effective market development techniques. Given these circumstances, the feasibility of local manufacture will depend heavily upon the volume of prospective demand and the size and character of existing plant capacity. These same factors likewise should prove highly significant in deciding how modernization of the Egyptian farm implement industry can proceed to best advantage.

Prospective Demand

Table XVI. 1 summarizes the Study Team's estimates of the maximum production capacity needed to meet Egypt's requirement for the recommended new types of equipment during the next several years. The first column indicates the year by which the volume of each item should reach a maximum; the second column, the number of machines required per year by that time.

In Table XVI. 1, requirements are assumed to reflect prospective demand. With an effective machinery introduction program on the lines recommended in Chapter XVII and an aggressive market development effort by manufacturers and dealers, the two should be roughly the same. In the absence of effective market development, demand would fall well below the level indicated. In that event, the production capacity which could be utilized efficiently would be reduced accordingly.

TABLE XVI. 1

ESTIMATED REQUIREMENT FOR NEW FARM IMPLEMENTS

Item	Year	Estimated Demand
10 hp thresher (already produced)	1983	600
40 hp thresher	1985	500
Mower-binder	1984	500
Disk harrow	1984	800
Spike tooth harrow	1984	800
Row cultivator	1984	300
Moldboard plow (two way)	1983	200
Soil scraper	1984	400
3 Point tractor utility box (for transport)	1983	300
5 - 6 hp diesel motors for irrigation pumpsets	1983	10,000

Existing Facilities

The major present producers of commonly used farm implements other than tractors are shown in Table XVI. 2.

TABLE XVI. 2

AGRICULTURAL IMPLEMENTS PRODUCERS, BY TYPE OF IMPLEMENT

Chisel Plows

Behera Company at Alexandria (state enterprise)

Tanta Motor Company at Tanta

Fahim Reghab Company, North Cairo

El Mansoura Company

Small workshops throughout the country

Drum Threshers

Behera Company

Tanta Motor Company

El Mansoura

Various small workshops throughout the country

Trailers

Behera Company

Tanta Motor Company

El Sheify Company at Tanta

Sisman Company at Cairo

Sallam Works at Dar Es Sallam (near Old Cairo)

El Nasr Automotive Company (NASCO) at Helwan

NICAR (Egyptian Co. for Tools and Engineering) at Shubra, North Cairo (a public sector enterprise)

Irrigation Pumps

Helwan Diesel Company (Military Factory No. 909), at Helwan

Shubra Diesel Company at North Cairo

Tanta Motor Company

Note that the Tanta Motor Company - a private firm - produces all four of the typ of implements included in that summary; the Behera Company--a public enterprise and Egypt's largest producer of farm implements - all those types except irrigation pumps. The other large plants tend to specialize in a single type of production as do the many small shops which turn out varying numbers of

hand-made implements a year. Some of these also are important sources of locally fabricated components for larger firms and of spare parts which they sell to dealers or directly to farmers co-ops et al.

Significantly features of several of the listed plants are described below:

Behera Company

Behera Company of Alexandria, founded in 1881, is a highly integrated state enterprise of major magnitude, engaged in a series of activities--erection of structural steel work for industrial plants, construction and assembly of steel cranes, building of dams, construction of pumping stations, land reclamation, earth excavations, road building, dredging, canal construction, manufacture of steel pipes, and production of a variety of agricultural implements. The manufacture of agricultural implements started in 1958 and now constitutes one of the Divisions of the company. It is said that the Behera Company currently accounts (1978) for 75-80 percent of the total production of farm implements in the entire country. It is for this reason that the present review of Behera operations is given in some detail.

Plant Space and Facilities: The area used by the Agricultural Implements Division comprises 4,000 sq. mt., of which 1,500 sq. mt. is the building area. The facilites include the following departments: iron-casting foundry, steel-casting foundry, forge shop, welding, machining, wood-working shop, moulding shop, assembly, painting, and testing. The plant has no design department as such but has the capability of copying and modifying designs of others. It has no heat treatment facilities of its own.

Employment and Wages: Agricultural Implements Division employs about 500 persons, comprising 100 office employees, 20 technical and supervisory personnel, and 380 shop workers. There is a wide variation in the age of factory workers, with the average age given at 35.

The plant operates 6 days per week on one 7-1/2 hour shift per day, plus overtime. The monthly basic wages for factory workers range from 15 to 80 Egyptian Pounds, with the average wage of about 40 L.E. There is an incentive system in effect, based on piece rate work and applied to either individual performance or group performance. As a result of this system, the average monthly earnings are said to exceed the basic monthly wage by about 25 percent.

There are several fringe benefits. First, the plant pays an annual bonus equal to one month's basic wage. Lunches are subsized by the plant, with employees and workers paying 3 L.E. per month. The plant also provides uniforms and safety equipment. Health insurance plan is in effect, with the employees contributing one percent and the employer two percent of the basic wage. All employees and workers are eligible to participate in the Government Retirement System and upon retirement receive 80 percent of the last basic wage. Management officials estimate that the fringe benefits received by all employees amount to about 15 percent of their basic wages. The total monthly payroll of the Division, including that of supervisory personnel, is reported to range between 4,000 and 5,000 L.E. According to the management, the average compensation received by workers at Behera plant is substantially higher than that at many other plants in the country.

Types of Implements Manufactured: The plant produces a variety of agricultural implements. Among these are: chisel plows, both trailed and tractor-mounted, of 7 and 9 tines with tines produced at El Nasr Forging Company at Helwan or imported from the Soviet Union; ditchers, ridgers and mould-board plows, using plowshares imported from East

Germany; heavy plows, sub-soilers, and 4-tine chisel plows for deep plowing in land preparation for cotton and sugar cane; land levellers in 3, 6, 10 and 14 feet widths, tractor trailed, with the hydraulic grade lifting mechanism, automatically operated but pressurized from the tractor hydraulic system; belt-driven drum threshers (and a few IRRI-type thresher-winnowers, with a built-in diesel engine); and 4-ton 4-wheel trailers.

Production and Selling Prices in 1977: During 1977 the plant produced the following implements at indicated selling prices, ex-plant:

Type	No. produced	Unit Selling Price	
Trailers	120	1,200 L.E.	
Chisel plows	200	185 L.E.	Tractor mounted
Heavy plows	30	710 L.E.	Trailed
Mould-board plows	20	500 L.E.	Plowshares import from East Germany
Levellers	70	515 L.E.	
Drum Threshers	100	470 L.E.	
Thresher-winnowers	100	1,750 L.E.	Contain imported diesel engine valued at 600 L.E

The selling prices are stated to include a 10 percent profit. A certain minimum number of each implement reportedly is maintained in stock for immediate delivery and as products are sold, the stock is refilled. No dealers are employed and the implements are sold to end users at the plant for cash.

The Behera plant maintains no service organization. In case of a breakdown, the plant will send a service technician to repair the implement. This service is free during the guarantee period of six

months. After the guarantee period expires, the purchaser must pay for all repair costs.

Production Capacity: In an ARE report entitled "Farm Mechanization Development in Arab Republic of Egypt," dated July 1977, the production capacity of the Behera Plant is given as follows:

Item	Units per year
Drum Threshers, belt-driven, 350-450 Kg/hr	600
Mounted chisel plows, 7-9 tines	1,200
Trailed chisel plows, 9-11 tines	1,200
Sub-soiler, trailed	240
Ditcher, trailed, 200 x 45 cm	240
Levellers, small, trailed, 6-10-12-14 ft. in width	480
Levellers, large, trailed, 6-12-14 ft. in width	360
Trailers, 4-wheel, 4-ton	300

The above figures appear to be unduly optimistic. Their attainment would most likely necessitate major additional investment in plant and equipment, and a major increase in trained manpower.

General Observations: Although the plant is more or less adequately equipped for the present level of production, it leaves much to be desired in a way of improvement and modernization. Most of the machines in the machine shop are nearly 10 years old and some are even older. A number of lathes are activated by a belt from an overhead revolving shaft rather than by individual motors. The shop for making moulds is rather primitive and requires new equipment. Presumably intended solely for the production and assembly of agricultural implements, the Agricultural Implements Division currently is performing numerous

miscellaneous functions. These include, but probably are not limited to: construction, repair and rendering various services to other divisions of the Behera Company. Perhaps as a result of such a variety of activities, there is no production line and the work is performed on a piece-meal basis by either single individuals or by small work gangs.

Tanta Motor Company

Located in Tanta, the Tanta Motor Company is a private sector enterprise engaged in production and assembly of various agricultural implements and water pumps. It also imports tractors and power tillers.

Local Production and Assembly: Among the implements now being produced or assembled are:

Chisel plows: 7 and 9 tines, produced from new steel, with the tips fabricated from old automobile leaf springs. In 1977, 64 9-tine plows and 58 7-tine plows were produced and sold at 200 L.E. and 170 L.E. per unit, respectively.

Threshers: drum type, belt driven, similar to that made by Behera, selling at 500 L.E.

Trailers: 2-wheel and 4-wheel types, with all parts except wheel rims manufactured in the shop. The 4-wheel trailer sells for 1,300 L.E.

Maize mill: manufactured under the Tanta Company's brand name.

Irrigation pumps: largely as an assembly operation. Pump castings already machined, are purchased from Damanhour plant, some 65 Km east of Alexandria. The only part machined at Tanta is the coupling plate for the pump set. The pump sets are equipped with

either diesel engines imported from East Germany, India or Yogoslavia or electric motors imported from the Soviet Union. The plant assembles about 300 pump sets per year. All pump sets come with 4 inches of intake pipe and one meter of discharge pipe. These are:

6.5 HP Diesel, with a 5" intake pipe and 6" discharge pipe, selling at 640 L.E.

11 HP Diesel, with a 6" intake pipe and a 6" discharge pipe, selling at 985 L.E.

7 HP electric motor, with a 5" intake pipe and a 6" discharge pipe, selling at 300 L.E.

The cost of diesel engines to Tanta Motors Company, whether locally made or imported from India or Yugoslavia amount to 230 L.E. for a 6.5 hp engine and 670 L.E. for an 11 hp engine.

Imports: The Tanta Company imports from Japan about 300 power tillers a year for orchard cultivation. These are Mitsubishi type, 7 hp and 13 hp selling in Egypt for 1389 L.E. and 1726 L.E., respectively.

The tractors imported by the company are of two types:

1. David Brown (J.I. Case Co.) 990 and 995; imported complete, cased and requiring only the wheels to be fitted and a few items bolted in place. It sells for 6,600 L.E.
2. Mitsubishi 1300, with a 4-wheel drive. It is a 2 cylinder diesel tractor of 15 hp and sells for 3,000 L.E.

General Observations: The Tanta plant is in effect an oversize workshop, with a very limited space for the variety and volume of its productions. Raw materials, items in the process of production or assembly, and

finished items are soon scattered all over the place.

The plant employs about 100 workers, of which 20 are boys under 15 years of age. The rest appear to be all under 30. Boys of 12-15 years of age routinely insert packing into irrigation pumps and electric welding. The machine shop is rather primitive, containing about a dozen essential lathes and machines. The whole plant is entirely too crowded for efficiency and safety of operations.

Sallam Works

Sallam Works is essentially a workshop, owned and managed by Dr. Eng. El Fattah Naguib. The workshop engages in production of a variety of metal work including such agricultural implements as chisel plows, drum threshers and trailers. All work is done on contract and no stock of finished items is kept.

The shop is equipped with lathes, grinders, saws, presses, electric welding, acetelene welding, milling machines, cutters, blacksmith facilities, and other essential equipment needed for the production of relatively simple agricultural implements.

As the firm lacks good distribution channels, trailers produced by the shop are sold through the General Engineering Company and plows through Saad El Aguizy. The shop also accepts orders from individual farmers.

Sisman Company

Sisman is a trailer manufacturer and produces trailers for a great variety of purposes. Monthly production rate is about 50 units of various types. Among trailers produced for agricultural users are: 1.1-ton 2-wheel trailer; and 4, 5 and 8-ton 4-wheel trailers. Axle bearings, hub assemblies and fifth wheel assembly are imported. The prices quoted for which some of these trailers were sold before the last increase in steel prices are:

4-ton, 4-wheel type, with a fifth wheel assembly	1,100 L.E.
5-ton, 4-wheel type, with a fifth wheel assembly (wt 1.9t)	1,730 L.E.
8-ton, 4-wheel type, with a fifth wheel assembly (wt 2.2t)	2,363 L.E.

Helwan and Shubra Diesel Companies

Though the two companies are at different locations - Helwan Diesel at Helwan and Shubra Diesel in Cairo-the two plants are under the same management and largely share technical expertise. In both plants, diesle engines are machined and assembled employing predominantly Egyptian materials. Pumping sets are sold for irrigation and other purposes. The engines are also used in producing welding generator sets and in small power emergency sets. The sets are placed on trailers for mobility. Engines are not sold separately.

At the Helwan Works, vertical diesel engines are produced based on the original design by Austrian Prof. Liszt. The engines manufactured are of two types, with all cylinders having common dimensions: (1) 11-120 HP (1-6 cylinders) and (2) 30-150 HP (2-6 cylinders). Forgings, castings and crankcases for these engines are supplied from other Egyptian factories, while fuel injection pumps and electrical equipment are imported. The engines are water-cooled. Annual production amounts to about 4,000 cylinders but plans are under way to increase capacity of the plant to 6,000 by 1980.

At Shubra Works, three Deutz-licensed type diesel engines are produced with output of 6, 10, and 16 HP, also water cooled. All components except the injection pump and electrical equipment are Egyptian made. All machining, heat treatment when needed, and assembly are all carried out within the plant. The engines manufactured at Shubra are of horizontal stroke, specifically designed to replace the sakia. Annual

production is about 1,500 but the plant intends to expand it to 2,500 by 1980.

Total employment at both plants, including management and technical personnel, amounts to about 1,800, and, as already mentioned, with the management and technical staff functions common to both factories. The Helwan factory has a group of travelling service engineers but the irrigation pumps are sold mainly by a tractor and engineering company which provides service at several rural depots in rural areas. Both plants appear to be well run, despite their different locations and a common management structure, with the two factories producing pump sets for different markets.

Some Auxiliary Facilities

Most if not all, manufacturers of agricultural implements do lack complete heat treatment facilities, such as for annealing and case hardening. Likewise, many of them depend upon other factories for supply of unmachined iron and steel castings, as well as for a variety of forgings. The following lists of factories supplying such services to agricultural implements manufacturers, though not complete, represent the major suppliers of these services and products:

Plants providing heat treatment facilities

1. Helwan Iron Foundries at Helwan, Cairo
2. El Maadi Company (Military Factory 54) at El Maadi, Cairo
3. Helwan Engineering Industries (Military Factory 99) at Helwan, Cairo
4. Helwan Iron Foundries (Military Factory 9), at Helwan, Cairo
5. El Nasr Forging Company, at Helwan, Cairo
6. Center for Engineering Design at Dar Es Salam

Plants supplying iron and steel castings

1. Helwan Iron Foundries, at Helwan, Cairo
2. El Nasr Foundry at Alexandria
3. Delta Steel Company, at Hokon, N.E. Cairo
4. El Mansoura Company, at Cairo

Plants supplying forgings

1. El Nasr Forging Company at Helwan, Cairo
2. El Maadi Company, at El Maadi, Cairo

Feasibility of Local Manufacture

Deciding how Egypt's needs over time for an assured flow of new types of farm implements best can be met involve a number of complex questions. Some are technical, some economic and others organizational. Providing definitive answers to such questions will require a separate study addressed specifically to the feasibility of local manufacture. In the Study Team's judgment, that feasibility should cover at least the following areas:

1. Economics of Local Manufacture

All other considerations aside, deriving the usual type of social and private internal rates of return estimates will indicate the economic advantage or disadvantage of local manufacture compared to importing the respective items. Needless to say, such caluculations can be made only in the context of the several other questions warranting consideration.

2. Organization of the Industry

There appear to be two principal ways in which modernization of Egypt's farm implement industry could proceed. One would be to concentrate near term

investment upon one or perhaps two existing plants such as the Behera Company and/or Tanta Motors. An alternative approach would involve assisting existing farm implement manufacturers in general to modernize and expand their production capacity through some kind of an incentive-loan arrangement. This phase of the analysis necessarily would start with a comprehensive inventory of existing production facilities with particular emphasis upon the respective plants' products lines, capacity, production and distribution methods, management, the organizational relationships among plants, and the financial/technical requirements for making the respective plants effective participants in a modernizing industry. In weighing the comparative advantages of concentration vs. dispersion, the ancillary roles domestic manufacture must play in the overall farm mechanization process deserve special attention. From the information available, it appears that small plants would be relatively ineffective in developing a market for new types of farm equipment. Ability to bear the risk of producing ahead of market demand, to maintain a market development staff, and to shoulder the cost of financing dealer stocks are all functions of size. In the current Egyptian environment, they also may be found to depend on whether the manufacturer is a public or private enterprise.

The appraisal of organizational alternatives also will need to take account of the present and potential role of small shops in supplying components to larger plants. The same is true of the possibility of smaller plants continuing in effect as second echelon producers of new types of farm implements. This is to say that advantage might be found in focusing near term investment upon modernizing only a few large plants with smaller shops taking up production of the respective items after design and other technical production problems have been resolved and a firm market developed

for them. The financial, technical and management-advisory assistance that would be needed to enable small producers to play this type of role would require specific attention. So would the possibility of government's assisting small producers to organize themselves into some kind of trade association to facilitate their access to reliable market information, improved production techniques, etc. In considering this type of two-tier modernization strategy, consideration clearly would need be given to the impact upon the large plant(s) of smaller shops taking over their market as production of a particular item becomes profitable. The overhead of product and market development is likely to be substantial. It may well be that only a state enterprise or government-subsidized private firm could bear that cost on a continuing basis.

In the analysis of organizational alternatives, due weight should be given to the relationship between modernization of the industry and other aspects of Egypt's overall farm mechanization program. Location likely will be found to be a particularly important factor in this regard. Proximity to the Research and Development Center proposed in Chapter XV would permit collaborative arrangements beneficial to both modernizing manufacturer and the Center. The same is true of the mechanization training program being established with FRG assistance at Alexandria University. This consideration also has significant implications for the choice between the concentration of assistance versus its dispersion among a realtively large number of plants.

Finally, the feasibility Study Team usefully could give attention to the question of public vs. private sector development of the farm machinery industry over time. Conclusions on this score obviously depend heavily upon the type of overall strategy found to be more promising. With dispersion of modernization assistance, the question would have limited significance as most

existing plants--but not production--are in the private sector. Under those circumstances, the question would appear to become one of an optimal mix of private and public enterprises. On the other hand, however, if modernization by concentration is found to be the more generally advantageous and, say, the Behera Company is the preferred candidate for assistance then the merits of that firm's remaining in the public sector over an extended period would appear to warrant specific consideration. For example, it is possible to visualize a projected set of circumstances where, after modernization has proceeded far enough to attract a joint venture partner, the Behera Company could advantageously follow NASCO's lead and spin off its Agricultural Implements Division into the private sector.

3. Technical Assistance Needs

From discussions with industry representatives and others familiar with the current state of farm machinery production in Egypt, the Study Team became convinced that an extended period of technical collaboration with an experienced foreign farm implement manufacturer or association is an essential prerequisite to Egypt's achieving anything like optimal benefits from local manufacture. In the context of a detailed feasibility study, this is, of course, but a hypothesis to be tested. In that process, the feasibility study team would be expected to consider not only the cost and benefits that could be derived from such collaboration, but also such questions as: alternative arrangements, size and composition of the advisory group, sources of supply, duration, and timing, i.e. whether the technical advisory assistance should precede or accompany physical modernization activities.

In the Study Team's view, the technical assistance and investment activities can best proceed together with the advisory group being available to assist with technical and managerial decisions about how modernization of the

particular plant or plants can proceed most advantageously. Without the concerned Egyptian plant(s) having firm assurance of the necessary investment funds, technical assistance likely would prove unproductive. Conversely, if detailed investment plans are set before the advisory group arrives, much of its potential contribution to efficiency of the modernization/expansion process inevitably would be lost. This assumes, however, that the feasibility study team in consultation with the plant or plants selected for modernization will have determined in broad outline the scope and magnitude of changes required. Should that objective not be included in its terms of reference, the advisory group advantageously could be brought into the process somewhat earlier. With an overall strategy of dispersion of modernization assistance, both the role and preferred timing of the advisory group's participation probably would be quite different than if modernization was to be concentrated upon one or two plants. For that matter, so would the results expected from those carrying out the feasibility study. In the one case, much of the detailed analysis of the individual plant requirements probably could better be left for the technical assistance advisors; in the other, the feasibility study team reasonably could be expected to perform that function.

4. Selection Criteria

No other single aspect of the feasibility study is likely to prove as important to the outcome of Egypt's overall local manufacture efforts as is the quality of the criteria derived for selecting the plant or plants to be given modernization assistance. In the first instance, these criteria must be framed with specific regard to the type of industry-development strategy proposed. Beyond that, they must be definitive with respect to the relative importance of particular firm/plant characteristics, e.g., management quality

and attitude, skill level of workers, access to additional trained workers, production practices, distribution system and methods, present equipment, expansion potential of plant, etc. Together with the inventory descriptions of existing facilities, these criteria should provide an easy basis for decision-makers without first-hand acquaintance with the respective plants to reach informed judgments about the allocation of assistance resources.

If history is any guide, there likely will be keen competition for the assistance funds. Consequently, in addition to providing a basis for selection among candidates who are - or think they are - qualified for assistance, the criteria should provide a plausible rationale of the choices made.

5. Financial Requirements

As in any similar study, the bottom line of this feasibility Study Team's responsibility would be producing analytically-supported estimates of the investment costs of whatever plant modernization program it concludes will best serve Egypt's interests over the next several years. These estimates must be of such character and specificity as to adequately serve three different needs: (1) provide a basis for internal rate of return calculations, (2) give ARE and AID or/and other donors a basis for making the necessary assistance decisions and (3) guide the target plant or plants in developing implementation plans.

To arrive at a general estimate of foreign assistance requirements, the Study Team assumed a strategy of modernization by concentration and took the Behera Company as a case illustration. Even though it currently is by far the biggest single producer of farm implements and the state enterprise charged with responsibility for ensuring that farmer demand for farm equipment is adequately met--by its own output if private companies do not fill the market--

the Behera Company would need substantial financial and technical assistance to turn its Agricultural Implements Division into an efficient producer of the new types of equipment required for optimal mechanization of Egyptian agriculture. For instance, in addition to essential modernization of equipment and production/marketing methods, some plant expansion would be required. If, as seems indicated, it were found that national interests would be best served by Behera's discontinuing production of items like trailers, drum threshers, and chisel plows (which private companies already are producing in volume) in order to concentrate upon new types of equipment, its financial requirements probably would be considerably less than if the new items were added to Behera's current product lines. The succeeding cost estimates assume this will occur and that Behera consequently would not need to develop modern plant capacity for mass producing all kinds of farm equipment. The estimates also assume that the company will engage in an aggressive product and market development effort vis-a-vis the new types of machinery; hence Behera will need assistance on terms making it possible to carry the overhead costs.

On another front, the Behera Company is a useful case illustration of considerations that perforce will go into the selection of plants to be assisted. Despite top management's contention to the contrary, it appears that farm machinery production is but a sideline to Behera. Even its Agricultural Implements Division devotes less than its full attention to farm machinery manufactur. Its performance in producing the IRRI-type thresher-winnower, for example, could not have reflected priority attention by the management of a company as large and generally successful as is Behera. In addition, as indicated by the earlier description of its present facilities, Behera has little design capability and lacks other essential facilities.

Observations and inquiries at the Behera plant indicate that modernization to meet projected demands for the new types of farm implements noted previously would require (a) technical assistance for 3-4 years with emphasis upon production management, developing design capability, establishing licensing arrangements and installing effective market development techniques. What is visualized under the heading of "technical assistance" is technical collaboration arrangement with a U.S. farm equipment manufacturer experiences in developing production capabilities of similar manufacturers in the United States and less developed countries. As a rough estimate, this aspect of the modernization process might cost $1-1.5 million. In the Study Team's judgment, simply modernizing the production facilities of Behera--or any other existing plant for that matter--would be a waste of investment unless accompanied by a well designed technical collaboration arrangement with a competent Western firm of sufficient duration to ensure that the essential management and production techniques are firmly rooted.

Recommendations

As indicated by the preceding discussion a comprehensive and competently-conducted feasibility study is an essential prerequisite to informed decision-making with respect to the place of local manufacture in Egypt's overall farm mechanization effort. Assuming that, like tractors, domestic manufacture of other farm equipment likely will be found advantageous, the Study Team arrived at the following recommendations:

1. Arrangements be made as quickly as possible for a comprehensive

feasibility study on the local manufacture of farm implements other than tractors. The terms of reference for the organization making this feasibility study should explicitly include consideration of Behera's role in the manufacture of commonly used implements and in developing the market for new types of machinery; the comparative cost and returns of modernizing assistance to small shops vs. larger plants, prospective longer term role of smaller shops in Egypt's farm machinery industry either as producers of entire implements or component fabricators; means of facilitating small producers' access to market information and technique for improving quality control; and criteria for selection of the plant or plants to be assisted.

2. USAID include in its overall farm mechanization-assistance planning the modernization of enough existing plant capacity to meet the domestic production/market development requirements for ensuring an adequate supply of the new types of farm machinery Egypt needs; This will enable mechanization to make an optimal contribution toward increasing agricultural production.

3. In that planning, USAID budget the modernization of Behera and/or some other plant(s) at around $8 million--including the technical collaboration contract and feasibility study.

4. In mechanization project discussions with MOA et al, USAID stress the importance of managerial interest in producing farm machinery and in the market/dealer outlet development concepts noted earlier as prime considerations in selecting the Egyptian company or companies for modernization assistance.

CHAPTER XVII

INTRODUCTION OF NEW TYPES OF MACHINERY

Purpose

For mechanization to make an optimal contribution toward increasing the productivity of Egyptian agriculture, it is essential that improved technology be progressively applied to additional cropping operations. As established elsewhere in this report, the new types of equipment that offer particularly promising opportunities in this regard are:

--A tractor-mounted disc and spike-tooth harrow combination to improve the quality of seed bed preparation and reduce tractor time requirements for seed bed preparation.

--Tractor-mounted row planters to provide better seed placement--hence germination--and facilitate mechanical cultivation of row crops.

--Self-propelled mower-binders to permit more timely planting of crops following small grains.

--Thresher-winnowers to reduce grain losses and help relieve the peak-season power and labor constraints upon timely performance of other cropping operations.

Assuming that proposed modernization of plant capacity for domestic farm implement production proceeds on schedule, by 1981 Egypt will have the capability for domestic manufacture of all these types of machines in sufficient volume to meet prospective requirements. In the interim, a well-designed and effectively implemented machinery introduction

effort can acquaint farmer-users and custom operators with the benefits these technological improvements can bring. This will both develop markets for locally manufactured machines as they become available and expedite their usage.

Program Management

In design, a machinery introduction program must be aimed specifically toward demonstrating the proper use of the respective equipment items and their advantages over present practice. Strategic placement of the demonstration units is crucial to maximizing their impact upon potential users. And it is necessary, of course, for enough custom operators in the preferred locations to be willing and able to obtain and put into use a sufficient number of the respective introductory items to gain the intended demonstration effect. As these initial operators will perforce be demonstrators and in effect "salesmen," it is essential that they be carefully selected with these responsibilities in mind.

Any new technology involves a certain amount of risk to initial users. Even though a particular machine has been thoroughly tested by research, the individual farmer will remain uncertain about its performance under field conditions until he has seen it tried himself. In Egypt, where the spread of mechanization depends upon custom operations, initial buyers face the added risk of customer acceptance and the cost of demonstrating the innovation until a profitable market has been developed. Consequently, it will likely be advantageous for government to share these market development risks and costs in the public interest --especially with such machines as high-capacity threshers that require

substantial investment. As circumstances will differ among machines and probably geographic locations, cost/risk sharing techniques can best be adapted to the needs of the respective situations.

On the surface, State Farms and/or Cooperatives might appear ideal channels for machinery introduction. Closer inspection, however, evidences that both have inherent weaknesses in this regard. Either State Farms or co-ops would avoid many of the financing and persuasion difficulties inevitable in getting new types of machines into effective demonstration use via private operators. However, by their very size, State Farms cannot remove the uncertainties about how a particular piece of equipment would perform on small farms. More importantly, State Farms are poorly situated to function as custom operators. Also, their record of machinery management is not such as to inspire confidence in their effectiveness as demonstrators of technological improvements.

Much the same is true of cooperatives. Notwithstanding their contribution to establishing custom tractor services in Egypt, more recent experience in that area leaves reason to doubt that cooperatives are the best available channel for introducing additional types of farm equipment. Capability aside, necessity for government sharing the costs of initial investments would differ only in degree from that involved with enlisting private farmer custom operators as demonstrators. And for government to return to the use of co-ops as instruments of intervention would appear to be a significant step backward from the free enterprise spirit of the Open Door Policy.

As implied by the preceding discussion, making machines available through introductory imports or local manufacture and deciding where

and how their use can be demonstrated most advantageously are but two of the three critical elements of an effective machinery introduction program. Only with an enlightened and aggressive extension effort at the village level can the expected results be realized. As village-level extension workers already are in place, no additional personnel would be required by this activity. The same is true with respect to AID participation, as the Machinery Management Advisors can cover needs in this area as part of their general mechanization-assistance responsibility. However, there is a requirement that the Agricultural Extension Department should make machinery introduction a high priority item in its program agenda. Extension personnel directly involved in this activity no doubt would benefit from some short course training in extension demonstration techniques with particular reference to the new types of farm equipment being introduced. Such training, however, is but a part of any on-going extension program, hence is a matter of orientation and emphasis rather than an additional requirement upon the Extension organization.

Scope and Content

In the Study Team's assessment the following types and number of new-type equipment represent a minimum adequate machinery introduction program at the present juncture:

TABLE XVII. 1

RECOMMENDED MACHINERY INTRODUCTION PROGRAM

Units	Type	Cost per Unit	Estimated Total Cost	Proposed AID Financing.
500	Disc/ spike tooth harrow comb.	$ 750	$ 375,000	$ 375,000
100	High capacity thresher-winnowers	6,500	650,000	650,000
100	Mower-binders	3,300	330,000	none[1]
200	IRRI-type thresher-winnowers	2,500	500,000	none[2]
100	Tractor-mounted sow-crop planters	3,300	330,000	330,000
	Total		$2,185,000	$1,355,000

[1]Preferred model is manufactured in Italy. MOA imported 50 of these machines in 1978 for field testing on State Farms.

[2]A model of this thresher adopted to Egyptian conditions was produced in limited numbers during 1977-78 for field testing using either imported Deutz or Hartz 10 hp engines. The Study Team knows of no US or 941-country source for such engines.

Procurement of all the above items except the high capacity thresher-winnowers should be initiated as quickly as funds are available to provide maximum opportunity for field testing and market development prior to completion of plant modernization for their local manufacturer in 1980-81. Delaying procurement of the high capacity thresher-winnower for one or possibly two years may be advisable. This would familiarize farmers with advantages of this type of equipment over existing methods, since the IRRI-type machine involves a substantially smaller initial investment

and thus requires fewer custom users for an operator to break even. Although the disk-spike tooth-harrow complex involves two separate implements, they should be introduced as a combination unit. Together, the benefits in terms of improved seed bed preparation and time requirements are significantly greater than the sum of those obtainable when either implement is used alone.

This initial introduction of farm machinery realistically can be viewed as only the beginning of a sustained machinery introduction program. It should, however, represent about all the imports required under this particular heading. Once the proposed Research and Development Center becomes operational, prototypes of particularly promising new types of equipment would be imported as necessary for field testing and adaptation under that part of the overall farm mechanization program. Others will be developed by the Center itself. Whether based on modification of prototype imports or the Center's own research and development activities, all new types of equipment "released" by the Center for general usage will require a well-designed and effectively implemented introduction effort. Consequently, research and development, local manufacture and machinery introduction are interdependent elements of an optimal mechanization program.

Cost/Benefit Comparisons

Succeeding sections of this chapter summarize presently available information on the prospective costs and benefits of using each of the above types of equipment under typical Egyptian farming conditions. As the machines in question have been little used in Egypt, both cost and

benefit data necessarily are "best estimates" based mainly upon experience in the United States and other countries. Even the data on operating costs and related aspects of presently used equipment rely heavily upon informed local opinion. That there is no significant body of Egyptian research upon which to base machinery introduction decisions bears mute evidence to the urgent need for attention to farm mechanization research and development.

Disc/Spike Tooth-Harrow Combination

The contribution of these implements to the quality of seed bed preparation--hence to improving plant germination and crop yields--is covered elsewhere in this report. However, a further word on the cost-saving opportunities they afford may be useful in the present context. Basically what the introduction of this combination of implements permits is better seed bed preparation with less plowing, dragging and hand ditching. As land preparation, particularly for maize and rice, comes at the season when labor and power supplies are most inadequate to the requirements for all farming operations combined, savings of man labor, animal power and tractor time can directly increase the timeliness of that operation and other farming operations alike. The following comparisons with alternative present practices illustrate the magnitude of potential savings involved:

TABLE XVII. 2

MAIZE: LAND PREPARATION, DAYS REQUIRED PER FEDDAN

Operation	Non-Mechanized[1]		Partially Mechanized[2]			Fully Mechanized[3]	
	Man Days	Animal Days	Man Days	Animal Days	Tractor Days	Man Days	Tractor Days
Plow	5.5	11.0	.25	--	.25	.125	.125
Disc & Harrow	NA	NA	NA	NA	NA	.125	.125
Drag	1.0	3.0	1.00	3.0	NA	NA	NA
Ridge	1.0	--	1.00	--	NA	.062	.062
Ditch	1.0	2.0	1.00	2.0	NA	1.000	NA
Finish	4.0	--	4.00	--	NA	4.000	NA
Total	12.5	16.0	7.25	5.0	.25	5.312	.312

NA = Not applicable

1 2 times user with animal-drawn baladi plow: 2times over board drag.

2 2 times over with tractor-mounted chisel plow. No other operation mechanized.

3 1 time over with tractor-plow; 2 times over with disc-spike tooth harrow combination; 1 time over with tracotr-mounted chisel plow with ridger attachment.

At 1977 labor and power input costs per unit, power and labor savings from using the disc/harrow combination for land preparation during peak seasons have an estimated value of about LE 9.00 per feddan compared to plowing and dragging with animal drawn equipment; LE 2.00 compared to plowing twice with a tractor and dragging the land twice with animals. The real gains from using the disc/spike-tooth harrow combination though come from the increased yield resulting from better germination, which, in turn, produces better and more even stands. As a result, with reasonable volume, custom operations would be attractive while permitting rates low enough to encourage farmer use of the equipment.

Harvesting (Mechanical Cutting) Machines*

Labor scarcity during the May-June wheat harvest, and again during the September-October harvest period for summer cereals and cotton, extends the grain harvest and delays land preparation, hence the planting of crops which follow. Mechanization of the cutting and threshing operations would thus reduce harvest losses and increase production of the crops which follow by allowing them to be planted at the optimum time. All told, some three million feddans are planted to cereals and beans each year. Another 1.3-1.5 feddans are planted to cotton, the stalks from which have to be removed before seeding wheat or berseem. Consequently, the mechanical cutting of cereals, beans and cotton stalks potentially could benefit production on three-fourths of Egypt's total cultivated area.

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* In Egypt, the term "harvesting" means cutting of the grain.

The harvesting (or cutting) of cereal crops is still done almost entirely with a hand sickle. Attempts to introduce the scythe as a better hand tool have been unsuccessful. Six man-days are required to harvest a feddan of wheat or rice by hand. Just getting the crop cut is, therefore, an arduous and time-consuming task to which much of the cause of late harvesting must be assigned. The extended harvest period also results in field losses due to shattering, lodging, and some reduction in dry matter. Published research on the grain losses attributable to various operations as preformed in Egypt is very limited. Indications are, however, that comparative losses by alternative harvesting methods are about as follows:

Harvest Method	Percent Loss
1. Cutting by hand, transport by camel, threshing by animals (norag)	22.7
2. Cutting by hand, transport by camel, threshing by stationary thresher	13.2
3. Combine harvesting	3.7

These data indicate that on the average 9.5 percent of the grain yield is lost due to hand cutting and camel transport. While dividing this loss between the cutting methods and means of transport can only be a matter of judgment at this juncture, the Study Team concluded that roughly half is attributable to each. Thus, more timely harvesting would, in effect, increase wheat and rice production by some 4-5 percent. Mechanical cutting of cotton stalks would save about 9 man-days per feddan during the fall peak season and free the land for earlier seeding of wheat or berseem alone.

A few imported Italian mower-binders are being tried in Egypt. The units are self-propelled by a 13 hp diesel engine and have a 1.3 meter cutting width. They have been very successful in wheat, but less so with the tall Japanese rice varieties. The Ministry of Agriculture has decided to encourage the use of the machine--but simply as a mower--as suitable for small holdings. If the unit is used without the knotting device, it becomes essentially a mower-windrower. However, it would appear desirable in this case to order it simply as a mower, which will reduce the cost about LE 700. The mower-binder costs LE 2300 in Egypt.

The following modifications have been suggested locally to make the unit more acceptable as self-propelled mower for rice:

1. Reduce the operating speed from 4 km/hr to 1.6 km/hr.
2. Increase the ground clearance (or push the cutter bar forward) so that the heads of tall rice will not strike the frame of the machine as they fall, and
3. Equip it with steel paddy wheels.

The use of combines is limited to the State Farms developing the New Lands. There are about 300 units in the country. Individuals have expressed interest in a small combine, but the small land holdings, divided by irrigation and drainage ditches, prohibit the economical use of combines. In Old Lands areas, self-propelled mowers or mower-binders, on the other hand, appear quite appropriate for custom operation on the typically small farming units.

Applying the principle for valuing family labor set out elsewhere in this report, hand harvesting of grain cost LE 4.56 at the 1977 average farm wage rate. In constrast, the comparable cost for harvesting by an Italian-type mower-binder comes to LE 1.85 per feddan. Counting the time required for collecting the winnowed grain into sheaves for

transport from the field, costs with a mower-winnower would be 10-15 percent higher. Following is a breakdown of the estimated per feddan cost of harvesting with a self-propelled mower-binder:

Selling price = LE 2300

Life expectancy = 5 years or 3000 hrs

End of use value = LE 230

Interest = 10.5 percent

Depreciation/hr = 0.690 LE

Interest = 0.211 LE

Fuel = 0.05 LE

Oil = 0.013 LE

Repair and maintenance = 0.69 LE

Operator wage/hr = 0.20 LE

Total = 1.85 LE per hour use

The model of mower-binder currently being field tested in Egypt has a field capacity of one feddan per hour. To reduce the wheat harvest period to an average of two weeks thus would require one mower-binder per 100 feddans or 2-3 machines per village on the average. On this basis, full mechanization of the entire wheat harvest would require about 10,000 machines. The same machine can be used for harvesting wheat, rice, barley, berseem and for cotton stalk removal as these operations come at different seasons. This should make the mower-binder an attractive machine for custom operations as the crop sequence would permit at least 400 hours of use per year.

As the preferred type of mower-binder is made in Italy, AID participation in financing the introductory imports is not feasible.

Through the Machinery Management Advisors in the proposed Technical Assistance Advisory Group, however, AID advantageously can assist in planning an appropriate introduction campaign and help ensure effective follow-through.

Thresher-Winnowers

Wheat and rice typically are threshed by one of three methods: (1) animal-drawn norag (2) tractor-drawn sledge or (3) locally manufactured tractor-powered drum thresher. Grain sorghum typically is threshed by beating the heads with sticks, various kinds of beans by norag or by hand methods. Survey results indicate that about half the threshing of rice and 60 percent of wheat is "mechanized" after a fashion. Mechanization of rice threshing, however, consists mainly of substituting tractor-drawn sledges for the traditional animal-drawn norags. Only some 10 percent of all rice is threshed with drum threshers as that machine produces a high percentage of cracked grain when used for rice threshing. Cracking is not a problem with wheat, however, and most of the mechanized wheat threshing is by drum thresher.

None of the presently used threshing methods separates the straw and grain. A custom-operated hand-powered winnower is widely used for separating and cleaning rice and wheat grain. However, much of this operation is still performed in the traditional way by men tossing the grain-chaff mixture into the air with forks for wind separation. Threshing by norag not only is time consuming but may leave the grain dirty and contaminated with animal excretions. Tractor-drawn sledges tend to avoid these difficulties but make inefficient use of tractors needed at the same time for field work. Some experts also argue that

driving a tractor over chaff for extended periods significantly increases engine deterioration and maintenance costs.

Belt-driven drum threshers are reasonably fast, typically threshing the grain from three feddans per day and are more efficient than either the norag or sledge. They too, however, make poor use of scarce tractor power, as the thresher needs only 16 hp of the typical tractor's 60 hp potential. And as noted previously, drum threshers are not a satisfactory way of threshing rice. Most importantly, as indicated in the preceding discussion of harvesting methods, grain losses can be cut in half by using a stationery thresher-winnower as contrasted to the norag or sledge and can be cut by perhaps a quarter compared to the drum thresher.

Development of a small thresher-winnower, which started from an IRRI design, has been sponsored by the Ford Foundation as part of a program for developing small, locally fabricated, multipurpose machinery to work with a 10 hp diesel engine. The concept has attracted joint participation by the Catholic Relief Services (CRS), the Behera Co. (a public-sector operation producing agricultural machinery) and support from a Food for Peace local currency grant to CRS. A limited number of this machine has been produced and field tested. The machines were well received in the trials on sorghum in Sohag during September and October 1978. Design modifications are being made to change from three to four transport wheels and to stiffen the engine mount.

The Ford Foundation, in cooperation with CRS, has concentrated on sorghum because there is no suitable machine presently available for this threshing crop. Threshing and winnowing of sorghum by traditional methods (beating with a stick) takes eight man days at a cost of LE 600 to LE 8.00 per feddan of sorghum in 1 1/4 hours at a machine

custom rate of LE 4.00 per hour or LE 5.00 per feddan. The machine is equipped with a small generator to power headlights so that a double shift can be worked. For threshing paddy, most of the knives should be removed from the cylinder. A reduced cylinder speed is required for soybeans. Threshing one feddan of wheat requires seven hours; one of rice is estimated at five hours. Design modifications to increase the wheat threshing capacity are being investigated. This machine appears to have an excellent potential for custom operation and would free tractors to do soil preparation work.

Another thresher-winnower designed by a staff member of the College of Agriculture, Cairo University, has been built by Salam Workshop. It includes a multi-purpose drum thresher, a fan and a mechanical agitator-conveyor--all operated by a 5 hp motor. The design is very simple and is still under development to improve the separating and cleaning efficiency.

As an interim step, introduction of the small self-powered thresher-winnower will make a significant contribution toward increasing the productivity of Egyptian agriculture. In some situations this type of thresher will best meet local needs on a continuing basis. More generally, however, the Study Team believes that once farmers become familiar with a thresher-winnower's advantages over present methods, both they and custom operators will prefer a larger and much faster machine.

The IRRI-type thresher can handle only about 1 2/3 feddans of rice or 1 1/4 feddans of wheat in eight hours. A drum thresher can do twice as much. Consequently, to optimize the contribution of further mechanization to grain threshing, it would be advantageous to introduce a high

capacity (2.5 tons per hour) thresher-winnower on a limited scale soon after the IRRI-type thresher becomes generally available. The Alvin Blanch Minor thresher manufactured in England or the type made in the United States for use on experiment station plots appears well suited to Egyptian farms. One high-capacity machine could thresh all the wheat or rice in an average-size village in about two weeks--an objective to be sought with optimal mechanization. As different crops have different harvest periods, there should be enough demand during a twelve-month period to make the high capacity thresher-winnower an attractive investment for custom operators. Such machines also should prove especially advantageous on the State Farms developing the New Lands. Comparative costs on threshing wheat by the respective methods are indicated by the following summary:

TABLE XVII. 3

COMPARATIVE COSTS OF THRESHING AND WINNOWING WHEAT BY ALTERNATIVE TYPES OF EQUIPMENT[1] PER FEDDAN

Item	Unit	Morag	Drum thresher	IRRI-type thresher-winnower	High capacity thresher-winnower
Elapsed time					
threshing	hrs	32.0	1.14	7.00	.74
winnowing	hrs	16.0	16.00	--	--
Total	hrs	48.0	17.14	7.00	.74
Costs					
Man Labor	LE	6.00[2]	2.40	2.66	.42
Animal Labor	LE	3.20	--	--	--
Machine use	LE	*	6.30[3]	5.30[4]	4.19[3]
Total	LE	9.20	8.70	7.96	4.61

*Nominal

[1]See Technical Appendix 4 for basis of cost estimates.

[2]Includes 4 boy days at approximately one-half the man day wage rate.

[3]Includes tractor costs.

[4]Self-powered. Cost includes both thresher and 10 hp motor.

As regards machinery introduction per se, AID financial assistance is warranted only with respect to introductory imports of high-capacity threshers. This is not to suggest that AID need not be concerned with getting the IRRI-type thresher effectively into use on a major scale. Rather it is that the Food For Peace local currency grant to IRC has enabled that organization to procure 50 of these machines for field testing and demonstration. IRC interests together with those of the Ford Foundation and the Engineering Department of Alexandria University should provide an adequate basis for MOA to build an effective introductory effort. As there is no US or 941-country source of the kind of diesel engine required for powering the IRRI-type thresher known to the Study Team, there is no apparent scope for AID assistance to importation of this component.

What USAID usefully can and should do as a priority matter is encourage MOA and other concerned parties to complete promptly the essential modifications of the prototype model already under field testing and to put the machine into production for general use. AID can also facilitate local manufacture through the plant moderization assistance proposed in Chapter XVI and can usefully expedite the introductory process through encouraging MOA to give the IRRI-type thresher higher priority than it has received to date. AID should provide appropriate technical assistance as circumstances warrant through the Machinery Management Extension component of the proposed Technical Assistance Advisory Group.

Introducing the high-capacity thresher will require more concerted planning and follow-through effort by both MOA and USAID than most of the other new types of equipment proposed for machinery introduction

treatment. If it is to shorten the threshing season significantly, the high-capacity thresher will be economical only where it can be used for two crops a year - the rice belt and wheat grain sorghum-growing areas of upper and middle Egypt. Even there, a large number of users is necessary to guarantee profitable custom operation of such machines. In the beginning, it may prove advantageous to concentrate on State Farms and rice-belt farmers with large combined acreages of rice and wheat who are willing to assume major demonstration responsibilities. As the machines can easily be moved from place to place, there is no need to limit initial coverage to a single village. In fact, inter-village cooperation in the use of high-capacity threshers might well produce social benefits of much wider significance.

For some years, Egyptian farmers probably will continue to use a mixture of threshing methods, with drum threshers increasing along with introduction of both types of thresher-winnowers alluded to above. Drum threshers are locally manufactured by the Behera Company in Alexandria, Tanta Motors in Tanta, Salaam Workshop in Old Cairo and many other small shops throughout the country. Assuming a positive introduction effort and active local manufacture/market development by modernized plants of the two types of thresher-winnowers recommended, the number and types of machines in use over the next several years might reasonably be expected to be about as follows:

Type	1978	1979	1980	1981	1982	1983	1984	1985
Drum	4000	4500	5000	5500	6000	6500	6800	6900
IRRI-type	100	200	400	700	1200	1800	2400	3000
High capacity	--	--	10	110	310	610	1110	1610

Planters

There is little scope at present for economical mechanization of seeding wheat or berseem. Nor is there yet available a practical means for mechanizing the transplanting of rice in Egypt. With row crops, however, the situation is quite different. Where field lay-out and size permit their efficient operation, 4-row tractor-mounted row crop planters can yield attractive returns. Consequently, the Study Team recommends that 100 such planters be procured for trial introduction on State Farms developing the New Lands and in land-reform areas where field consolidation and joint cultivation are established practices.

Compared to present hand-seeding methods, field trials indicate the better seed placement possible with mechanical planters can increase the yield of cotton and maize by at least 10 percent. Similar increases should be possible on grain sorghum and bean crops. Counting only the yield increases on cotton and maize, the calculations in Chapter XXIV indicate that row-crop planters of the type recommended would yield an internal rate of return of about 40 percent to the Egyptian economy. At 1977 farm-gate prieces for cotton, maize and equipment, and taking into account reduced labor and seed costs, each planter would produce an estimated net return per year of some LE 750 or about 30 percent of its initial cost. This is not to suggest, of course, that a custom operator could expect to realize that level of return, as it reflects the total benefits to be shared between the equipment owner and the farmers who use it on a custom basis. Nonetheless, such returns would permit profitable custom operation at rates which farmers could well afford to pay.

The preceding calculations make no allowance for improved timeliness of planting, which could add a few percentage points to the overall returns, especially in the case of maize. Those calculations likewise take no account of the much more significant additional benefits that could derive from the mechanical cultivation made possible by the use of row-crop planters.

Introduction of cultivators is not recommended at this time. Mechanical planting alone will represent a major technological change having significant psychological and cultural implications. Only after farmers have become accustomed to mechanical planting can they be expected to adopt still another practice that so radically alters traditional farming methods as would mechanical row-crop cultivation. On State Farms that transition probably could be effected much more rapidly than on individually operated units.

CHAPTER XVIII

APPRENTICESHIP TRAINING

Background

With only partial mechanization of agricultural operations in Egypt, there is, nonetheless, a shortage of skilled workers able to repair and make spare parts for tractors and other farm implements. The scattered small repair shops have limited staff and, like all other employers of skilled labor, are losing better workers to higher paying jobs in the cities or abroad. As mechanization progresses, and the drain of skilled workers from rural areas increases, the shortage of skilled labor may well become the principal bottleneck to efficient use of farm machinery nationally.

The growing demand for trained mechanics signifies opportunities for mechanically gifted underemployed farm youths and demobilized service men. As mechanics, they would make a greater contribution to agricultural productivity than as workers on the farm a few days a year. One source of jobs would be the machinery repair and service centers proposed for financing under the USAID mechanization-assistance program. Other repair and parts-making shops will also require skilled personnel as further mechanization expands their business. NASCO and other farm machinery manufacturers now have to search out raw recruits and give them post-employment job training before they become useful employees. In general, national emphasis on mechanization of agriculture implies a program for which capable mechanics will be in demand.

Recommendations

To meet the twin needs for meaningful work for underemployed farm youths and the growing demand for mechanics, the Study Team proposes that a five-year apprenticeship training program be organized and operated through the Arab Federation of Agricultural Workers. The Federation is keenly interested in organizing mechanic training in rural areas to keep amibitious farm youths in work related to agriculture. For some time, Federation leadership has been actively seeking ARE or other finacial support to start a network of centers for such training. The proposed apprenticeship program would serve the same purpose without requiring the substantial investment in buildings and equipment that development of training centers entails.

Implementing Entity

By interest and organization, the Federation is uniquely qualified to assume leadership of the proposed apprenticeship activity. It is a private, non-profit labor union whose membership includes virtually all agricultural workers in Egypt. In addition to its national headquarters staff in Cairo, the Federation has a representative in each governorate, district and village or area served by a cooperative where that area is not a single village. Its national officers maintain close liason with the Ministry of Agriculture. A unit in MOA has general oversight responsiblities with respect to the Federation's union activities, especially as they relate to organizing and contracting for supplying laborers for public works such as canal cleaning and New Lands development. In addition to finding opportunities for employment

of farm laborers through its own contracts, the Federation also monitors private contractors who mobilize farm workers for seasonal operations to ensure fair wages and working conditions. These operations are for the most part carried out by local unions. Their elected representatives serve on the district and governorate level governing bodies. Consequently, the Federation comprises a network of personnel with extensive operating and group-participation experience. As a result, the local unions ensure that the interests of their members are served as fully as possible and that, through the Federation, national and governorate leadership are responsive to village level interests.

Operational Arrangement

Under this recommendation, AID would make a five-year conditional grant to the Federation for mounting an apprenticeship program of a size, scope and design mutually agreed among the Federation, MOA mechanization program leadership and USAID. Within a broad policy framework, the Federation would assume full responsibility for organizing and implementing the program. Specifically the Federation would:

a. Work out agreements with qualified mechanics and/or repair shops in rural areas for training assigned apprentices.

b. Select and assign promising apprentices.

c. Pay from the AID grant funds, apprentices' stipends and/or living costs while in training.

d. Also from AID grant funds, pay trainers such charges as may prove necessary to enlist their participation.

e. Arrange with nearby secondary agricultural schools and/or teachers to provide special short courses for apprentices at times regular classes are not in session.

f. Provide adequate program supervision to ensure that the quality and quantity of training given is in accord with agreed plans.

g. Facilitate post-apprenticeship employment of successful program graduates with particular emphasis upon employment in agricultural-related work in rural areas.

As regards program supervision, the Federation would engage at its national headquarters a full time Program Director professionally qualified to guide the organization and operation of local level apprenticeship training activities. In addition, the Federation would engage a professionally qualified person to serve full time as Training and Employment Director in each governorate or other reasonably large geographic area. These governorate-level Program Directors would have primary responsibility for: organizing the local apprenticeship training activites through the village unions or other appropriate means; and for continuing oversight of the programs after they are established to ensure that the content and quality of training provided meets acceptable standards. Salaries and travel expenses of the national and governorate-level Program Directors and the costs of requisite support staffs would be paid by the Federation from the AID grant funds.

Content of Training

Substantively, the apprenticeship program would combine on-the-job training with special short courses at nearby secondary schools where the number of apprentices in an area warrants. Particular emphasis would be given to placing apprentices with skilled mechanics. The objective would be to provide the variety and quality of work experience that would in 11 months transform a raw recruit into a trained mechanic capable of efficiently repairing

farm equipment. It would be too much to expect, of course, that in so short a period every apprenticeship training graduate would be equipped single handedly to cope with the complex problems entailed in major repairs of motorized equipment. Some might be. More generally though, it is anticipated that graduates would be prepared to go into existing small or large repair shops, fabricating or assembly plants or Area Service Centers and perform with acceptable efficiency under general supervision.

An after-hours, short course program is also recommended, one designed to broaden the apprentices' technical perspective and thus prepare them to move beyond work as mechanics and into more senior jobs as they gain experience. These courses would be organized and conducted outside regular school hours by local teachers who would be appropriately remunerated by the Federation from the AID grant funds.

In the Study Team's judgement this apprenticeship training effort can best concentrate upon producing trained mechanics. Given the paucity of trained tractor drivers a case could be made for including that aspect of machinery management in the apprenticeship program. This possibility was considered but rejected for three main reasons:

First, the locus, duration and substance of training for tractor drivers would have to be quite different from that appropriate for mechanics. To include tractor driver trainees would in effect require that the Federation operate two different training programs at the same time. Manageability considerations alone consequently argue strongly against combining the two activities.

Second, the basic skills of tractor driving and utilization can be developed satisfactorily through short group courses. Organizing and conducting such short courses in local communities is intended to be one of the major functions of the proposed Machinery Management Task Force.

Third, several tractor driver training facilities already are in operation. Reports indicate that they are enjoying indifferent success partly because they require farm youths to be away from home for an extended period. This problem could be largely overcome by localizing such tractor driver training facilities--particularly if the relevance and quality of training provided also were improved.

In the Study Team's judgment, Egypt's needs for better-trained tractor drivers could be met more appropriately by a separate effort directed toward this objective than by incorporating it into the proposed apprenticeship program. Much can be done on this front through effective use of train-the-trai techniques as an integral part of the overall machinery management extension subproject.

Number of trainees

The Study Team recommends that the apprenticeship program be designed to accommodate an average of 400 apprentices per year (i.e. in each 11 months). Given the substantial organizing effort required at the outset, the first year's program might not include half that number; in years two and three the total might rise to 450 or 500; there would be a tapering off in the fourth and fifth years as the most pressing need for additional mechanics is met.

With no formal apprenticeship programs of the type envisaged presently in operation in Egypt, forecasting the demand for graduates of the proposed program necessarily is speculative. Study Team observations in various parts of Egypt indicate that the young boys who learn the rudiments of equipment repai working with "shade tree' mechanics have no difficulty finding jobs. Complaints were widely heard about the exodus of skilled workers, particularly mechanics, to higher paying jobs in the Oil States. And even fleeting reflection upon the state of repair of Egypt's tractor fleet, especially the units owned by cooperatives and State Farms, leaves little question as to the need for a large increase in the number of trained mechanics.

The recommended target of 2000 apprentices during the five-year program period is based on the preceding considerations. Its magnitude is particularly

influenced by the Team's expectation that a high percentage of those trained by this program will sooner or later move to more remunerative employment in urban areas or join the outflow of Egyptian workers to take advantage of employment opportunities outside Egypt. Consequently, the target figures assume that the number of apprentices entering training will need to be two to three times the estimated requirements for servicing farm equipment in rural areas. While this "leakage" increases the necessary size of the apprentice training effort, it is by no means a loss either to the economy or to the broad purpose of AID assistance to Egypt. Training given those taking non-farm jobs, whether within Egypt or abroad, would produce net gains to the Egyptian economy by upgrading the urban work force and/or increasing the earnings, hence remittances, of those working abroad.

The Study Team further assumed a general broadening of the market for mechanics to result from a heightened interest in maintenance generated by the whole farm mechanization program. The Machinery Management Extension and Service Center Development subprojects would have significant impact in this regard. With the hoped for increased awareness of the importance of machinery care and quality repair services would come pressure on small repair shops to upgrade services; for new ones to emerge better to serve local communities; for State Farms to employ trained mechanics to keep equipment in full operation; and for cooperatives individually or collectively to retain trained mechanics to service their own machines and perhaps meet first eschelon repair requirements of their members.

With emphasis upon the speculative nature of any forecast of prospective demand for mechanics having 11 months of apprenticeship training, the five-year,

2000 apprentice target figure assumes a breakdown of employment for these personnel along the following lines:

200 to Area Centers and satellite small shops.

300 to other small shops in rural communities

100 to component/spare part fabricators situated in rural or suburban localities

100 to State Farms and cooperatives

1,300 to foreign and urban employment including Egyptian plants manufacturing or assembling farm implements

2,000 Five-year total.

Sources of Trainees

Trainees selected for the Apprenticeship Program would be ambitious but underemployed farm youths who, if they do not find interesting and remunerative jobs in the rural areas, would be likely to migrate to the cities. Many, no doubt, would come from among the 10,000 "assistant agricultural engineers" graduated each year by Egypt's 55 secondary agricultural schools; their studies will have provided some exposure to subjects related to farm mechanization. Young men completing their military service are another large source for apprentice recruitment. Having experienced the amenities of urban living during their military service, these young men reportedly are particularly loathe to return to the privations of rural underemployment, hence, they are most likely to migrate to the cities in search of a more satisfying way of life.

As the roster of potential candidates would substantially exceed the number that could be accommodated in the proposed program, recruiting enough promising candidates to fill each year's classes would be no problem. On the contrary, the challenge to the Federation and participating local unions

would be to establish screening procedures to ensure that candidates are selected on merit, and that among those who are basically well qualified, perference is given to youths in farm families at the lower end of the economic scale.

Program Costs

The cost estimates summarized in the attached table assume one apprenticeship training program in each of 20 governorates with 20 apprentices trained for 11 months in each. Should USAID/MOA/Federation discussions of this proposed program indicate the preceding projections of prospective off-take to be lower or higher than circumstances warrant, the funding level could be adjusted accordingly. Particular care needs to be taken, however, not to start this program on a scope that would overtax existing implement capabilities. The Study Team feels it important to gear planning at the outset to realistic joint estimates of the number of qualified trainers likely to be willing to participate and the size of program the Federation can manage effectively. The quality of the end product is likely to prove a decidely more important determinant of the program's success than mere volume.

Apprenticeship Training Progam
Estimated Five-Year Costs

Governorate Training Programs	5-year Total[1]
Training costs	
Stipends for apprentices during training	$ 754,300
Fees to local repair shops providing on-the-job training	171,400
Payments to local teachers conducting special classes outside regular school hours	92,600
Instructional materials and supplies	68,600
Support Costs	
20 governorate program directors	123,400
National Program Director in headquarters of the Arab Federation of Agricultural Workers	51,400
Secretarial and clerical aides	8,300
Travel and per diem (governorate and national) Program Directors	62,500
Total	$ 1,332,500
20% allowance for contingencies	266,500
Grand Total	$ 1,599,000

[1] All cost data include an allowance for inflation of 10 percent of the base year per year.

CHAPTER XIX

PARTICIPANT TRAINING

Introduction

For Egypt's Farm Mechanization Program to make its best contribution to agricultural production and national welfare, many individuals, from farmers and custom machine operators to national program leaders, will perforce have to change customary practices. Willingness and ability to make the requisite changes ordinarily come with knowledge of the opportunities particular changes offer and how they can be realized. Given enough time, domestic experience and institutions may produce both the awareness of opportunities and the capabilities for exploiting them effectively. However, study abroad and exposure to an environment where technological change is already well advanced, can significantly advance the time-frame for progress at relatively low cost. These are the purposes seen for participant training in the mechanization-assistance program.

Recommendations

Two broad, mutually reinforcing types of participant training are proposed, each with its own particular purpose, clientele and modus operandi:

A. Short term: exposure/motivation-type study tours to create an awareness of the benefits of efficient use of improved technology

and the management, service and related requisites for achieving high efficiency in the use of farm machinery.

B. Longer term training to add depth to (1) junior and middle level staff members of MOA, the co-op system, agricultural banks, et al who are or will be directly concerned with significant aspects of farm mech-nizat and (2) selected Instructor or Assistant Professor level personnel from Faculties of Agriculture.

Short-Term Programs

To gain impact, this effort would be relatively large and diverse at the outset and taper down in scope and focus as momentum of the mechanization progr increases. Subject matter and selection of participants will be focused on points in the mechanization system where lack of understanding of the needs for changes in current practice might be serious constraints upon progressive farm mechanization. Specific constraints typically emerge from workings of a system and invariably change in character and locus as a program matures. Details thus could best be left to annual reassessment by MOA mechanization program leadership and the Technical Assistance Advisory Group, with participation by USAID as it deems appropriate.

Near term priorities evident from the present study illustrate the scope an character of the exposure/motivation type of short-term participant training visualized. Beyond that, it is feasible only to indicate the probable level of financing likely to return high dividends in succeeding years of the 5-year AID-assistance program. Four nearby countries- Greece, Yugoslavia, Turkey and Spain - might be especially good locales for most of the short-term training in the first two years. Special arrangements would need to be made with the respective governments to accommodate the number and variety of study tours involved. With such arrangements and appropriate coverage of the special costs involved, it should be possible to make these study tours considerably mor

substantive than guided visits to local institutions. With adequate advance timing, it is not too much to expect that a system much like that developed in the United States could be established where the receiving country organize topic-oriented short courses to supplement observation contacts at sites appropriate to a given study group's interests.

For such a system to work, Egypt would have to do its part by scheduling study tours well in advance, selecting well qualified participants, providing them with effective pre-departure orientation for the study program, detailing their personal responsibilities to make it succeed, and insuring that departure schedules are maintained. Managing a short-term participant training program of this sort will involve a substantive and logistical work load of some proportion. Thus, it is recommended that MOA designate a reasonably senior officer to be director of this activity for its first two years. Funding for this function and responsibilities of the director are discussed under Section 3 below. The content of the short-term programs might include the following subjects:

1. Machinery Management:

   a. Two-month study tours for six 3-man teams of district and governorate level agricultural officers who have major farm mechanization responsibilities in their respective areas.

   b. One-month study tours for five, mixed 3-man teams composed of village co-op managers and local custom operators. Most of the custom operators would be selected from among small farmers who have turned to custom operation as a means of expanding their livelihood. Generally it would seem preferable for the co-op managers and custom operators to come from different parts of the country in order to spread the impact.

   c. Two-month study tours in Japan, Korea and/or the Philippines for one 3-man team of senior and/or middle level MOA officials and senior consultants responsible for mechanization program leadership to observe and discuss small farm-machinery management practices and related government programs.

2. Mechanization Extension Methods

   a. Two-month study tours in the U.S. for Egyptian members of each of the Joint Task Force sub-units discussed earlier in this report. It would be essential that this training be given as soon as possible after Task Force members are selected, preferably before the American counterparts arrive in Egypt.

   b. One-month study tours in the U.S. for three 3-man teams of governorate and/or district level extension specialists. This training would be primarily at the county level emphasizing extension techniques as applied to farm machinery use and maintenance.

3. Service Center Installation and Operation

   a. Two-month study tours in the U.S. and Greece for two 3-man mixed teams comprising members from the MOA unit responsible for setting standards and monitoring service quality and for designees from Area Centers approved for establishment or upgrading assistance through the proposed Service Center Development Incentive-Loan Fund.

4. Research and Development

   a. Three-month study tours in the U.S. on applied research project design for two 3-man teams of Assistant Professor-level agricultural engineers and social scientists concerned with mechanization research directly or through their graduate students.

Longer-Term Training

The principal purpose in all instances of longer-term training would be to develop leadership potential. This training would complement that for the 30 Egyptian graduate students participating in the Egyptian-American Collaborative Research program proposed in the Research and Development section of this report. The programs visualized include:

1. Two-year study programs at U.S. Land-Grant Universities for 10 persons during the 5-year project period who would obtain an MS degree in Agricultural Mechanization and return to Egypt upon completion of that degree to work in the field of mechanization.

2. Three-year study programs at U.S. Universities for 5 persons during the 5-year project period to enable them to earn a PhD degree in

Agricultural Eingineering, Agricultural Mechanization or other fields relating directly to agricultural mechanization.

3. One-year post-doctoral study in the U.S. for 10 participants during the 5-year project period, the candidates selected primarily on the basis of demonstrated leadership potential.

Estimated Costs of Participant Training Program Recommendations

The costs of the short-term and long-term training programs have been estimated as follows:

1. Short-Term Participant Costs

First year	
Machinery management	$ 106,800
Mechanization extention methods	65,000
Service Center installation & operation	30,300
Applied research design	28,400
Total first-year training	$ 203,500
Second year	162,800
Third year	111,000
Fourth year	56,400
Fifth year	30,200
Five year total	$ 563,900

2. Long-term Participant Costs

	Start	Finish	Total Cost
First year	--	--	--
Second year	9	4	$ 159,300
Third year	8	7	239,900
Fourth year	5	5	214,400
Fifth year	3	5	166,600
Total			$ 780,200

3. Director of Participant Studies

To coordinate planning of participant studies and to establish arrangements

unit with an expected life of two years would be established in the Undersecretar for Engineering and Farm Mechanization. Staffing for this office would comprise:

-- A senior level Egyptian Director with substantial international experience. This individual would spend a high percentage of his time travelling: first to establish training arrangements with the receiving countries and subsequently to facilitate the study tours of respective study teams.

-- A mid-level Egyptian Assistant Director to concentrate on internal aspects of the farm mechanization participant training program. As the Director will be away much of the time, the person filling this position must have the maturity of judgement and seniority for independent action.

-- Two logistical aides and a secretary to handle transportation and other logistical support arrangements.

The principal reason for establishing this special unit is to insure that short-term participants sent abroad have productive tours. After two years of operation, processes in the receiving countries should have become sufficiently well established to function satisfactorily without direct MOA involvement. The special unit thus could be abolished at that time and its functions transferred to the ARE office responsible for all other participant training activities.

To facilitate establishment and operation of the Farm Mechanization Participant Training Office during its life span, AID would finance all operating expenses including the salaries of the Egyptian personnel involved.

Participant Study Director Costs

	1st year	2nd year	2-year Total
Director (incl. travel)	$ 20,400	$ 24,500	$ 44,900
Asst. Director (incl. travel)	4,500	4,900	9,400
Secretarial & clerical aides	2,000	2,200	4,200
	$ 26,900	$ 31,600	$ 58,500

CHAPTER XX

PLANNING AND EVALUATION

Approach

Any organization's effectiveness in achieving its intended goals frequently depends heavily on the efficiency of its management information system. This system, however structured or informal, provides leadership with the basis for decision-making and planning in the first instance and in the second for adjusting plans to operating experience. Thus, the soundness of leadership decisions turns in large measure on the timeliness, relevance and reliability of information which its management information system produces. Needless to say, the larger and more complex the organization and the more rapidly leadership must reshape or adjust programs. the less it can afford to depend upon unstructured decision-making information.

At present the information flow to MOA mechanization program leadership is largely informal, unstructured and meager. Outreach of the existing management information system is limited and episodic. No staff unit exists that specializes in gathering and analyzing data useful for program planning and evaluation. Instead, collection, analysis and interpretation of relevant information is largely limited to what the Undersecretary can do himself, amidst the multitude of other claims upon his time, with some inputs from the Supreme Council on Farm Mechanization and other committees. Despite these limitations, he has been able, during his brief tenure, to accomplish much by way of redirecting national farm mechanization policy and program execution philosophy.

However well it may have served program leadership needs in the past, the existing management information system must be considered inadequate for present needs. No one encountered in the course of the present study is more cognizant of the present system's inadequacy or more understanding of how and why it must be strengthened, than the current Undersecretary for Engineering and Farm Mechanization. Far from implying criticism of present program leadership, the succeeding suggestions for strengthening the Undersecretariat's management information system should be read as supporting and, hopefully, accelerating changes already in process. Without an adequate system for decision-making information quickly brought into being, there is reason to doubt whether any person, regardless of how capable, energetic and dedicated, can effectively manage the added farm mechanization inputs outlined in this report. Strengthening the Undersecretariat's capacity with a data base for program planning and evaluation is vital to the efficient use of additional farm equipment and related programs. The Study Team recommends that Government's intent to proceed promptly to establish the required data system be formalized in a covenant to the farm mechanization assistance agreement.

Recommendations

It is recommended that a Planning and Evaluation Staff Unit be established immediately within the Undersecretariat for Engineering and Farm Mechanization. The director of that Staff Unit would report directly to the Undersecretary and be looked upon as an extension of his personal role in this field. This unit need not be large. In fact, size might be a handicap. Three or four top-flight professional analysts together with appropriate clerical and support staff would be

adequate to currently-visible needs. A high quality staff would be critical. To attract professionals required to meet the Undersecretariat's management information needs, it is recommended that full advantage be taken of the Ministry's already-established incentive pay policy.

Developing an effective management information system responsive to priority needs of program leadership is no simple task. In particular, it requires an appreciation of the process of high level decision making which comes only with experience. Consequently, to assist the Undersecretary to establish an effective management information system would be a priority task of the Team Leader of the overall AID-financed Technical Assistance Advisory Group (TAAG). In addition to bringing seasoned expertise to bear on technical aspects of information system development, this individual would make a continuing substantive contribution to the flow of decision-making information reaching the Undersecretary through the feed-back from subgroups of the TAAG working daily with key components of the overall farm mechanization program.

Beyond the services of the TAAG Team Leader, the costs of which are set out in another section of this report, AID should make no other financial contribution to establishment or operation of the Undersecretariat's Planning and Evaluation Staff Unit. To do so would inevitably weaken MOA concern with insuring that adequate provision would be made for the critical functions which that unit must perform. As indicated earlier, there must be convincing evidence of firm government resolve significantly to strengthen the Undersecretariat's capacity for competently maintaining an adequate and timely flow of reliable decision-making information. Without such evidence there might be good reason to doubt that other recommended AID inputs toward further mechanization of Egyptian agriculture would produce the full benefits expected.

CHAPTER XXI

TECHNICAL ASSISTANCE ADVISORY GROUP

General

The recommended number, duration of tours and principal functions of AID-financed technical advisors have been outlined in sections of this report which deal with the five components of the farm mechanization assistance program which include requirements for Technical Assistance. This section brings these respective elements together as a cohesive Technical Assistance Advisory Group (TAAG) and summarizes the qualifications to be sought in each respective team member. It also summarizes the personnel and support costs detailed in the respective subproject budgets; recapitulates the local cost components of those budgets; and shows the effect on AID financing requirements of applying the proposed step-down principle to local cost financing.

Qualifications Requirements for TAAG Members

The qualifications to be sought in each category of American advisor personnel are summarized in the following pages. Those for Egyptian members of the respective Joint Task Forces should parallel as closely as possible those for their respective American counterparts. In both instances the priority needs are for individuals who are (a) experienced in the particular fields in which they will be working (b) problem-oriented in their approach to mechanization and (c) demonstrably capable of dealing competently with practical problems.

Team Leader

The incumbent of this position will double as Team Leader for a 13-man multi-disciplinary Technical Assistance Advisory Group and Advisor on program planning and evaluation to the MOA Undersecretary for Engineering and Farm Mechanization. He will be responsible for coordinating the activities of Team Members to ensure effective interrelation of their efforts. As the Team Leader, he will establish an intra-team system to provide a timely flow of experience-based information to supplement the output of the Undersecretariat's management information system. In his role as Advisor to the Undersecretary, the Team Leader's priority responsibility will be to help develop a management information system adequate to the Undersecretary's decision-making requirements. This will include, but not be limited to, evaluation of performance of all major components of the Ministry's farm mechanization program.

The person filling the Team Leader position should have a strong background in agricultural program planning, administration and extensive first-hand experience in senior level decision making. Formal training in management principles is highly desirable; solid grounding in management information systems, principles and operations is mandatory.

It is necessary that the person chosen for this position have extensive overseas experience, preferably in the Middle East, and have demonstrated capability for working effectively with senior host-country officials.

Prior service as Team Leader of a large technical assistance activity is highly desirable.

Machinery Management Extension Advisors

Each Machinery Management Extension Advisor must have demonstrated a strong action orientation toward working with farmers in resolving farm mechanization problems. Prior experience in LDC's, expecially in the Middle East, is desirable in all specialties. All must be willing and able to undertake extensive field travel in Egypt. Brief qualifications for each type of Advisor are shown below:

Agricultural Engineer-Field Machinery: B.S. in Agricultural Engineering or Agricultural Mechanization, preferably the latter. Experience in agricultural extension and machinery sales and/or service is desirable.

Agricultural Engineer-Irrigation and Drainage Machinery: B.S. in Agricultural Engineering, Irrigation Engineering, Agricultural Mechanization or equivalent. Must have extensive first hand knowledge of irrigation, land leveling and drainage equipment. Experience in extension and private custom operations is desirable.

Farm Management: B.S. in Agricultural Economics with major in Farm Management. Practical field experience in farm management extension or work of similar nature is essential. Also must have working familiarity with farm machinery cost and returns analysis and agricultural credit.

Agronomist: B.S. in Agronomy. Experience with tillage research and/or demonstrations, preferably on field crops of the type grown in Egypt, is highly desirable as is experience in agricultural extension or similar work with farmers. Experience as an agronomist working with fertilizer sales organization would be useful.

Extension Education Specialist: B.S. in Extension Education, Agriculture or equivalent. Extensive experience in developing and implementing extension education programs with farmers is mandatory. Particularly important is that the incumbant have demonstrated ability to improvise both methods and visual aids to meet new types of situations.

Small Manufacturer Advisor: B.S. in Agricultural Engineering, Agricultural Mechanization, Industrial Engineering or equivalent. Experience working with a small manufacturing plant would be useful. Should have broad knowledge of manufacturing techniques, raw materials procurement, product sales and service and dealer development. Experience as an Extension Farm Machinery Specialist helpful.

Repair Service Advisors

Attached to the Engineering Department of the Undersecretariat for Engineering and Farm Mechanization for two years each, two technicians would be primarily responsible for assisting that department with the following five key functions:

-- Planning and carrying out an impact campaign to get presently inoperable tractors into use as rehabilitated machines or to use them for spare parts.

-- Drafting performance standards for farm machinery service centers and establishing an effective performance monitoring system.

-- Establishing a spare-parts catalogue and availability-information service.

-- Facilitating the flow of imported or locally fabricated spare parts to Area Service Centers and local repair shops.

-- Counseling service facility operators on practicable ways of improving their service to clients and custom machine operators on how to make best use of repair facilities.

Both advisors must have a strong action orientation, extensive experience in farm machinery repair and maintenance and be willing and able to undertake extensive field travel. Prior relevant experience in LDCs would be helpful, as both advisors must in effect hit the ground running. One must be a qualified "service technician" with experience as a service manager or equivalent at the distributor level with a major farm machinery company. He should have a BS in Agricultural Mechanization or the equivalent, but in this case experience is more important than his area of specialization in college. The second advisor

should be an agricultural engineer with practical experience in working with machinery such as serving as a vocational agricultural instructor typically provides. He must have at least a BS in Agricultural Engineering, Agricultural Mechanization or Vocational Agriculture and have demonstrated particular capability for communicating a service concept of machinery repair and maintenance to students and/or farm machinery operators.

Machinery Development Advisor

The Advisor on machinery development to the Director of the MOA Research and Development Center would be intimately involved in identifying types of new or improved farm equipment that could contribute meaningfully to increasing Egypt's agricultural production. He also would be concerned with: testing selected imported machinery items thought suited to Egyptian farm conditions; modifying prototype equipment to meet local needs; designing and developing new pieces of equipment where circumstances warrant; and with assisting the Director in encouraging local manufacturers to produce proven models. In collaboration with the Center Director, the Machinery Deveopment Advisor also would work with the agricultural research stations at the different universities to coordinate their machinery development research with that of the Center.

The candidate must be a professionally qualified agricultural engineer with at least an M.S. degree and extensive experience with development/modification of equipment to meet particular farm needs, preferably in or for less-development countries. Industrial experience in farm equipment research and development would be highly advantageous. Beyond academic training and relevant experience, the demonstrated ability to adapt relatively unsophisticated machinery items to the needs of particular farming situations is required. Imagination,

an applied orientation, patience and appreciation for the necessity of relating technology to the environment are needed characteristics.

Sakia Replacement Program Advisors

As the American members of the Joint Task Force on Sakia-replacement, two advisors will have primary responsibility for bringing U.S. agricultural extension and training methods to bear on an informational/motivational campaign to encourage and assist farmer groups to replace animal-drawn sakias with motor-driven pumpsets. Both must be experienced in train-the-trainer techniques and in organizing farmers for group activities.

Both should have at least a B.S. degree in Agriculture, have sufficient maturity to gain easy acceptance by Egyptian colleagues and farmers and be willing and able to travel extensively in rural areas. At least one should have first hand experience with irrigation farming, preferably pump irrigation. Prior relevant experience in LDCs would be desirable.

Research Administration Advisor

Chief among this Advisor's responsibilities will be assisting the Director of the MOA Mechanization Research and Development Center in planning and guiding the implementation of a broad-based program of mechanization-related research in cooperation with universities, Government research facilities and individual researchers. In particular, the functions will include advisory assistance in (a) setting research area priorities (b) evaluating project proposals submitted by applicants for financial assistance through the mechanization research fund (c) counselling applicants on research design and appropriate methodology and (d) stimulating mechanization-research interests among institutions, individual scholars and private industry, expecially in collateral fields such as crops,

livestock and the social sciences.

As the bulk of this aspect of the Research and Development Center's program will be carried out by or in universities, the person for this advisory position should have the qualifications of a senior professor with extensive exposure to research administration at the college level in a Land-Grant University. A broad-guaged Director or Assistant Director of a U.S. Agricultural Experiment Station would make an ideal candidate.

Experience with farm mechanization research is essential but this Advisor need not have an agricultural engineering background. Far more important than technical expertise in farm machinery as such is the need to have demonstrated high capability in planning and directing applied research, be well grounded in modern research methodology and be able to take a broad view of what the field of farm mechanization logically encompasses.

A PhD is essential as much of this advisor's work will be with Egyptian university personnel. Prior successful overseas experience, preferably in the Middle East, would be highly desirable. With or without such first hand experience in less developed countries the individual chosen as Research Administration Advisor must have a demonstrated interest in tackling the needs of developing countries for applied research on agricultural mechanization.

The Egyptian Director of the Research and Development Center should be an experienced research administrator with sufficient engineering background to be able to guide engineering staff in designing/modifying equipment to meet Egyptian farming conditions and to negotiate effectively with farm equipment manufacturers to test/produce promising prototypes developed by the Center.

TAAG Foreign Personnel and Logistical Costs

In total, the recommended TAAG comprises 13 American specialists serving tours of 2 to 5 years each, a total of 55 man years. Their terms of service and costs are shown below.

	Duration	Man Years	Total Cost (000)*
Team Leader**	5 years	5	$ 720
Machinery Management Extension (6)***	5 years	30	4,320
Service Center (2) Development and Tractor Rehab.	2 years	4	504
Sakia Replacement Program (2)	3 years	6	792
Mechanization Research and Development (2)	5 years	10	1,440
	Total	55	$ 7,776

* Based on total per man year costs and allowances as provided for by A.I.D.

** Also serves as Planning and Evaluation advisor to Undersecretary for Engineering and Farm Mechanization

*** Agricultural Engineer specialists on irrigation, land leveling and drainage equipment also service (the technical assistance) needs of the Soil Amelioration subproject, especially its land-leveling component.

American advisory personnel are budgeted at an all-inclusive first year cost of $120,000 per man year plus an allowance for annual escalation of 10 percent of that base figure. Cost data on all TAAG members except the Team Leader are non-add items in arriving at total program cost as they are included in the respective subproject budgets.

Activity	5-Year Total
Team Leader:	
Personnel Costs*	$ 720,000
Support Costs:	
Sedan for travel to field team work sites, universities, et al and necessary travel in Cairo	6,000
Spare parts	600
Vehicle repair and maintenance	2,500
Fuel, oil and lubricants	1,400
English-speaking driver - 5 years	6,000
Total	$ 736,500

TAAG Headquarters**	5-Year Total
Office rental	144,000
Furniture & equipment	9,500
Office supplies	2,900
Telephone and Telex	7,200
1 English-speaking Secretary	20,600
2 typists	20,200
4 clerical aides	20,600
Total	$ 225,000

* Includes in-country per diem and any travel by means other than project vehicle.

** Provision for office supplies, secretarial and clerical assistance, etc., made in the subproject budgets for Joint Task Forces would be pooled for overall TAAG support if recommended arrangement for officing all members at TAAG headquarters is followed.

Project Support Costs

To assure mobility of Team Members and counterpart personnel participating in the Joint Task Forces, operating costs of transport vehicles as well as the vehicles themselves would be AID-financed. Except for the Team Leader, who is not allocated to a specific subproject, all support costs are included in the respective subprojects. Consequently, only the Team Leader support costs and

TAAG headquarters office rental are shown above.

Experience of the present Study Group strongly recommends inclusion in the project a plan providing for AID financing of office accommodations for TAAG headquarters large enough to also house the Egyptian professional and support staff required by the proposed Joint Task Forces. The EWUP model seems an admirable one to follow. While office space rental is technically a local cost item, it is shown here since MOA would probably not need to keep those separate quarters once the TAAG activities have been completed. Therefore, it seems appropriate to exempt the office rental item from the step-down principle applied to all other local costs which AID would help finance.

Three critical components of the proposed mechanization system-improvement program are built upon the concept of Joint Task Forces. This approach is designed to focus concerted professional expertise upon relieving key constraints to progressive mechanization of Egyptian agriculture. In each instance the Task Force has interdepartmental or inter-ministerial functions. At the same time, however, each must be attached administratively to one MOA department. The logical administrative attachment is to the Undersecretariat for Agricultural Extension. However, to function effectively, the Task Forces must be allowed to operate as quasi-autonomous units under the broad policy guidance of the Undersecretaries for Extension and Engineering/Farm Mechanization in two instances and with similar participation by the Ministry of Irrigation and Land Reclamation in the case of the Joint Task Force on Sakia Replacement.

Experience in other countries has shown the most severe limitation on effective participation by host country professionals in technical assistance activities is the freeing of their time to participate regularly and having funds to travel as program needs dictate. These constraints are certain to be

especially acute in the case of the proposed Joint Task Forces, since their functions are outside the ongoing program of the Agricultural Extension Department, and personnel for them well may be drawn from departments other than Extension or even from outside government. To insure that these Task Forces function with fullest possible effectiveness, it is recommended that (a) the salaries, travel expenses, and other costs of Egyptian members be funded by AID grant on a step-down principle and (b) MOA take fullest practical advantage of its established incentive pay policy in attracting to these Task Forces the best qualified Egyptian personnel available. Under the proposed step-down financing arrangement local operating costs would be funded by AID grant as follows: 100 percent for the first two years; 70 percent for the third year; 50 percent for the fourth year; and 20 percent in the fifth and final year. Those subprojects running less than 5 years would follow this same phased funding for their respective durations. A major reason for proposing progressively increased participation by ARE in financing these joint activities is to facilitate their institutionalization by the time the technical assistance program ends. Assuming they have proven their worth, it is reasonable to expect that the respective joint activities will have become regular parts of the Ministry's extension and research programs by the time the AID-assistance program is completed and thus be able to compete satisfactorily for personnel and regular ARE budgetary allocations.

Applying the step-down formula to local cost financing for the 5-year farm mechanization program period, total requirements for AID grant financing would be:

1st year	$ 187,600
2nd year	132,400
3rd year	101,100
4th year	67,200
5th year	29,000
Five Year Total	$ 517,300

CHAPTER XXIV

SOCIAL SOUNDNESS APPRAISAL

Analytic Framework

As evidenced by the economic analyses developed in the preceding chapter, further mechanization of Egyptian agriculture on the pattern recommended in this report will yield attractive returns to investment from the standpoint of the economy as a whole. This is not to say, however, that all members of the Egyptian public will benefit equally from such investments, as the criteria employed in those analyses inherently treat an economy as an undifferentiated aggregate. Other sections of this Study Team report shed additional light on the economics of farm mechanization by approaching the subject from different perspectives. For example, Chapter XVII illustrates the comparative costs of performing different farming operations with modern and traditional equipment respectively. Those analyses show that further mechanization would significantly benefit the average Egyptian farmer. Chapter XXIV adds a further dimension to the overall analysis of the economics of further mechanization by exploring the impact of mechanization upon the cost and returns of families operating farms of different sizes and types.

For all the extent and variety of their coverage, these various economic analyses are all essentially farm-operator oriented. Consequently, they necessarily leave largely unanswered critical questions regarding the probable impact of mechanization upon other affected segments of Egyptian society — most particularly, hired labor families. By their nature, the types of economic analyses

alluded to likewise can shed little meaningful light on the effects of farm mechanization upon different segments of rural society, e.g., the role of women and children in agricultural activities; upon rural institutions which today remain largely geared to traditional farming methods; upon consumers in general; especially those in urban areas; and upon the crowding of cities, which has both its economic costs and social consequences.

In arriving at estimates of the social impact of further mechanization, the succeeding analyses employ two main types of approaches. One derives from the central concept of welfare economics which says, in effect, that collective public interests are advanced by any change which causes those who benefit to gain more than those who are disadvantaged lose by reason of that change.* This concept provides a powerful tool for analyzing the social impact of farm mechanization _if_ (a) all relevant magnitudes can be quantified and (b) there is a consensus on the relative importance of gains or losses to different social and/or economic groups. Neither of these prerequisites can be met satisfactorily in the case at hand. Paucity of relevant data precludes quantitative analysis of most significant aspects of the social consequences of further mechanization of Egyptian agriculture. The second constraint is even harder to overcome analytically. Whether a unit of gain or loss is taken to be the same for all groups or more from some and less for others can only be value judgements.

Given the Congressional mandates which _inter alia_ require that AID assistance to any country benefit primarily the poorest segments of that country's society, the temptation is strong to take a page from George Orwell's _1984_ and say,

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* Microeconomic Theory, J. M. Henderson and R. E. Quandt (McGraw-Hill, 1968).

"Small is good, big is bad". While this may be true in general, given the value priorities which now guide U. S. foreign assistance, so simplistic a treatment of Egyptian farm mechanization might well lead to conclusions that are quite erroneous in terms of the value priorities which prompted the dichotomy in the first place. Consequently, although the Study Team instinctively shares the prevailing views that disadvantaging those who have little offsets even substantially larger gains by those who are already relatively better off, the succeeding analyses endeavour merely to present the facts and leave the value judgments to readers of this report.

The second type of approach employed is essentially that of applied logic. For coping with those relevant magnitudes which could not (many cannot) be quantified, the Study Team found no practicable alternative to logical deduction. Value biases are especially hard to avoid with this technique, as practically all elements of an analysis become based on value judgements of one kind or another.* For example, is it "good" or "bad" for women and children to take an active part in farm work? In all kinds or only some? Does comparing participation rates among women in Egypt with those of economically more advanced countries imply that it is socially good or bad if Egypt's figures are higher or lower than those in say, France, Canada or the U.S.? Such questions are endemic to almost any qualitative analysis, especially in the value-laden setting such as that posed by mechanization of Egyptian agriculture.

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* For a particularly instructive discussion of the role of value biases in social research, see Appendix II of Gunnar Myradal's An American Dilemma: The Negro and Modern Democracy, (Harper, N.Y., 1944).

Substantively, the succeeding analyses focus upon five by-products of farm mechanization generally considered to have negative social consequences in an overpopulated, underemployed rural economy. In broad outline they are: displacement of labor, rural-urban migration, lessened role of women, increased commercialization of agriculture and displacement of tenants. As will be seen from subsequent discussion, these several elements of the overall farm mechanization question are so interrelated as to preclude completely separate treatment. Therefore, while each component is discussed here under a separate heading, others are introduced from time to time to indicate how they heighten or ameliorate the impact of the particular aspect then under consideration. In none of these instances are the social effects of mechanization likely to be all plus or all minus. Therefore, consequences other than those of the particular set of variables noted are introduced in the respective contexts to provide a better balanced picture. Throughout, social impact is weighed in terms of the pace and content of further mechanization that would result from full implementation of the recommended program set out in this report.

Labor Displacement

Mechanization is inherently labor-saving. The Study Team's proposed five-year program is no exception. The question at hand, therefore, concerns the social costs and benefits of such labor savings, their respective magnitudes, and how they are likely to be shared among different segments of the Egyptian populace. To draw meaningful conclusions to these broad questions, it is necessary to consider the probable impact of further mechanization upon specific

population groups in the context of existing and prospective circumstances.

To keep the range of relevant circumstances within manageable bounds, the ensuing analysis is bounded by the following operational premises:

1. Labor-saving mechanization displaces labor when (a) the rate of labor-saving exceeds that of off-farm migration stemming from other causes and (b) such excess in labor savings is not offset by mechanization-related increases in farm labor requirements.

2. The direct impact of labor-saving mechanization upon different components of the farm labor force depends upon their respective ability to share in the benefits of those labor savings.

3. Labor-saving increases farm production whenever (a) further reduction in the seasonal or permanent supply of labor would decrease production and/or (b) mechanization permits increased cropping intensity which in turn increases farm labor requirements.

4. Given finite national foreign exchange resources, reduction in farm production — either its rate of increase or total volume — reduces (a) the quantity of available food and fiber to the non-farm populace and/or (b) the quantity of other commodities available to the entire non-farm and farm population if the mix of imports is shifted to maintain food supplies per capita. Differently stated, this premise implies that any reduction in per capita farm production will, at the minimum, increase the rate of inflation — the burden of which falls most heavily upon the urban poor — particularly those whose incomes are not responsive to changes in consumer prices.

5. The volume of wage employment offered is a function of the farm wage rate and the impact of change in total hired labor cost upon farm operators' net returns. This is to say that at some point an increase in hired labor cost will reduce the over all demand for hired labor, all other factors the same. That point is reached much more quickly on units where hired labor constitutes a high proportion of total labor used than on those where hired labor is but a small fraction of total production costs.

As the foregoing set of interdependencies suggests evaluating the potential social impact of farm mechanization becomes largely a matter of examining the trade-offs among the probable outcomes of alternative courses of action. The nature of these trade-offs is indicated in a broad way by key characteristics of the Egyptian agricultural economy as reflected by the 1978 Farm Management Survey. Farms with 5-50 feddans of cultivated area currently comprise about 12

percent of all bona fide operating units.* However, farms of this size account for some forty percent of all crops grown and employ three-quarters of all the hired labor used. Indications are that these large farms with an average of roughly ten feddans of cultivated land hire something over one-half of the labor used in their farming operations. This contrasts with about ten percent for farms in the 1-5 feddan range, which have on the average about 2.15 feddans of cultivated land.

Cropping intensity (ratio of crops grown to cultivated area) on the larger-sized units averaged fifteen percent below that being achieved by operators tilling 1-5 feddans. These averages do not tell the full story, though, as cropping intensity declines rapidly as size increases above five feddans. Units of the upper end of the 5-50 feddan range use their cultivated area only 75 percent as intensively as did those at the lower end of the smaller-size group. This pattern appeared with all subgroupings of the sample farms. This suggests that with Egypt's currently low degree of farm mechanization, the scarcity and cost of hired labor together with inadequate draft power is causing many large farmers to forego the planting of a second crop on part of their acreages. Data from the 1961 Census of Agriculture indicate there was comparatively little decline in cropping intensity with farm size over a comparable size range when allowance is made for the substantial acreage of unreclaimed land on very large farms at that time. As farms with more than 10 feddans of cultivated area require some hired labor virtually the year around, it seems reasonable to assume that the bulk of Egypt's permanent hired workers are engaged on units of that size. This

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* Excludes units with less than one feddan of cultivated areas as explained in Chapter VI. Also see that chapter for the method used in this report for estimating hired labor requirements.

being the case, it may well be that in considerable part the operators of large farms have been adjusting their land use in recent years to the rise in the cost of retaining permanent hired workers.

Finally, note must be taken of the elasticity of the farm labor supply with respect to wage rates and that of food products with respect to consumer prices. Judging from the rapid increase in farm wage rates since 1973, it appears that the overall supply of temporary farm workers — family and hired — is quite inelastic. Given the number of operator family members apparently on Egyptian farms today, increases of such magnitude logically could occur only in the presence of a high "reservation wage" and/or low mobility of potential temporary workers. On the food side, consumer demand for basic foodstuffs is notoriously insensitive to price changes the world around. The ARE likely would not impose rationing nor alter its existing food subsidy policies except under dire circumstances. It follows, therefore, that any decrease in food production per capita would perforce increase food subsidy outlays, hence, increase inflation or produce that same effect indirectly by reducing other imports in favor of increasing those of wheat, sugar and livestock feedgrains.

Farm Labor Force

The most recent complete enumeration data on the size and composition of the Egyptian farm labor force are those provided by the 1961 Census of Agriculture. As indicated by Table XXIV. 1, farm workers of all types, ages and sexes at that time totalled roughly 6.6 million. Farm operators and members of their families comprised 63 percent of that total; permanent hired workers and their family members, 9 percent; and temporary hired workers, 28 percent. Not unexpectedly, these proportions varied significantly among farm size groups, with the

TABLE XXIV. 1

EGYPTIAN FARM LABOR FORCE, 1961
BY TYPE, AGE AND SEX OF WORKER
(Thousands)

Type of Worker	Age and sex						All Ages	
	5/6 - 12*		12 - 18		18 & over			
	M	F	M	F	M	F	M	F
Family**	524	247	668	180	2281	271	3473	698
Hired	481	285	545	247	769	122	1795	654
Permanent	112	35	139	32	263	18	514	85
Temporary	369	250	406	215	506	104	1281	569
TOTAL LABOR FORCE	1005	532	1213	427	3050	393	5268	1352

* Census reported family workers 5-12 years, hired workers 6-12 years.
** Operators working their own land and members of their families considered to be in the labor force.

Source: 1961 Census of Agriculture

ratio of hired to total workers increasing from 23 percent on family-size units (1-3 feddans) to 77 percent on farms of 20-50 feddans. As they refer only to numbers of persons engaged in farm work for some part of the year, temporary hired workers met a much smaller proportion of total farm labor requirements than these data might suggest. Many no doubt worked only a few days during the year — e.g. children picking cotton — and few probably were employed for more than 100-120 days. The Census provided no information on that point nor about nonfarm employment of agricultural labor force members. Considering the economi circumstances of 1960, however, it seems doubtful that many were so engaged.

As indicated by the analyses developed in Chapter VI, the Egyptian farm labor force is little if any bigger today than it was in 1961. The total numbe

of family workers probably is some 10-15 percent larger than in the earlier period and the aggregate of landless temporary and permanent hired workers 25-30 percent smaller. A considerable part of this shift in labor force composition resulted from landless laborers having acquired owner-operator status through the Land Reform Acts of 1961 and 1969 and subsequent distribution of New Lands reclaimed following completion of the High Dam. Since 1973, the total numbers of both family and hired workers have been reduced significantly by the "temporary" migration of farm workers to take advantage of rapidly expanding opportunities for higher-paying employment overseas and in nonfarm areas within Egypt. In addition, indications are that a considerably smaller percentage of women and children participate in farming operations today than was recorded by the 1961 Census. This apparent decrease could be due to differences in respondents' interpretations of the questions asked in the 1961 Census compared to those interviewed in the 1968 Farm Management Survey. However, ancillary evidence supports the conclusion that a combination of social and economic changes in the intervening years has prompted a real reduction in participation rate among women and young children. For example, survey data reveal a surprisingly high percentage of farms in the 1-3 feddan size range using hired labor when, with participation rates anywhere near as high as they were in 1961, there were more than enough female family members of working age to perform the particular operations for which workers reportedly were hired.

Considering the various pieces of available evidence, the Study Team concluded that the 1977 farm labor force probably comprised some 7 million individuals engaged full or part time in farm production activities. Operators of farms larger than one feddan and their family members made up roughly three-quarters of that total; hired workers the remaining twenty-five percent. How the hired

worker total breaks down between temporary and permanent can only be speculated upon. Logic argues that the total number of permanent hired workers probably has decreased substantially since 1961, as a high proportion of such workers were on farms over 50 feddans in size. As in 1961, currently available data provide no insight into the extent or nature of farm workers' off-farm employment. The Farm Management Survey was intended to provide data on these points, but interviewing complexities invalidated the results as a basis for generalization. However, with the heightened economic activity during the past five years in urban and rural non-farm areas alike, it is reasonable to expect that many nominally temporary farm workers now actually look upon seasonal farm employment as an avocation.

The relevance of labor force composition to the social impact of labor-saving mechanization lies in the way labor savings affect different components of the farm labor force. Savings of family labor result in more free time and/or reduced expenditures for hired labor. If nothing else changed, reduction in hired labor requirements would mean fewer days of seasonal employment per year for temporary hired workers and probably a reduction in the number of permanent hired laborers. As indicated in Chapter VI in this Study Team report, hired labor requirements are simply the difference between calculated total labor requirements and the estimated supply of family labor available. By that probably oversimplified assumption, any labor saved during peak seasons reduces hired labor employment by that same amount. But, as will be seen from subsequent discussions, whether or not such labor savings result in the <u>displacement</u> of hired workers in the sense of reduced numbers of days of employment per worker per year depends upon what other relevant circumstances change as a result of mechanization, or occur for extraneous reasons at the same time that mechanization is progressing.

Prospective Labor Savings

Any estimate of aggregate labor savings through farm mechanization has validity only with respect to the assumptions made in arriving at that particular estimate. The time span considered is of critical importance in this regard. So is the number of different kinds of machines assumed to be involved – itself a function of the time period. Finally, regardless of how accurately one predicts adoption rates, efficiency of machine use and the host of other pertinent variables, calculated direct labor savings will still be subject to misinterpretation from the standpoint of mechanization's impact upon employment opportunities for farm workers. This is because such calculations abstract from other developments over the time period in question-- which inevitably affect both the usage of labor on farm and non-farm employment opportunities.

Table XXIV. 2 summarizes the potential labor savings over a 10-year period for hypothetical rates of adoption of the various types of modern equipment recommended by this Study Team report. The assumed adoption rates for the respective machinery items are probably near the maximum that realistically can be expected during the next decade. If such adoption rates were achieved and mechanization produced no change in cropping intensity, these calculations indicate total labor requirements would be reduced about 12 percent in ten years. Not all of these labor savings would come during peak seasons when total requirements exceed the supply available from family labor. If the supply of family labor remained unchanged and there was no increase in cropping intensity, 42 percent of the savings in year 10 would be in family labor and 58 percent in hired labor.

TABLE XXIV. 2

TOTAL LABOR SAVED AT ASSUMED RATE AND COMPOSITION OF FARM MECHANIZATION[1]

In Million Man Days

Years From Base	Source of Labor Savings			All Sources
	Seedbed Preparation	Harvesting/ Threshing [2]	Irrigation	
1	3.3	*	.1	3.4
2	5.8	*	.5	6.3
3	8.7	.3	1.1	10.1
4	12.3	1.0	2.0	15.3
5	17.1	1.9	3.2	22.2
6	23.2	3.3	5.0	31.5
7	29.7	4.9	8.3	42.9
8	37.1	6.8	13.8	57.7
9	44.3	8.9	22.3	75.5
10	50.7	11.2	33.9	95.8

* Negligible

[1] Base year totals in man equivalent days at 1977 calculated levels: seedbed preparation — 117 million; harvesting/threshing —-217 million; irrigation — 170 million; total requirements including non-crop operations — 772 million.

[2] Assumes only small—grain harvesting/threshing/winnowing mechanized.

A major reason why neither family nor hired labor requirements decline as much as might be expected with a near-optimal pace of mechanization is the higl percentage of total labor requirements made up of operations that cannot practicably be mechanized in the foreseeable future. Cultivation of row crops and harvesting of cotton, maize, berseem, and many miscellaneous crops are significant cases in point, as are rice-transplanting and manual control of cotton leaf worm infestations.

Labor Displacement

A farm operator family would mechanize only to the extent such mechanization would improve its overall welfare. Any "displacement" of family workers through labor saving mechanization, consequently, can be presumed to be voluntary, hence, to benefit the families concerned. An exception to this generalization would be cases where mechanization in general caused pressure upon small operators to give up farming so that remaining units could be enlarged. Owner-operators would feel such pressure only if mechanization caused farm product prices to fall faster than they could reduce their production costs by mechanizing. This situation is not likely to arise in Egypt in the near term. Tenant farmers, however, could be more vulnerable to displacement due to mechanization-generated labor savings and enhanced economies of scale. That possibility is explored in a later section on tenancy.

While farm operator families are not usually subject to involuntary displacement due to mechanization, this is not the case with hired farm workers. If nothing else changed, most labor savings realized from mechanization would, at the minimum, reduce the days of employment per worker per year. It is most unlikely, however, that all other relevant circumstances will remain unchanged over the next decade. Two highly significant changes are reasonably predictable. One - increased cropping intensity - will stem directly from mechanization; the other - continued net migration - will be influenced mainly by alternative employment opportunities. How these two forces interact, and their comparative paces, will largely determine the impact of mechanization-generated labor savings upon the welfare not only of hired farm workers but also of farm operator families and non-farm consumers.

Table XXIV. 3 provides a framework for assessing the impact of labor saving upon respective groups affected.

TABLE XXIV. 3

EFFECTS OF MECHANIZATION ON HIRED LABOR REQUIREMENTS UNDER ALTERNATIVE CONDITIONS

Item	Base Year[1]	Years After Base 2	5	10
		Million Man Years		
1. Total Labor Requirements[2]	772	766	750	676
2. Hired Labor Required[2]	104	101	91	56
Change in Hired Labor Required Due to:				
3. Increased Cropping intensity[3]	---	*	+4	+19
4. Reduced Family Labor Supply[4]	---	+5	+14	+27
Hired Labor Required				
5. Total	104	106	109	102
		Days Per Year		
6. Per base year man equivalent available	90	92	95	89
7. Per man equivalent available after migration allowance	90	102	123	167

* Insignificant

[1] Estimated 1977 levels from Chapter VI.

[2] Assumes no change in cropping intensity.

[3] Assumes cropping intensity increases from current national average of 190 to 200 over 10-year period at the same rate as mechanization reduces labor requirements.

[4] Assumes continuation of permanent and temporary migration at 1973-77 average rate.

In Table XXIV. 3, Line 1 reflects the annual total of labor savings from Column 4, Table XXIV. 2, for three years in that 10-year time series. Line 2 is the sum of weekly differences between total labor requirements and available family labor calculated in the manner described in Chapter VI. Under these restrictive assumptions, the days of hired labor required per year would be cut in

half by the tenth year. In this instance, mechanization-generated labor savings would result in extensive hired-labor displacement. Farm operators would benefit from reduced hired-labor costs; non-farm consumers would not be affected directly.*

Line 3 shows the effect on hired-labor requirements of relaxing the above assumptions only to the extent of allowing cropping intensity to increase as mechanization progresses from the present national average to full double cropping by the tenth year. Such an increase should be achieved fairly easily with the increase in mechanization projected as a basis for calculating the labor savings. It would be possible, however, only if the total supply of farm labor remained near its present level. Under the Line 3 assumptions, total farm production would increase roughly five percent. This by itself would not maintain per capita supplies of food and fiber but would dampen considerably the rise in prices which otherwise would come with a progressive lowering of per capita supplies. The hired farm worker component of Egypt's farm population would benefit by having a third more employment per year than if cropping intensity remained unchanged. And, under the ceteris paribus assumptions governing this analysis, farm operator families would gain from the 5-percent increase in production and from the 27-day reduction in hired labor costs.

Line 4 further relaxes the initial assumptions to allow continued attrition in the family labor supply at the rate experienced in the period 1973-77. With increased cropping intensity and a reduced family labor supply, hired-labor requirements and employment per hired worker would be slightly higher in year 2 than they are today; 4 percent above present levels in year 5; and

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* For simplicity, this analysis abstracts in all instances from the various production-increasing effects of further mechanization set out in other parts of this report.

would become about the same as they now are in year 10. Under these conditions, the hired-labor force would be virtually unaffected by mechanization. The number of days of employment available per hired worker would change little over the entire 10-year period. Assuming no change in the supply of hired workers or in extraneous factors, farm wage rates would not rise much, if any, above present levels. Food prices would not necessarily rise due to the reduction in family labor, by the present assumption, as there are sufficient hired workers available to meet all requirements above those covered by family labor.

Taking the patterns of Lines 1-4 together, mechanization-generated labor savings would appear to benefit farm operators and non-farm consumers at little loss to hired workers. Far more important than those combination effects, however, are the probable consequences of there being no increase in mechanization. The reduction in family labor supply would continue, as it presumably is unrelated to the pace of mechanization. But without increased mechanization, by the tenth year, cropping intensity no doubt would decline substantially from its present level. By that time, the reduction in family labor supply would equal 26 percent of the base-year hired-labor requirement. Under such circumstances, seasonal labor shortages would be much more intensified and farm wage rates would perhaps double. As large farms heavily dependent upon hired labor produce nearly half of Egypt's crops, they would find it increasingly advantageous to skip a winter or summer crop in order to get higher yields with more timely planting if they could reduce their hired-labor costs in the process.

It might appear on the surface that the hired farm-labor force would stand to benefit substantially from the reduction in family labor supplies if

mechanization did not offset that reduction through labor savings. However, Lines 5 and 6 of Table XXIV. 3 indicate that, in reality, they likely would have fewer days of employment at higher pay with no higher annual income. As they have to buy all or most of their food, hired farm workers would have a higher food bill just as would non-farm consumers. Without further mechanization, the rise in food prices would be considerably more than the loss in crop intensity increase implies, because all the other production-increasing effects of mechanization would be foregone as well.

Line 7 of Table XXIV. 3 carries the relaxation of initial assumptions a step further by allowing the attrition of hired farm workers through temporary and permanent immigration to continue at its 1973-77 rate. Some reduction in the number of hired farm workers likely will occur with or without further farm mechanization. Whether the pace actually is faster or slower than that experienced over the past five years will depend on many factors other than mechanization. But, if it should proceed at the 1973-77 rate, the consequences are fairly predictable. In general, they would represent an intensification of those surmised above, in the event of an attrition in the family labor supply not offset by mechanization-generated labor savings. Judging from recent experience, the supply of seasonal farm workers responds relatively little to higher wage rates. In that event, increases in demand per worker of the magnitudes reflected by Line 7 would cause wage rates to rise precipitously. Physical shortages of seasonal labor together with farmers' adjustments to rising hired labor costs would reduce total farm production substantially with attendant increases in food prices or/and overall inflation. In this connection, it should be remembered that Line 7 reflects a situation in which mechanization is progressing at something like the projected absorptive capacity of the Egyptian farming community. Without that increase in mechanization,

but with attrition in family and hired workers proceeding at their 1973-77 rates, farm production could but drop sharply.

What would actually happen, of course, is that the several factors included in the calculations underlying Table XXIV. 4 would conteract one another. Where an equilibrium would be reached is by no means self-evident, as Egyptian experience provides little basis for anticipating the combined effects of changes in the respective variables of the magnitude and duration implied by those hypothetical projections. On balance, though, it seems reasonably safe to say that unless opportunities for off-shore employment of Egyptian workers decrease sharply from their present levels, labor savings by farm mechanization in the decade ahead would largely substitute for labor lost to agriculture through temporary and permanent migration.

Other Agricultural Workers

Further farm mechanization inevitably would affect the welfare of several types of agricultural workers besides those covered by the preceding analysis. Those in four occupations would be particularly affected: custom winnowers of wheat and rice, tractor drivers, farm machinery mechanics, and farmers renting out their animals for draft work. Compared to the number of farm operators, each of these groups is quite small. Nonetheless, the mechanizatior strategy planners need to take them into account in deciding where a balance best can be struck among all affected segments of the Egyptian public.

Custom winnowing of small grain currently provides something like 1.5 - 2.0 million man days of employment per year or about one percent of total agricultural employment. As such work is highly seasonal, it seems doubtful that custom winnowing could be the only source of income of those supplying these services. Thus, the effect of introducing thresher-winnowers into Egyptian

agriculture would, in the first instance, reduce this component of the custom operators' employment rather than displacing them from agricultural work entirely. If agricultural employment opportunities proceed on the lines indicated by Table XXIV. 4, there would be need for the manpower now devoted to hand-winnowing of grain in other farming activities.

With increased mechanization, the demand for both tractor drivers and farm machinery mechanics would increase apace. Presumably, most of this need would be met by farm youths. Numerically, these additional employment opportunities would not loom large in the overall agricultural scene. But, being generally higher paid positions, such mechanication-generated alternatives would offset more aggregate labor savings than their numbers imply.

Survey results indicate that cow-renting is not a widespread practice. Sharing appears to be the more common method used by small farmers in meeting temporary needs for an additional work animal for plowing or other operations requiring two head. Considering reported custom rates, present prices for meat and milk and the loss in production resulting from working cows or buffaloes during their lactation periods, renting out work animals does not appear to be a very profitable business. Nor does it appear that providing custom animal power is a major source of income to very many cattle owners. Increased availability of motorized equipment will no doubt disadvantage somewhat those small farmers and others who, today, get part of their annual income from renting out their work animals. Neither the amount of their respective losses nor the number of families affected appears to be significant from the standpoint of the overall Egyptian economy.

Migration From Rural Areas

The preceding section considered migration from the standpoint of its impact upon farm production and employment opportunities for hired farm workers. In that context, permanent and temporary migration from farms was treated as an independent variable in order to ascertain the extent to which mechanization-generated labor savings are likely to result in the displacement of hired farm workers. Migration also deserves consideration in overall mechanization strategy planning from the standpoint of its impact upon the locales to which farm migrants move. This becomes especially significant where migration results from the "push" of mechanization-generated displacement of farm workers rather than the "pull" of alternative employment opportunities. In addition, the migration assumptions made in the preceding analyses deserve further exploration as a basis for judging what the future may, in fact, hold with respect to the supply of labor available to Egyptian agriculture.

Trends of Migration

As in all developing countries, migration from farms to cities has been considerable. The 1960 Census showed 63 percent of Egypt's total population residing, by census definition, in rural areas. When the 1976 Census was taken that ratio had dropped to 56 percent. Comparison of census data for 1966 and 1976 shows rural population growing by only 1.39 percent a year, while urban population increased 2.73 percent a year. Some of this difference presumably was due to the reclassification of rural villages to urban units, as was the case in the period before 1966.

Without making allowance for this factor, detailed analysis of population growth in each governorate indicates that population has been leaving the rural

areas at an average rate of about one percent or 195,000 persons a year. There apparently were also outward flows of about 5,000 a year from the frontier governorates of the Red Sea, New Valley, Matrouh and Sinai, and about 30,000 a year from Suez and Port Said (both considered urban) and from Ismailia (about half urban) largely as a result of the wars of 1967 and 1973, which caused wide devastation. These flows away from rural areas and special urban areas were balanced by expansion of other urban areas and by migration abroad. The latter is the big new element that apparently reduced farm labor supply enough to spark the rapid increases in wages that began in 1973.

The 1976 Census reported 1,425,000 Egyptians abroad, including dependents, with the comment that "in previous censuses, enumeration of Egyptians abroad was not effected due to their negligible number at that time."* A 1978 study estimated that perhaps 50,000 were abroad in 1966, with the flow abroad between 1966 and 1976 averaging about 135,000 a year, with the upward trend continuing in 1977.** As the bulk of this outflow has occurred since 1973, the number going abroad during 1973-77 probably was double the 1966-76 average. Officials of the Arab Federation of Agricultural Workers, whose members include most agricultural workers, estimate that between 750,000 and 1.5 million agricultural workers went abroad for employment between late 1973 and mid-1978. In support of their estimate, they point to the sharp drop in Federation membership during that period. Presumably, some of these workers went instead to urban areas in Egypt, for during that period, 1966-76, "Metropolitan Cairo" (Cairo Governorate plus Giza City and the city of Shubra-el Kheima) grew at a rate of 40,000 a year; the urban areas of Behera

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* The Preliminary Results of the General Population and Housing Census 22/23 November 1976 in Egypt (CAPMS, Jan. 15, 1978), p. 6.

** MIT study, in preparation.

Governorate by about 20,000 a year; and the urban areas of other governorates by about 35,000 a year.

TABLE XXIV. 4

APPARENT AVERAGE ANNUAL MIGRATION
BETWEEN 1966 AND 1976

From rural and frontier areas	200,000
From war-torn areas	30,000
Total migration from:	230,000
To overseas	135,000
To Metropolitan Cairo	40,000
To urban Behera	20,000
To urban areas of other governorates	35,000
Total migration to:	230,000

As noted earlier, rural migration to the cities is not a new phenomenon in Egypt — or elsewhere in developing countries. In the period 1936 to 1947, rural migration reached a high level, with 44.5 percent of each year's natural increase in rural population being drained off to the cities. Presumably, a good deal of this migration resulted from the great expansion in construction and other economic activity in urban areas associated with the British war effort of 1939-45. The level of rural migration fell drastically to 22 percent of natural increase in the period 1947-60, perhaps associated with some return home of the migrants of the previous period. But since then the tendency of the rate of migration to rise as economic development proceeds has reasserted itself, with the ratio of

rural migration to natural increase rising to 37 percent in 1960-66 and to 40 percent in 1966-76.*

Not only have the rural areas been losing people in general; they also have recently been losing males faster than females. Since most agricultural workers are males, the impact on farm labor is self evident. In 1976 the masculinity index (number of males per 100 females) for Egypt as a whole was 104.1.** In urban areas, the index was 105.8, while in rural areas it was 102.8. In the rural areas of Sohag, Qena and Aswan Governorates, there were actually less males than females. One explanation offered for the latter finding is that in these three Governorates, which are the most traditional in Egypt, it is common in the rural areas to have more than one wife. Another possible explanation is that the outmigrants from these Governorates were more likely than in other rural areas to leave their families behind when they left to seek work in the cities or abroad. In any event, the fact that the index in rural areas was far lower than in the urban areas indicates that a great many more of the migrants to the cities were male than female, presumably comprising both single males and married males who left their families behind in the villages. The 1966 Census does not report the masculinity index separately for urban and rural areas, or the data from which to calculate it. However, it is believed that the practice of single males and married males without families going to the cities for jobs is not a new one.

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* Cf. Mabor, op. cit., pages 197-198, for earlier periods.

** The reason why the Census found 4 percent more males may be that male children, especially in poor families, get better food, medical attention, clothing, housing, etc., and hence are more likely to survive; or it may be because females in the family are not reported as uniformly as are males, or both.

Reasons for Rural Migration

The reasons for rural outmigration have been extensively studied.* Two main categories have been differentiated: the "push" factors and the "pull" factors. The former seem to have been, by far, the more important up to 1973 and no doubt have played an important role in more recent years. Particularly significant among the push factors are: poverty of farm life, the unstimulating atmosphere of the villages, the constraints of a closely knit extended family, and the continual division required by Muslim laws of inheritance of farm plots to the point where they are too small to support a family. The report of an interview survey made in 1964/65 concluded at that time that "push" factors were far more important than "pull" factors. Among the "push" factors reported, the most important were landlessness and the lack of land to rent, which leave many workers only the options of wage labor (much of which is seasonal) or quitting agricultural employment. Another important "push" factor was the desire to have an independent life and income away from the extended family.**

The "pull" factors operate primarily on the younger people, especially on those able to qualify for higher education, which, if completed, results in automatic government employment. They also are reported to strongly influence those who have completed their required military service, in the course of which many have been exposed to the amenities of urban life and some have received vocational training and experience that qualify them for nonfarm jobs. A different kind of

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* Recent studies are summarized in Mahmoud Abdel-Fadil, Development, Income Distribution and Social Change in Rural Egypt (1952-1970), Cambridge University Press, 1975, pages 112 - 114, and in Mabor, op. cit., pages 200 - 204.

** INP/ILO, Final Report on Employment Problems in Rural Areas, Cairo, 1968.

"pull" – the demand of expanding industries for additional workers at attractive wages – is very important in attracting workers to the other Arab states. It does not seem to operate much in Egypt itself, however, except for the construction industries, which are booming, yet at the same time are hampered by labor shortages resulting from the "temporary" migration of construction workers to higher-paying jobs abroad. Nonetheless, domestic non-agricultural employment increased by 1,470,000 (35 percent) between 1969/70 and 1977, whereas agricultural employment increased by only 243,000 (6 percent) in the same period (Table XXIV. 5). is also true that the wage differentials for most city jobs are substantial, food costs are low because heavily subsidized, and the "informal sector" provides flexible employment opportunities, albeit at low wages. On the other hand, the better-paying city jobs are hard to get outside of construction.

TABLE XXIV. 5

EMPLOYMENT IN AGRICULTURE AND OTHER SECTORS
1959-60 TO 1977

Employment in Thousands

Year	Agriculture	Other Sectors	Total
1959 - 1960	3,245	2,761	6,006
1964 - 1965	3,751	3,623	7,374
1969 - 1970	4.048	4,227	8,275
1970 - 1971	4,057	4,449	8,506
1972	4,134	4,577	8,711
1973	4,164	4,696	8,860
1974	4,212	4,827	9,039
1975	4,218	5,212	9,430
1976	4,224	5,404	9,628
1977	4,291	5,697	9,988

Source: 1959-1960 and 1964-1965: Ministry of Agriculture.
1969-1970 and afterwards: National Bank of Egypt, Economic Bulletin, various issues.

Moreover, although real farm wage rates declined by 20 percent between 1966 and 1972, and this decline could well have provided a "push" in that period, they turned around in 1973 and rose 75 percent between then and 1978 (Table XXIV. 6).

TABLE XXIV. 6

REAL FARM WAGE RATES, 1966-1978

1966 = 100 for Each Index

Year	Man-day Wage Rate		Rural Consumer Price Index	Index Real Wages
	PT	Index		
1966	25.5	100	100	100
1967	25	98	102.3	95.7
1968	24	94.1	106.7	88.2
1969	25	98	114.6	85.5
1970	25.5	100	123.0	81.3
1971	25.8	101.2	124.0	81.5
1972	26.5	104.0	131.0	79.3
1973	28.5	111.7	141.2	79.0
1974	35.1	137.7	161.0	85.5
1975	46.5	182.4	180.6	101.0
1976	61.6	242.0	202.3	119.6
1977	76.0	298.0	222.0	134.0
1978	88.0	346.0 (Jan.-June)	256.2 (March)	139.0
1978	90.[illegible]	356.0 (July-Sept.)		

Sources: Man-day Wage Rate: Ministry of Agriculture, Agricultural Economics Research Institute.

Rural Consumer's Price Index 1966-1977: Central Agency for Public Mobilization and Statistics, as reported in Samir Radwan, Agrarian Reform and Rural Poverty, Geneva, International Labor Office, 1977, p. 31; 1973-1978: Central Agency for Public Moblization and Statistics, as reported in National Bank of Egypt, Economic Bulletin, successive issues.

In summary, the principal factors affecting rural-urban migration are the general "push" factors acting on low-income agricultural workers, the strong pull to overseas work, and the selective "pull" factors (higher education, military service) acting on the younger males at a time when they are entering their most productive period. Ease of transportation is a facilitating factor. Because transportation within Egypt is so easy, rural workers can readily visit the cities to look for jobs. Moreover, those working in the cities can readily visit their rural villages to which they retain strong loyalties, without giving up their city jobs.

Government Attitude Toward Migration

The Government is seriously concerned by the amount of migration from rural areas to the cities, both because it leads to overcrowding in the cities and because of its impact on farm labor supply, hence on agricultural production. The "Manpower" section of the Agricultural Volume of the Five-Year Plan: 1978-82 states that, "To curb agricultural workers' migration from old lands in rural areas to the cities, restrictions can prohibit the residence of these workers in places other than their original homes. . . Migration and emigration can also be regulated by government agencies, in the light of the agricultural needs of various areas. . . Servicemen who are demobilized must return to the countryside to resume their agricultural activities. . . Agricultural mechanization must be ex-expanded to relieve demand for workers". These remedies offered in the specific context of possible solutions to a problem confronting the agricultural sector have not prompted government action toward giving them effect. To do so would seem to conflict seriously with the free-enterprise spirit of Egypt's prevailing Open-Door Policy.

Commercialization of Agriculture

Any major technological change inevitably tears at the fabric of a traditional agrarian society in a variety of ways. To name a few: it opens new opportunities for individual initiative; creates a need for new institutional arrangements; alters the character and significance of class differentation; and ordinarily reduces the self-sufficiency of farm operator families. Further mechanization of Egyptian agriculture will, in particular, increase its commercialization, i.e., bring Egyptian farmers increasingly into the market economy. Given the variety of other forces playing upon the Egyptian farming community at the same time and the paucity of relevant data, one can but speculate upon the direction and nature of societal changes likely to accompany the type and pace of further mechanization recommended in this Study Team report. That such mechanization will proceed predominantly on the basis of custom-hire equipment profundly influences the ways in which its social consequences are likely to be manifested.

Entrepreneurship

A traditional peasant farmer finds little necessity for making new decisions day by day. Over time with no significant change in technology, cropping patterns, production methods, etc., tend to become those which make best use of the resources available.* Introduction of custom-hire tractors and mechanical threshing services on a large scale over the past decade has faced both the users and suppliers of these services with the necessity for making new kinds of decisions. That entrepreneurship has grown apace is evident on both fronts.

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* Schultz, T.W., op. cit.

Private owners now provide the bulk of custom tractor services, virtually all of the mechanical threshing equipment and all of the yet-limited number of motorized irrigation pumps outside the sugar-cane-growing area of Upper Egypt. To be successful, custom operators must make critical business-like decisions day after day. Decisions about buying the equipment in the first place, like those regarding its subsequent use and maintenance, call for a type of initiative not needed in traditional farming.

The availability of custom hire machinery similarly heightens the rewards of initiative to individual farm operators – small and large alike. At bottom are the fundamental questions: Will it pay? Is the risk of loss from making the necessary cash outlay worth taking? With today's inadequate supply of tractors to meet all needs in a timely manner, the individual farmer also must decide whether it is better to wait for the custom operator or to do this year's operations with traditional equipment. As indicated in Chapter XII, gaining the benefits of irrigation by motor-driven low-lift pumps will require not only in-individual and group initiative to obtain the equipment, but also a willingness to form new patterns of cooperation. Further mechanization will increase all these demands and opportunities for entrepreneurship. In the course of economic history, growth in entrepreneurship typically has been associated with national and personal development. Nonetheless, to the individuals concerned, and their communities, such progress comes at some price in terms of coping with new types of pressures upon them, their families and their communities.

With further commercialization also will come the risks of increased dependence upon the market economy. As prices of both farm products and major input items are controlled by the Egyptian government, the risk of loss in cash income through falling prices is not great. Exposure to such losses due to natural causes remains; but again, with all crops grown under irrigation, this

risk is not nearly so great as in countries where yields are highly dependent upon rainfall. Similarly, risks to custom operators of not having enough customers willing to pay rates adequate to produce an acceptable return on their equipment investment are not substantial under existing equipment-short conditions. However, as machinery becomes more plentiful, such risks can but multiply.

Far outstripping the risks noted above are those stemming from unexpected losses of equipment time due to poor repair facilities and lack of spare parts. To farmers depending upon custom tractors for their draft power, breakdowns subject them to the risk of delayed cropping operations and the necessity for changing their production plans. Custom operators who also are farmers face not only those risks with respect to their own farming operations, but also loss of expected income from custom work and the time spent looking for repairs. Thus, while mechanization in general can be expected to stimulate entrepreneurship, until they are remedied inadequate supporting services will, at the same time, tend to stifle individual initiative to modernize agricultural production.

Institutional Arrangements

Even without further mechanization, the commercialization of Egyptian agriculture would grow over over time as it has during the past several decades. What progressive farm mechanization can be expected to do is quicken the pace in particular aspects. The character and roles of rural institutions similarly will change through time in response to incentives other than those created by mechanization. Schooling facilities are a particular case in point, transportation and communication another. Consequently, while mechanization will play a part in the expected commercialization process, its prospective impact on

rural institutions must be viewed in the context of a progressively more open rural society.

Perhaps the most vivid example of institutional change related to mechanization is the formation of cooperatives in the mid-1960's. Cooperatives emerged initially as a means of providing custom tractor services to local communities. As custom services became institutionalized and private operators entered the field in growing numbers, the role of cooperatives as custom service suppliers has declined until now they own only one-fifth of all farm tractors. This is to say that the institution born to promote farm mechanization largely has been supplanted by another type of mechanization-related institution. Whether by design or accident, with the expansion of privately supplied custom tractor services, cooperatives have become, in effect, a user-controlled means of regulating custom rates by continuing as an alternative source of custom services. As tractor numbers increase, it seems likely that competition among private operators will perform that regulating function. Thus, during a comparatively few years, Egypt has seen three major changes in a rural institution stemming more or less directly from mechanization-generated commercialization of its agricultural sector.

Also affected significantly by the growing commercialization of agriculture is the rural credit system. Even now the financial assistance of relatives is sought less than it used to be. In a village study made in 1967, only 20 percent of the respondents said they turned to relatives for assistance in financial matters.* In the first instance, greater commercialization

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* Ilya F. Harik. The Political Mobilization of Peasants, Bloomington, Indiana; Indiana Univ. Press, 1974, pg. 196.

increases farmers' dependence upon institutionalized sources of credit for the purchase of machinery and production loans to meet service charges until their crops are harvested. And, as indicated by Chapter XXII and other references in this report, the willingness and ability of the farm credit system to respond to farmers' credit needs will determine, in considerable part, the pace at which mechanization proceeds in the years ahead. An illustration of institutional change in the credit system to respond to mechanization-generated needs is the NASR Social Bank's innovation of what amounts to a leasing arrangement to enable farmers with limited collateral to buy tractors for custom operation. By retaining ownership of the machine until the purchase price is repaid, the usual down payment and collateral requirements can be waived, with limited risk to the lending institutions. A second illustration is found in the Agricultural Credit Bank's practice of considering a borrower's prospective income from custom services as a factor in determining eligibility for a tractor loan

Institutional impact of another kind will stem from the commercialization of irrigation water-lifting as animal-drawn sakias and man-powered tambours are replaced by motor-driven pumpsets. Sharing arrangements built around these traditional means of irrigation have long since become firmly institutionalized. As indicated by Chapter XII, economies of scale are such that farmers' ability to gain the benefits of the more efficient mechanized equipment depends upon their willingness to enter into sharing arrangements with a larger group of neighbors. Economics aside, such change will, on the one hand, contribute to further opening of the rural society and broaden the base for cooperation among farm families which could have social significance far beyond modernizing this particular aspect of crop production. Conversely, however, so fundamental a change in interpersonal relationships inevitably will generate some social

tensions. It has been said that "development of whatever kind is a wrenching experience." Mechanization of irrigation in Egypt inevitably will bring that by-product of development to bear directly upon the village community.

Class Differentiation

In general, the commercialization of agriculture – or any other segment of an economy, for that matter – tends to heighten class differentiation. Those best able to profit from the process ordinarily are the rich, as they have the means for adopting efficiency-increasing methods of production. Such differentiation characteristically is heightened by the tendency for profits from improved technology to be capitalized in land values.

All of these typical attributes of commercialization are present in the Egyptian scene and doubtlessly have been enhanced by the expanding mechanization which has occurred during recent years. Until recently, ownership of at least ten feddans of land was a prerequisite for buying an imported tractor. The Agricultural Credit Banks technically still apply that criterion in considering applications for tractor loans. Membership on the Board of Directors of a cooperative requires ownership of ten feddans. Appointments to the Municipal Councils tend to go to the larger land owners.

These types of circumstances are, of course, by no means peculiar to Egypt. And it seems reasonable to expect that further commercialization of its agriculture – hence its mechanization – will tend to heighten their influence upon class differentiation. On the other hand, there are characteristics of the Egyptian setting which mitigate those influences to a greater extent than appears the case in other developing countries. Chief among these are: (a) the prevailing custom-hire basis of farm mechanization; (b) the agrarian reform laws

which control both cash rent and the size of ownership holdings; (c) the socialist political philosophy introduced by President Nasr; and, (d) the current pressure of labor requirements upon the supply available for meeting peak season requirements. Although the last three factors affect both the character of farm mechanization and the ways in which its benefits are likely to be shared among different segments of Egyptian society, their influences upon the consequences of commercialization of agriculture are not peculiar to mechanization.

That the development of mechanization since the mid-1960's has developed on the basis of custom-hire equipment — and no doubt will continue to do so — has two different kinds of effects upon rural class differentiation. As shown by Chapter X, the custom-hire system has enabled small farm operators to participate in mechanization to about the same extent as large ones. And except for their lesser dependence upon hired labor and their already making fuller use of their land, Chapter XXV indicates that family-sized farm operators stand to gain as much from further mechanization as do those of the larger units considered in that analysis. Consequently, on this particular ground it does not appear that further mechanization per se will significantly increase class differentiation in the Egyptian rural society. Ownership of custom equipment likely will have a more pronounced effect in this regard. Even there, though, despite past government policies favoring tractor ownership by large farmers, survey results indicate that 28 percent of all privately owned farm tractors are owned by farmers with less than five cultivated feddans. Interestingly enough, as high a percentage of the small farm operators had relatively new tractors as did those with larger acreages.

Another type of class differentiation peculiar to the commercialization process will be strongly abetted by custom-based mechanization. This results from the typically different roles of buyers and sellers in general. In any given village, the number of custom machine operators is quite small in comparison with the number of farmers using their services. They are the owners of scarce equipment, tangible evidence of "wealth" which others in the village do not possess. They have opportunity for doing their own work first while users wait their turns. As traditional peasants characteristically view any market as exploitative, it would be only natural for users of custom services to view their neighbors who supply those services as taking advantage of them. That at current custom rates tractor owners do not appear to be getting a high return over operating expenses, interest payments, et. al., is more or less beside the point. It is what other members of the community <u>think</u> custom operators are getting that makes for class differentiation.

Farmers interviewed by the Attitudes Towards Mechanization survey discussed in Chapter VIII were ambivalent in their responses to questions in this area. On the one hand, they viewed custom operators as "getting rich." At the same time, though, respondents did not feel that custom operators were exploiting farmers by charging exorbitant rates, whether or not these two expressed attitudes are inconsistent depends upon what actually motivated the respective responses. The former could reflect the usual have/have not dichotomy; the latter, recognition that they, too, were benefiting from the custom services and were willing to pay the rates charged for them. In any event, farmers apparently do not view their custom-operator neighbors as taking excessive advantage of them, all things considered, as many reportedly use private custom services

at somewhat higher rates per feddan than the co-ops charge even when co-op tractors are equally available.

Self-Sufficiency

Participation in the market economy necessarily reduces a farm family's self-sufficiency. Mechanization aside, few Egyptian farm families could be completely self-sufficient today even if they wanted to be. Each must cooperate with his neighbors in lifting irrigation water, unless his fields are so located as to make practicable their watering by an individually owned and family-operated tambour. Even small farmers have to buy fertilizer, insect control materials and some food items. Those with only one work animal must make some arrangement for obtaining the use of an added one for plowing or other farming operations requiring two head.

Custom-based mechanization does further erode farmers' self-sufficiency by making them dependent upon an additional market. In particular, it makes the timing of their crop operations subject to decisions by custom operators about the allocation of their services. Like their counterparts the world around, Egyptian farmers are inherently highly individualistic. But there is no indication that they place such value on self-sufficiency as to forego economic opportunities. They generally accept government crop quotas — partly, no doubt, to obtain fertilizer at subsidized prices. And they have shifted rapidly in recent years from traditional animal-drawn equipment to custom-hire plowing and threshing. Therefore, it appears that on balance, the value Egyptian farmers place upon family self-sufficiency is not likely to impose a significant constraint upon an otherwise feasible pace of mechanization. Nor is the further attrition

in self-sufficiency occasioned by widened use of custom-hire equipment likely to be perceived by farmers as a loss of appreciable magnitude.

Roles of Women and Children

Like labor savings and migration, the relationship of further mechanization to the roles of women and children in Egyptian agriculture must be considered from two quite different perspectives. One concerns prospective changes in those roles that are likely to result from causes other than mechanization, and the effect of such changes upon the pace of mechanization itself. The second set of considerations turns upon the impact of mechanization upon the welfare of farm women and children.

Participation in Farm Work

At the time of the 1961 Census of Agriculture, some 393,000 women 18 or more years of age were reported to be in the farm labor force. Another 427,000 females between the ages of 12 and 18 likewise were engaged in farm work, as were 1.5 million children of both sexes less than 12 years of age. All together, these groups comprised 35 percent of the 1961 farm labor force. Participation rates among adult women were far higher for temporary hired workers than for either operator family members or permanent hired workers. The ratio of females to males in the 18-and-over age range was 1:5 for temporary hired workers; 1:8 for family members, and 1:15 for permanent hired workers. One-third of all temporary hired workers were children under the age of 12 compared to 15 percent in the family labor component. This suggests that hired workers' children were employed mainly for relatively short periods on seasonal tasks such as manual control of the cotton leaf worm and the picking of cotton. Children in farm

operator families probably were more generally engaged in such tasks as minding the cows and buffaloes pulling sakias.

Indications are that participation by women and children in crop operations has declined considerably since 1960. Statistics are not available for recent years, but it seems likely that the downward trend in the number of females in the agricultural labor force reflected by the 1950 and 1961 Censuses probably continued up to 1972 and has accelerated somewhat in recent years. In 1950, there were 606,000 females in the agricultural labor force, 17.6 percent of the total. In 1961, the total number was only 502,000 or 13.1 percent of a larger total farm labor force. In large part, this downward trend reflects the tendency for farmers, as their incomes rise, to withdraw their wives from field work which they consider demeaning. Apparently, no such stigma attaches to women's milking the family cows or/and buffaloes, and preparing milk, cheese, and butter for sale in the local market. Judging from the findings of the IPB/ILO study alluded to in an earlier context, these activities may well account for the bulk of the direct participation in agricultural production of adult female members of farm operator families. Considering the contribution of animal products to total income on most Egyptian farms, their production is by no means a minor function.

This is not to say, of course, that this by-product of farm mechanization can be expected to radically alter the role of farm operators' wives in family decision-making. Reportedly, in the families of small farm operators, the husband dominates the household. He gives his wife an allowance for household expenses and keeps the rest of the family earnings to spend as he wishes. He probably does not consult her on such questions as buying custom machine services. To the extent the wife does exert an influence, it probably would be in

favor of mechanization to reduce the heavy labor load on the family and especially to free her children for more schooling. In any event, there is no obvious reason to presume that mechanization would reduce the influence of women in family affairs. If anything, it should be conducive to a slow but progressive elevation of their status.

Mechanization and the Role of Women

Given their already low rate of participation in field work, mechanization likely will have comparatively little effect upon the role of women in Egyptian agriculture. With milk production increasing as mechanization frees cows and buffaloes from draft work, the importance of womens' roles in family-income generation likewise will increase. As the kinds of crop operations which women do as temporary hired workers cannot be mechanized in the foreseeable future, their roles likewise should be little affected by further mechanization. If anything, the patterns of potential change reflected in Table XXIV. 5 above suggest that opportunities for women as temporary hired workers are likely to increase over the next decade.

Effects on the Role of Children

Unlike that of adult women, the role of children and teenage boys and girls will be significantly affected by further farm mechanization. And if temporary and permanent migration continue at their current rates, the availability of such workers may affect the benefits derived from mechanization. "Boy days" – as the term is used in Egypt to describe tasks requiring other than adult male workers – currently comprise roughly one-half of the country's total farm labor requirements. Except for irrigation water-lifting, threshing by animal-drawn norag and taking care of farm animals, these requirements are concentrated heavily

in a relatively short period during the peak summer months. If performance of these boy-day operations is delayed due to shortage of workers, some of the gains in timely planting made possible by mechanization inevitably would be lost. Conversely, participation rates among farm children appear to be altering the composition of the labor force, with adult males taking over tasks traditionally performed by operator family members.

Like in many other aspects of Egypt's overall farm labor picture, factors other than mechanization are chiefly responsible for the apparently changing role of children. The selective character of temporary migration increases the ratio of children to adult males in the farm population. Unless relieved by mechanization, it would seem inevitable that, as labor becomes relatively more scarce, children would be pressed increasingly to assume the more arduous tasks now performed by adult males. This would slow or perhaps even reverse the otherwise expected tendency for parents to withdraw their children from regular farm work as their incomes rise.

Working in the opposite direction is school attendance. More children are going to school and for more days a year. This results in part from government inducements; in part, from growing interest in education among rural people who increasingly recognize its value in opening the way for a better life for the next generation. Enrollment in primary school is compulsory and has been growing at about the same rate as the population. Enrollment data indicate that in 1976-77 90 percent of all boys ages 6-10 and 60 percent of all girls in that age group were in school. Enrollment in preparatory school (grades 7-9) has been growing by eight percent a year. In 1976-77, the number enrolled was equal to 71 percent of all boys and 40 percent of all girls of ages 12-14.

In a recent survey, nearly ten percent of the farmers responding to questions about reasons for current labor shortages said that greater school attendance by children was an important factor. In general, it would appear that school attendance actually interferes less with participation by children and teenagers in agricultural work than farmers' statements imply. The bulk of the boy-day labor requirements comes during periods when schools normally are not in session. There may be times, however, such as in the fall of 1978, when school opening has to be delayed to free children for helping with the cotton harvest or when school has to recess in the spring to allow the children to help with the planting of row crops.

In general, mechanization should make it easier for more farm children to attend school and escape the drudgery of some traditional tasks. Replacing sakias with motor-driven pumps is a particular case in point. Minding the cows and buffaloes pulling sakias accounts for a large proportion of the boy-day input of farm-operator family members. That regularly recurring task extends well into the school period in both the spring and fall months. It also leaves the children involved little time for play. In addition, the monotony of that task surely must dull children's initiative and enthusiasm for rural living.

Tenancy

A possible result of the growth of private ownership of tractors is a reduction in tenancy, if tractor owners evict tenants from lands the owners have rented out or if tractor owners buy rented land and then evict the tenants. This happened to a considerable extent when tractors were financed by the World

Bank in the Philippines and Pakistan. In Pangasinan province in the Philippines, about five tenants were displaced per tractor. In the neighboring province of Nueva Ecija, however, less than one tenant per tractor was displaced. In the Punjab (Pakistan), about two tenants were displaced per tractor. In both areas, however, some of the tenants continued working as tenants on other land (sometimes reduced in size), and others converted to wage laborers, often on the same farm.* Farm tenancy in Egypt has in fact been decreasing as mechanization has been increasing, but it is not at all clear that mechanization has been an important factor. The area of leased land in 1952 was 3,670,000 feddans, or 60 percent of cultivated land. By 1962, the area had dropped 16 percent to 3,065,000 feddans, or 51 percent of cultivated land.** A recent estimate is that "more than 40 percent of Egypt's cultivated surface is still rented."***

While the trend of tenancy appears to have been downward, the most important factor in bringing about the observed reduction was not tractorization, but agrarian reform. The Land Reform Acts of 1952, 1961, and 1969 not only limited the size of holdings – hence the amount that any owner could rent out – but also greatly improved the position of tenants. Prior to 1952, it was more profitable to rent land out than to cultivate it, because land hunger was so strong that exorbitant rents could be charged and exploitative sharecropping arrangements could be made. With the improvement in the tenants'

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* World Bank Report No. 1357, op. cit., pp. 64-66.

** Abdel-Fadil, op. cit., p. 22.

*** John Waterbury, "Egypt's Agriculture: Administered Pricing and State Intervention". Common Ground, Vol. 4, No. 2 (1978), p. 37.

position brought about by these Acts, it became more profitable to cultivate one's own property than to rent it out. Rents were limited to 7 times the basic land tax as assessed in 1949, rental contracts in effect made permanent and strict limits imposed on share-cropping agreements. Owners therefore used various statagems to regain control of their rented land.* At the same time, rented land that was part of land-holdings larger than the maximum allowed by the legislation was sold or distributed by government to small landless farm workers in family-sized lots. This substantially reduced the amount of rented land.

Amendments to the land reform legislation passed in June 1975, reversed the situation and increased the profitability of renting out. Moreover, this new legislation removed the restraints on share-cropping arrangements. Under 1952-75 conditions, these restraints could have operated to discourage farm owners from purchasing or hiring tractors and other machines, as the additional net profit gained by improved cultivation and reduced costs had to be shared equally with those tenants not paying cash rents. The amendments of 1975 permitted land-owners to change share-cropping arrangements. Thus, land-owners could appropriate the entire benefit from cost reduction and production increase resulting from mechanization. However, scarcity of labor will discourage them from doing so. Share-croppers now stand to benefit from mechanization mainly through its reduction in their labor requirements. At the same time they typically bear none of the costs of that mechanization.

Share-cropping is not very general in Egypt. In 1961 that form of tenancy accounted for only 10 percent of all leased land and was significant only in holdings of 3 to 20 feddans where 14-18 percent of the leased land was farmed by share-croppers. Cash rental is the predominant method of leasing land in

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* Samir Radwan, op. cit., pp. 29-30

Egypt. As cash rents are controlled by law, tenants of this type are able to gain the entire benefit of reductions in cost and increase in production resulting from their use of machine services. Consequently, it is not surprising that in the 1978 Farmer Attitude Survey renters were found to be as highly mechanized as were owners.

TABLE XXIV. 7

DEGREE OF MECHANIZATION BY TYPE OF HOLDING

Degree of Mechanization	Owners	Renters	Both own and rent	Total
High	28%	37%	20%	28%
Medium	32%	21%	27%	30%
Low	40%	42%	43%	41%
Number	90	38	30	158

In 1975, cash rents went up substantially, and both cash renters and sharecroppers found their income and security of tenure reduced. While they were thus adversely affected in these ways, at the same time the landowners' positions were improved enough so that their incentive to cultivate their own property, rather than rent it out, was greatly reduced. Moreover, the phenomenon observed in Pakistan and the Philippines, where tractor owners purchased additional land and evicted the tenants, is apparently not often found in Egypt.
Few present owners are willing to sell their land; eviction of tenants is still difficult. There are strict limits on the amount of land that may be owned – 50 feddans by an individual, 100 feddans by a family – and custom operation provides a practicable alternative to self-cultivation as a means of efficientl

utilizing modern farm machinery. In addition, with farm wage rates rising rapidly and temporary hired workers scarce at peak seasons, some large land owners may find share-cropping the most advantageous way of meeting their labor needs. It is therefore understandable that the Study Team heard of no reports of tractor owners evicting tenants. Present indications are that eviction of tenants will not be a serious problem associated with tractorization in the foreseeable future. Of course, circumstances could change in the future. For example, as the number of tractors increases, competition could drive custom rates down to the point where custom service is no longer profitable. If that occurred, the incentive for tractor owners to control more land would increase. Even then a tractor owner would find it difficult to enlarge his self-cultivated area unless the long-standing safeguard of tenants' security were drastically modified. A more likely consequence of such a decline in custom rates would be a reduced purchase of new tractors. It would not take long for normal attrition to bring custom rates back to a level acceptable to custom operators.

Other Social Factors

Thus far, discussion has centered primarily upon potentially negative social consequences of mechanization. Some by-products of mechanization clearly are socially desirable. Some of these, like the personal growth stimulated by enhanced opportunity for entrepreneurship, were noted in passing in earlier contexts. A few others deserve specific attention in assessing the social soundness of the approaches to further mechanization of Egyptian agriculture recommended in this Study Team report. The same is true of social factors likely to

encourage or constrain the otherwise feasible rate and content of such mechanization. As they lend themselves purely to qualitative analysis, the succeeding annotated outline mainly identifies the more important of these factors to help make certain they are not overlooked in planning an overall mechanization strategy.

Drudgery

Government policy statements on farm mechanization stress the desirability of relieving farmers of drudgery. This emphasis stems partly out of concern for farm family welfare, partly from that of making farming more attractive and thereby keeping young farmers on the farm. It is not clear how strongly the farmers themselves feel about the drudgery of farm work. Certainly, there is plenty of drudgery in plowing for many days a year with an animal-drawn country plow. Even more monotonous and mind-deadening are the long hours spent by boys driving the animal which turns the sakia. However, "drudgery" was not mentioned as a "push" factor in the IPB/ILO study noted earlier as a reason for rural-urban migration. On the other hand, in the 1978 survey of farmer attitudes, reduction in drudgery was the most frequent response to the question, "How will the mechanization of your farm be of benefit to you?" It seems reasonable to surmise that in deciding whether or not to spend money for a machine or to rent its services, one of the factors the farmer takes into account is relief from drudgery – at least his own, if not also that of his wife and children.

Leisure

Mechanization reduces the amount of time a farmer and his family have to spend on tasks that practicably can be mechanized. Where no reduction in hired labor is involved, this creates additional leisure time. In advanced economies,

leisure has a distinctly positive value. At the current stage of development in rural Egypt, increased freedom from farm work by adult male members of the family labor force probably would not of itself prompt farm operation to spend money on mechanization unless it enables them to find supplemental part-time employment off the farm. This might change as mechanization and socio-economic development advance over time. For the next decade, however, it appears that added leisure for adult males best can be treated as a neutral factor so far as influence upon the pace of mechanization is concerned.

As regards women and children, the situation is quite different. Note was taken in an earlier context of the tendency for farmers to withdraw their wives from field work as their incomes rise. The growing value placed upon education likewise enhances the value of freeing children from farm work during the school term. While both of these social changes work in the direction of encouraging farm mechanization, it would be a mistake to exaggerate their importance in the near term. Except for water-lifting and some rice-threshing, most of the field work women and children do comes in the summer, when schools are out and most seasonal hired labor is employed. Additionally, it is on crop operations that cannot practicably be mechanized. Thus, on balance, it seems likely that in the short run the opportunity for increased leisure will at most have a modest influence on the pace and content of mechanization. In the longer term, it may be a more decisive factor.

Appeal of Motorized Equipment

No one traveling in rural Egypt can long doubt the social value villagers attach to tractor ownership. While the evidence is less clear on the subject, use of tractor in one's own farming operation - albeit acquired through a custom hire arrangement - apparently has a simlar social value. Quite apart from its

utility and profitability, the machine is a symbol of modernity, of new and presumably more efficient ways of doing things. A representative of a private group helping to modernize Egyptian agriculture reportedly attempted to get farmers to adopt an animal-drawn mechanical seed drill that they could see planted seeds at consistent depths, saved 50 percent of the seeds formerly used, and increased yields by 7 percent. The farmers showed little interest because, they explained, the seed drill had no engine. For them, it wasn't worthwhile changing their planting method unless they could vault into the engine age.

Nowhere is the powerful influence of social values upon mechanization practice more apparent than in farmers' preference for 60-65 hp tractors. As indicated by the analysis in Chapter X, a 45 hp unit would be more efficient under Egyptian farming conditions. After discussing the comparative economies of the smaller tractor with a number of Egyptian farm mechanization experts and villagers, however, the Study Team concluded that, for the present at least, the personal preference of the 65 hp tractor was such as to make the 45 hp unit unacceptable to most farmers.

Religion

Although it might be supposed that religion would tend to favor traditional ways of doing things, and although religious leaders in some other Moslem countries oppose modernization, such does not appear to be the case in Egypt. The Koran's strictures against paying interest appear not to preclude the payment of interest on farm production loans or on borrowings for the purchase of farm equipment. Money lenders were active in Egyptian agriculture for generations before they were effectively eliminated by the land reform's establishment of government institutions to provide credit for farmers. Millions of production

loans, involving interest, are now made each year. Millions of savings accounts pay interest. Moslem leaders (imams) in the villages are appointed and paid by the Government and generally support government development policies, such as family planning and saving, holding that these help the community and thus are consistent with Moslem teachings. Moreoever, Shayk Mahmud Shaltut, a former rector of Al Azhar University, wrote extensively in support of interest and banking. Moslem leaders desiring a rationale for defending the payment of interest have his writings to draw upon. But apparently the issue is not raised seriously enough to make this often necessary.*

Beneficiaries of Mechanization

As has been seen from preceding sections of this analysis, further mechanization of Egyptian agriculture can be expected to affect diverse segments of Egyptian society in a multiplicity of ways. Also evident is the prospect of various social factors playing a role in shaping the feasible pace and content of mechanization: some encouraging it, others standing as constraints. Except for externally stimulated migration, none of the social factors considered appears likely to have much effect upon the kind and degree of mechanization visualized by the overall Study Team report. Nor are those social factors likely to be significantly affected in the near term by an otherwise feasible pace of mechanization. How the benefits of mechanication are shared among affected groups will depend in large part upon what happens outside the agricultural sector, especially with respect to off-shore employment opportunities and government policy vis-a-vis farm product prices and food subsidies. As any

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* Ilya F. Harik., op. cit., pg. 181.

equilibrium analysis requires some constants in order to arrive at definitive conclusions, external migration and government policy are assumed to remain unchanged in the succeeding recapitulation of the prospective social impacts of mechanization with respect to affected groups.

Consumers

Given Egypt's system of administered farm prices and food subsidies, the principal beneficiaries of farm mechanization probably will be consumers: urban, rural, nonfarm, and landless farm laborers. Agricultural price adjustments in recent years indicate a predisposition on the part of ARE to allow farm product prices to rise only as much as is deemed necessary to induce farmers to produce target quantities of the different crops. That farm-gate prices for cotton and rice are well below their world market levels is a particular case in point. This apparent policy orientation of holding farm prices down to maximize government revenues from exports and minimize the subsidies required to keep consumer prices comparatively low and avoid excessive general inflation, logically would lead to taxing away, in effect, most of the producers' surplus from increased production and/or cost reduction generated by farm mechanization. Presumably, future farm price adjustments will take into account the farmer returns necessary to induce an optimal rate of mechanization. That margin plus whatever difference there is between the rate of price adjustment and that of production increase/cost reduction probably will mark the extent to which farmers in general retain the benefits of mechanization.

Significant exceptions to the preceding generalization are animal products, fruits and vegetables. As the prices of these products are not controlled, the price elasticity of the respective products and farmers' response to market opportunities will largely determine how mechanization-generated benefits from

their production are shared between farmers and consumers. Throughout the present study, fruit and vegetable production has been assumed to be little affected by the kind of farm mechanization under consideration. Milk and meat production, on the other hand, are expected to increase significantly as mechanization frees cows and buffaloes from draft work. Considering the strong market demand for meat and milk and the low production per head of baladi cows and buffaloes, it seems unlikely that mechanization will increase supplies at a rate faster than the growth in consumer demand. Thus, it is reasonable to anticipate that farmers will be able to gain most of the monetary benefits from increased production of these commodities, while consumers benefit from having larger supplies available. As milk and meat comprise a substantial share of anticipated production increases, these benefits are by no means inconsiderable – especially to small farmers whose ratio of animals to cultivated area is much higher than the national average.

Consumers in general – farm and nonfarm alike – also stand to gain in modest degree from the increase in skill levels generated by expanded farm machinery service facilities. This can work in two different ways. With higher skills, workers going abroad command higher pay, which in turn increases their ability to make remittances to their families remaining in Egypt. Additionally, seldom are workers in any trade able to retain all of the gains in their productivity represented by their enhanced skills. Thus, to this extent, consumers in general would benefit from that increased productivity.

Finally, urban consumers in particular would stand to gain some by relief from reported shortages of unskilled laborers willing to do construction work. This benefit would vanish, of course, if urban and rural nonfarm development and/or migration for offshore employment should slow down appreciably.

Hired Farm Workers

Here a distinction must be made between those who till a small piece of land and those who are completely landless. With Egypt's custom-hire-based system of farm mechanization, the former can benefit from further mechanization in much the same way as farm operators. Survey results indicate that such part-time tillers/laborers utilize custom tractor services to nearly the same extent as do farm operators. Also, their ratio of cattle numbers to cultivated area is high. As they utilize their small plots quite intensively, and need no hired labor that could be replaced by mechanization, members of this group would gain less from mechanization than would operators of larger than family-sized farms. And, needless to say, the amount of their gains per family would be small. Nonetheless, in proportion to their land resources, there is no reason to expect these "patch farmers" to necessarily benefit less from mechanization than operators of family-sized units. Landless laborers stand to benefit from increased farm mechanization largely as consumers. Increased cropping intensity on the larger farms made possible by mechanization would create opportunities for more seasonal employment. This would be offset in part, however, by reduction in demand for hired workers on large farms in those crop operations which practicably can be mechanized. Overall, mechanization can be expected to dampen the increase in farm wage rates, but rising labor costs would, themselves, exert a similar influence by curtailing the otherwise feasible rise in cropping intensity. Where that balance would be struck, in the face of continued reduction in the overall farm labor supply, is hard to say. It does not seem likely, however, that landless farm laborers as a group would either benefit or lose much in employment opportunities as a direct result of the kind and rate of further farm mechanization recommended in this report.

Farm Operators

Here again, a distinction must be made among subgroups of this broad category. As indicated previously, the extent to which farm operators in general will benefit from mechanization will depend in large measure upon government policy. Within that constraint, operators of large farms are in a position to benefit more from increased crop production than those tilling family-sized units. This is mainly because large farms currently utilize their land less intensively than do smaller ones. As they hire much of their labor, large farm operators can expect some reduction in production costs from reduced labor requirements, whereas labor savings on family-sized farms mainly result in increased leisure for farm operators and less necessity for women and children to participate in farm work, However, assuming that the cropping intensity on large farms increases with mechanization, their total wage cost would be increased accordingly.

On smaller-size farms, the economic benefits stem mainly from production increase resulting directly from cost reduction through mechanization. As indicated by the typical farm analyses in Chapter XXV, 75-80 percent of the calculated increase in net returns on family-sized farms comes from the value of milk and meat saved by relieving female cattle from draft work; on the large units, 60-70 percent is from that source. In this context, it is worth stressing again that the bulk of crop production increases that can be expected from mechanization will come from larger than family-sized farms. When all factors are considered, small farmers stand to realize as high a return on their investment on custom machine services as do those operating larger units.

Operator benefits from expanded subsoiling and land-leveling services will depend upon where they are located geographically. Those in areas seriously in need of periodic subsoiling obviously will be the primary beneficiaries from investments in expanding the Soil Amelioration Organization's capability to cover more of such lands each year, hence at more frequent intervals. Families

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operating farms of all sizes should benefit to the same degree from the yield increases produced by this method of land improvement. As only a part of total national production comes from such lands, these farmers should be able to retain most of the net income benefits from their investment in hiring the work done. Current yields on these lands, however, are well below the national average. Consequently, rather than giving those farm families who are able to benefit from subsoiling investments an advantage over those who cannot, this activity would merely redress part of the comparative disadvantage those benefitted now suffer.

Like subsoiling, the benefits from precision land leveling will rebound to farmers – mainly in Upper Egypt, who lose a significant part of their potential yields due to the irregular surface of their fields. In all other respects, the sharing of benefits from mechanizing land leveling would be the same as in the case of subsoiling.

Tenants

Barring unexpected change in government policy with respect to cash rental rates, most Egyptian farm tenants stand to benefit from further mechanization in essentially the same way and extent as do owner-operators of similar sizes and types of farms. Today, cash-rent tenants comprise roughly 90 percent of all tenants and their tenure is quite secure.

Share-croppers who make up the remaining 10 percent of Egypt's tenant farmers should be little affected one way or the other in income terms. As their productivity would rise with the use of improved equipment, they might over time be able to capture some part of that increase. Their ability to do so, however, will depend heavily upon farm labor supply conditions in general. These operators and their families would gain the benefits of reduced drudgery,

increased leisure, reduced requirements for participation by women and children in field work, enhanced opportunity for school attendance, etc., to essentially the same extent as other farm families.

Custom Operators

Being farmers as well as custom operators, these entrepreneurs will benefit from further mechanization on both fronts. As farmers, they should be able to gain a bit more from timeliness of their cropping operations than do those using their custom services. At the same time, however, their equipment is committed elsewhere much of the time. Also, as custom operators, machinery owners necessarily have to spend a great deal of time managing their custom operations, arranging for equipment maintenance and spare parts, etc.

On balance it appears that, under present conditions of poor maintenance facilities and inadequate spare parts, a custom operator's return on investment, risk and management time is little, if any, higher than that on a farmer-user's investment in machinery hire. Those who are able to use their tractors extensively for nonfarm transportation work, such as brick hauling, apparently are doing much better than this financially. In regular farm work, though, which accounts for the bulk of all custom operation, custom rates currently are only about twice the machinery cost per feddan if no allowance is made for either down-time or the time and cost of moving between the fields worked. Egyptian farm mechanization specialists who have studied the cooperatives' cost accounting practices say that their custom tractor rates – which tend to be 15-20 percent lower than those charged by private operators – do not make adequate allowance for depreciation. This would support the Study Team's impression that by and large, custom operators look mainly at their marginal cost – i.e., machine operating expenses – in setting the rates they charge their neighbors for custom plowing and threshing.

What the future holds with respect to custom rates — hence the way in which the benefits of machinery use are shared — depends in large measure upon the effects of competition as the number of tractors, etc., increases. Today the availability of cooperative custom services exerts a levelling influence. Should rates rise faster than farmers consider warranted, the current trend toward cooperatives reducing their participation in the custom service market might well be reversed. With tractors readily available, however, it seems more likely that competition among private operators will hold custom rates to levels commensurate with the cost of supplying custom services. In fact, concern is expressed in some quarters that the market for custom tractor services might become flooded and thus drive rates down to an unprofitable level. In that event, of course, users would benefit at the expense of machinery owners. That could happen only for a relatively short time if a large number of overly optimistic operators entered the market. In due course, though, a custom rate structure that significantly benefited users at the expense of machinery owners would result in fewer tractor services.

The number of additional tractors recommended in this report is believed to be near the prospective absorptive capacity of the Egyptian market over the next five years. If that estimate is reasonably accurate and the number of tractors recommended are put into farm use, the growth in user demand should keep custom rates in roughly the same relationship to user benefits as they are today. In that event, users and custom operators would benefit to much the same extent from further mechanization. Again, however, the total benefits to be shared will depend heavily upon government price policy.

Rural Service Sector

Chief among the members of this category are service facility entrepreneurs, mechanics and tractor drivers. All of these elements would be affected favorably and significantly by expanded farm mechanization. Numerically, this group is, and will continue to be, quite small. Its contribution to Egyptian society in general, however, would be several times what the numbers might imply. On the one side, expansion and improvement of farm machinery repair facilities would benefit most Egyptian farm families to some degree. In addition, the expansion/improvement process itself can but exert a modernizing influence upon the communities in which the facilities are located. And, as noted previously, these facilities will raise the skill level of a fraction of the Egyptian labor force. As such workers typically are highly mobile, this effect would be felt over time in urban as well as rural areas.

CHAPTER XXV

IMPACT OF MECHANIZATION ON TYPICAL EGYPTIAN FARMS

Introduction

Barring government intervention of a kind and intensity that seems unlikely, the pace and content of further farm mechanization will depend primarily upon what it pays farmers to adopt. At this time, farm mechanization in Egypt depends primarily on hired services. Therefore, initial decisions about the types and number of additional machines to be made available to farmers rest with custom operators. Experience leaves little reason to doubt that if there is a market for these services at rates yielding a reasonable return on investment and management time, the private custom operators will supply that demand. Since the demand for custom services derives from the extent to which individual farmers find them profitable, the ultimate decision makers are, in the final analysis, the individual farmers.

Chapter XXIII of this Study Team report approached the economics of further farm mechanization in terms of returns on investment in particular kinds of equipment from the standpoint of the Egyptian economy as a whole. Chapter XXIV in turn, considered the social consequences of further mechanization primarily in aggregative terms. The present analysis extends those insights by exploring the impact of mechanization upon the incomes of families operating farms of particular sizes and types. To avoid possible misinterpretation, it is important to keep in mind certain key differences between the concepts appropriate to typical farm analyses and those underlying the internal rate of return calculations in Chapter XXIII. These concern mainly the

pricing of farm products and relevant input items. Designed to reflect prospective returns on investment to the Egyptian economy, the internal rate of return calculations appropriately employ the world prices for farm products and machinery used. For the reasons explained in Chapter XXIII. such "shadow" prices differ from those which Egyptian farmers receive or pay by a wide margin in many cases. As the current analysis is concerned with cost and returns to typical farms, it is appropriate to use 1977 farm-gate prices for valuing farm products and the cost to farmers by custom operators of farm machinery.

A "pricing" difference of another kind concerns the way labor inputs are treated. While alternative employment opportunities have become considerably more abundant over the past several years, they still are relatively limited in the short run. Consequently, the internal rate of return calculations include no credit for labor saved by mechanization. Conversely, at the farm level hired labor is a cost and its reduction a saving to the individual farmer regardless of general employment conditions in the economy at large. As the typical farm analyses are couched in terms of net returns to the operator family, savings of family labor by mechanization do not enter into the net return calculations. If there were abundant and immediate alternative opportunities for employment of family labor saved by mechanization, such benefits logically would be included in estimating the profitability of mechanization. As they are not, particularly for seasonal employment, family labor savings are disregarded in the typical farm analyses as they were in the internal rate of return calculations.

With respect to farm characteristics affecting the profitability of mechanization, size and type were found to be the only two making sufficient

difference to deserve specific consideration. Farm size affects mainly the amount of hired labor needed and, under existing conditions, the extent to which cultivated land is double cropped, i.e., the cropping intensity. Hired labor requirements increase rapidly with farm size as family size and composition differ only marginally between small and large units. As will be seen from subsequent discussion, cropping intensity declines rapidly with farm size above the 3-4 feddan range.

Even when farms are stratified by size groupings, the remarkable apparent homogeneity of cropping patterns remains. This is to say that when all farms of particular sizes are taken together they appear to have about the same percentage of their cropped land in the respective crops. Only when they are stratified by both type and size are the meaningful differences revealed. The Farm Management Survey, conducted as a part of the present study, provides for the first time a large-sample basis for examining farms by type within size groups. It was on this combination basis that typical farms were selected for detailed analysis of the differential impact of mechanization upon operator family incomes.

Size Distribution

The most recent complete enumeration data on major characteristics of Egyptian farms by size groupings are those provided by the 1961 Census of Agriculture. Judging from comparisons of those data with comparable size groupings of the farms covered by the 1978 Farm Management Survey, cropping patterns have changed surprisingly little over the past two decades. However, two major influences have significantly altered the size distribution of

operating units. The Land Reform Act of 1961 and 1969 virtually eliminated ownership holdings* larger than 50 feddans and created around 400,000 additional owner-operated farms in the 2-4 feddan range by distributing those lands to landless farm workers. Some of the New Lands reclaimed since the completion of the High Dam also have been distributed in similar sized units. Further altering the size distribution of ownership units has been the fragmentation resulting from Muslim inheritance customs. Indications are that this factor has altered the size of operating units less than it has that of land ownership. With farms already quite small, many operating units reportedly stay intact -- with one son continuing in farming and other inheritors moving to cities or other non-farm locations. Nonetheless, there has been some increase in the number of "farms" of less than one feddan even though their percentage of all operating units probably is about the same as it was in 1961.

The 1961 Census put the total number of farms at 1.6 million. Considering the several factors at work during the intervening years, the Study Team took 1.9 million as a reasonable approximation of the 1977 number of farms by the Census definition. Units smaller than one feddan comprise about one-fourth of the total in both instances, leaving some 1.2 million bona fide farm operating units in 1961 and 1.4 million in 1977. The 1961 Census size distribution of farms shown in Table XXV. 1 is based on total land area; that for 1977 on cultivated area. For units smaller than 10-15 feddans, the difference is insignificant. Larger farms in the 1961 Census, however, had substantial proportions of uncultivated land. In many cases, this represented land under reclamation by private operators which subsequently became part of the New

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*In Egypt, the term "holdings" may refer to either operating units or ownership tracts. Throughout this report, "holdings" means operating units.

Lands development area.

TABLE XXV. 1

SIZE DISTRIBUTION OF EGYPTIAN FARMS, 1961 and 1977

Farm Size* (Feddans)	1961 Census (% of Total)	Estimated 1977 (% of Total)
Less than 1	26	28
1 - 2	24	19
2 - 3	17	24
3 - 4	11	16
4 - 5	6	4
5 - 10	10	6
10 - 20	3	2
20 - 50	1	*
50 - 100	*	*
100 & over	*	-
All sizes	100	100

* Less than 1 percent
** Total land area in 1961, cultivated area in 1977

Although relatively few in number, large farms account for a high percentage of Egypt's total farm production. In 1961, when there was a considerable number of very large farms, half of all crops grown were on five percent of the farms. Even now, the ten percent of all operating units with five or more feddans of cultivated land account for some two-fifths of Egypt's total crop production; the 3-4 percent larger than ten feddans for about one-fifth. From the standpoint of the number of farm families affected, the impact of mechanization upon the net returns of families on the more numerous family-sized units of 1-3 feddans is a prime consideration in mechanization strategy planning.

From the standpoint of Egyptian consumers in general, the factors that weigh most heavily in assessing strategy options are (1) the prospective profitability of further mechanization to operators of farms which are larger than average size and (2) how further mechanization would affect the productivity of such units.

Types of Farms

Analysis of the Farm Management Survey data revealed the proportions of different crops grown is the most useful criterion for distinguishing among farm types. Rice growing is confined to an area in the Upper Delta, sugar cane to Upper and Middle Egypt. As these two crops clearly affect the impact of mechanization, units growing either of them were treated as separate types. Within the remainder of the sample units, the proportion of cultivated area planted to miscellaneous crops was found to yield significant differences in other cropping pattern characteristics. Consequently, those units were divided among farms with more than one-third of their cultivated lands in such crops and those with less than one-third so utilized. In Upper Egypt, grain sorghum and lentils are widely grown as food crops as contrasted with maize in other regions. In the Delta in particular, the miscellaneous crops are predominantly vegetables, as they are on many units in Upper and Middle Egypt. Farms with a high percentage of miscellaneous crops thus were divided into two geographic subtypes.

Initially, units growing neither rice nor sugar cane and having a small percentage of miscellaneous crops were divided between those growing cotton and those without cotton. When stratified by total cultivated area, the latter group was found to consist predominantly of "farms" with one feddan or less of

total cultivated land. In fact, the bulk of all sample units of that size proved to be of this subtype. All units with less than one feddan of cultivated area are treated in this study as part-time enterprises. When they are removed, combining general farms without cotton with those reporting cotton did not appreciably alter the composite cropping pattern of operating units larger than one feddan.

Applying the indicated criteria resulted in five type groupings of bona fide operating units:

1. Mixed general farms, all-Egypt.
2. Rice growing farms.
3. Mixed general farms with a high percentage of miscellaneous crops, Upper Egypt.
4. Mixed general farms with a high percentage of miscellaneous crops, Lower Egypt.
5. Sugar cane growing farms.

As sugar cane is grown on only a small percentage of all farms, the number of sample units of that type was too small to permit stratification by size groupings. Significant characteristics are shown in Tables XXV. 2-5 by simple averages of the raw survey data. As there actually are relatively few large farms of any type in Egypt, the small sample numbers for units larger than five feddans largely account for apparent anomolies in the patterns depicted by the respective tables. Detailed analysis of the respective size-type groupings, however, confirmed the general relationships between size and cropping pattern used in the subsequent analyses of mechanization impact on representative farms of particular types and sizes.

TABLE XXV. 2

MIXED GENERAL FARMS, ALL EGYPT[1] CROPPING PATTERNS, LIVESTOCK HOLDINGS AND TENURE, 1978

Item	Farm Size-Cultivated Area				All Sizes[2]
	1-2	2-3	3-5	5 and over	
	Feddans per Farm				
Cultivated Area	1.36	2.21	3.40	11.20	3.57
Cotton	.51	.81	1.26	3.24	1.18
Wheat	.48	.89	1.38	3.12	1.20
Maize	.77	1.02	1.71	4.59	1.63
Berseem	.71	.80	1.29	3.61	1.30
Miscellaneous Crops	.68	.20	.12	1.13	.29
Total Crops Grown	2.55	3.72	5.76	15.69	5.60
Cropping Intensity	187	168	169	140	157
	Number per Farm				
Cows	.48	.62	1.13	1.73	.84
Buffaloes	.64	1.00	1.00	1.50	.96
Ewes	.18	.32	.25	1.59	.59
Goats	.36	.55	.25	.50	.43
Donkeys	.93	.94	1.04	1.77	1.09
	Percent of Total				
Owner Operator	60.0	51.0	45.9	63.7	55.1
Tenant	26.7	36.2	33.3	13.6	29.0
Part Owner	13.3	12.8	20.8	22.7	15.9
All Tenures	100.0	100.0	100.0	100.0	100.0
Number of Farms	45	47	24	22	138

1 Excludes all farms growing rice or sugar cane and all others on which miscellaneous crops occupied more than one-third of the total cultivated area.

2 Excludes units with less than 1 feddan of cultivated land.

TABLE XXV. 3

FARMS GROWING RICE, DELTA[1]
CROPPING PATTERNS, LIVESTOCK HOLDINGS AND TENURE, 1978

Item	Farm Size-Cultivated Area				All Sizes[2]
	1-2	2-3	3-5	5 and over	
			Feddans per Farm		
Cultivated Area	1.64	2.26	3.48	12.13	4.72
Rice	.77	.86	1.46	5.00	1.93
Cotton	.47	.75	.80	4.04	1.44
Wheat	.54	.65	.96	3.66	1.39
Maize	.26	.57	.86	2.52	1.06
Berseem	.82	.95	1.21	4.17	1.72
Miscellaneous Crops	-	.28	.59	1.49	.62
Total Crops Grown	2.86	4.06	5.88	20.86	8.16
Cropping Intensity	174	180	169	172	173
			Number per Farm		
Cows	1.25	.85	1.12	1.85	1.19
Buffaloes	1.38	.94	.81	1.80	1.12
Ewes	-	.08	.78	.15	.32
Goats	-	.09	.12	.25	.13
Donkeys	.88	.88	.75	1.80	1.03
			Percent of Total		
Owner Operator	62.5	52.9	53.1	70.0	57.5
Tenant	25.0	23.5	34.4	15.5	25.5
Part Owner	12.5	23.6	12.5	15.0	17.0
All Tenures	100.0	100.0	100.0	100.0	100.0
Number of Farms	8	34	32	20	94

1 Virtually all rice is produced in a localized area of the Upper Delta.

2 Excludes farms growing sugar cane.

TABLE XXV. 4

FARMS WITH HIGH PERCENTAGE OF MISCELLANEOUS CROPS,
LOWER EGYPT[1] CROPPING PATTERNS, LIVESTOCK HOLDINGS AND TENURE, 1978

Item	Farm Size-Cultivated Area				All Sizes[2]
	1-2	2-3	3-5	5 and over	
	Feddans per Farm				
Cultivated Area	1.18	2.34	3.69	7.71	3.93
Cotton	-	.40	.79	1.30	.65
Wheat	.17	.47	.98	1.25	.74
Maize	.71	1.09	1.64	2.33	1.48
Berseem	.56	.74	.85	2.17	1.14
Miscellaneous Crops	1.25	1.59	2.26	4.92	2.65
Total Crops Grown	2.69	4.29	6.52	11.97	6.56
Cropping Intensity	228	183	177	155	169
	Number per Farm				
Cows	1.14	.92	1.00	1.69	1.22
Buffaloes	.57	1.17	1.00	1.31	1.02
Ewes	.14	-	.08	-	.07
Goats	.29	.74	.17	.25	.35
Donkeys	.79	.83	1.17	1.88	1.22
	Percent of Total				
Owner Operator	57.1	66.7	66.7	69.2	64.7
Tenant	28.6	8.3	25.0	7.7	17.6
Part Owner	14.3	25.0	8.3	23.1	17.7
All Tenures	100.0	100.0	100.0	100.0	100.0
Number of Farms	14	12	12	16	54

[1] Excludes farms growing rice or sugar cane. Farms of this type are found mainly in the environs of Cairo and Alexandria.

[2] Excludes all units with less than 1 feddan of cultivated land.

TABLE XXV. 5

FARMS WITH HIGH PERCENTAGE OF MISCELLANEOUS CROPS, UPPER EGYPT[1] CROPPING PATTERNS, LIVESTOCK HOLDINGS AND TENURE, 1978

Item	Farm Size-Cultivated Area				All Sizes[2]
	1-2	2-3	3-5	5 and over	
			Feddans per Farm		
Cultivated Area	1.21	2.07	3.15	8.36	3.19
Cotton	.19	.49	.24	1.41	.54
Wheat	.42	.55	1.33	2.23	.96
Maize	.30	.75	1.41	1.73	.91
Berseem	.42	.53	.87	1.23	.68
Miscellaneous Crops	1.20	1.53	2.46	5.42	2.32
Total Crops Grown	2.53	3.85	6.31	12.02	5.41
Cropping Intensity	209	186	200	144	170
			Number per Farm		
Cows	.62	.64	1.00	1.36	.83
Buffaloes	.69	.64	1.00	.73	.72
Ewes	1.06	1.27	.67	.18	.91
Goats	.44	.55	1.00	--	.48
Donkeys	.94	.95	1.44	1.27	1.09
			Percent of Total		
Owner Operator	56.2	63.6	44.4	45.5	55.2
Tenant	18.8	27.3	11.2	18.2	20.7
Part Owner	25.0	9.1	44.4	36.4	24.1
All Tenures	100.0	100.0	100.0	100.0	100.0
Number of Farms	16	22	9	11	58

[1] Excludes all farms growing rice or sugar cane.

[2] Excludes units with less than 1 feddan of cultivated land.

Differential Impact of Mechanization

As noted in the referenced tables, "cotton general" and "rice" farms make up two-thirds of all the operating units covered by the Farm Management Survey. For each of these types, two typical units were taken for detailed analysis of the potential impact of mechanization upon operator family costs and returns. In each instance, the 2-feddan unit represents about the upper limit of labor self-sufficient or family-size farms; the 8-feddan unit, large farms heavily dependent upon hired labor.

Given Egypt's characteristic three-year rotation system, the cropping pattern observed in any given year does not necessarily reflect actual land use over a period of time. Having struggled with fitting the crops grown on a particular type and size of farm into a rotation that accorded with planting dates and other farming practices, the Study Team could but wonder how individual Egyptian farmers make it come out right year after year. But since they apparently do, a sequence of crops with planting dates and time requirements for different crop operations, as indicated in Chapters V and X of this report, was used in arriving at the cropping pattern for the respective typical farms shown in Table XXV. 6. In this context, it must be emphasized that those cropping patterns represent what it is possible for farm operators to do under the particular assumptions with respect to mechanization adopted for the present analysis. Consequently, they probably approximate optimal land use under those assumed conditions. That many farmers do not achieve that optimum is evident from the spread of planting dates and those of other crop operations reflected by the Farm Management Survey results.

TABLE XXV. 6

SIGNIFICANT CHARACTERISTICS OF TYPICAL FARMS OF SPECIFIED TYPES AND SIZES UNDER ASSUMED DEGREES OF MECHANIZATION

Item	Rice Farm				Cotton-general Farm			
	2 Feddan		8 Feddan		2 Feddan		8 Feddan	
	Non-Mech.	Fully Mech.	Non-Mech.	Fully Mech.	Non-Mech.	Fully Mech.	Non-Mech.	Fully Mech.
Cropping Intensity (%)	200	200	170	200	200	200	180	200
Crops Grown (fd)								
Cotton	.70	.70	2.90	2.90	.65	.65	4.00	4.00
Wheat	.70	.70	2.70	3.80	.75	.75	3.00	3.20
Rice	.87	.87	3.40	3.40	-	-	-	-
Maize	.43	.43	1.70	1.70	1.35	1.35	3.60	4.00
Berseem	1.30	1.30	2.90	4.20	1.25	1.25	3.80	4.80
Idle	-	-	2.40	-	-	-	1.60	-
Total Crops Grown	4.00	4.00	13.60	16.00	4.00	4.00	14.40	16.00
Livestock (No.)								
Cows	.85		1.70	.30		1.50		
Buffaloes	.94	Same	1.30	Same	.95	Same	1.50	Same
Donkeys	.88		1.90		.40		1.10	
Other[1]	*		*		.15		2.40	
Total Animal Units	2.50		4.30		2.60		4.40	

* Insignificant

[1] Sheep and/or goats

One of the most striking differences between small and large farms of any of the types studied was the sharp decline in cropping intensity with farm size above 3-4 feddans. Lest that apparent anomaly be merely a data fluke, the individual sample farms by size and type were arrayed by cropping intensity. The decline persisted -- with small farms generally showing a cropping intensity of around 2.00 and very large farms, were in the 1.50-1.75 range. When considered in the context of crop sequences and the relation of yields to planting dates, it appeared to make economic sense for operators of non-mechanized large farms to 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. Therefore, rather than simply reducing crop output by a factor reflecting their lower cropping intensity, an idle-land component was built into the crop sequences for 8-feddan farms of each respective type. Even though some 2-feddan farms showed cropping intensities are less than 2.00, full double cropping was taken as the most representative practice among operators of that size unit.

A second significant difference between small and large farms is the substantially higher ratio of cows and buffaloes to crop land on smaller sized units. The number of livestock for the respective typical farms shown in Table XXV. 6 are Farm Management Survey averages for units of those types and sizes. Inspection of the individual farm data confirms that these numbers fairly represent actual conditions when allowance is made for the physical impossibility of any farmer owning a fraction of a head of livestock.

Assumptions

To provide a manageable basis for discerning the potential impact of mechanization on typical farms of the two types and sizes chosen for detailed analysis, all farms were assumed to be completely non-mechanized at the outset

and to utilize all the kinds of land preparation, harvesting-threshing, and irrigation equipment recommended in this report. This obviously creates an unreal dichotomy as even small farms today use motorized equipment for part or all three of these operations. In like fashion, it is not likely that all farm operators of any farm size or type will be fully mechanized any time soon. Nonetheless, the framework for analysis adopted does provide a meaningful indication of the direction and magnitude of changes likely to accompany mechanization.

As indicated previously, the respective cropping patterns adopted represent what is possible within certain constraints. The most significant of these constraints is available draft power since this analysis assumes hired labor to be available as needed to meet all labor requirements above those supplied by the farm operator and members of his family. In the simulated conditions under study, draft power would not limit the timeliness of any operation on 2-feddan farms of either type. As two animals are required for plowing, the operator of such a farm would have to work out a sharing arrangement with a neighbor or rent some animal labor. Indications are that sharing is the more common practice. On the 8-feddan farms there would be enough animal power to meet requirements, but only if individual cropping operations requiring draft power were spread over a longer time period. Thus, for example, land preparation on 8-feddan farms was assumed to require three weeks of elapsed time as contrasted to two weeks on the 2-feddan units. This naturally affects the timeliness of planting some crops on the larger units and, together with the actual availability and cost of hired labor, seems largely to explain why large farmers have a lower cropping intensity than do small ones even at today's degree of mechanization.

The ratio of animal power to draft requirements also affects the number of days per year each animal has to be used for draft work. And, as was shown in Chapter VII, there is a direct relationship between days worked and the reduction in milk and meat a cow or buffalo produces. Therefore, the milk and meat loss due to draft work on each non-mechanized farm model was adjusted by the ratio of calculated days worked per year to the 165-day base used in Chapter VII for estimating the national average milk and meat loss per working cow and buffalo. While available data on the shape of the curve relating milk loss to days worked are very sketchy, chances are that the straight line adjustment made here understates somewhat the loss on small farms and overstates that which would occur on large non-mechanized units. If such be the case, the 2-feddan farms would gain relatively more and the 8-feddan ones somewhat less than the summary calculations indicate.

Small farms in Egypt characteristically carry more roughage-eating animals than their berseem production would seem to support -- if national berseem requirements per head as used as an average. The two types of 2-feddan models used for the present analysis are no exception to that rule. Only by radically altering their cropping patterns could they produce enough berseem to feed their livestock at the national average rate. On the 8-feddan rice farm, berseem production also falls a bit short of calculated requirements. In actual practice, farm operators have the choice of buying berseem or feeding their animals less well with consequent loss in milk production and work efficiency. To simplify the present analysis, enough berseem was assumed to be purchased to bring total availability per animal unit to the national average. Whatever biases this assumption produces in the comparative net benefits of mechanization are probably small.

In calculating grain savings from mechanizing, the threshing/winnowing of wheat and rice, the same 9.5 percent factor used in Chapter XXIII was applied to all four types and sizes of typical farms. The same machine cost factors likewise were applied to all four typical farms in arriving at cash costs under fully mechanized conditions. In all cases, all machines were assumed to be custom-hired at rates based upon operating costs plus depreciation allowance. To be on the safe side, the respective custom rates assumed for this analysis are higher than experience with custom-hire tractors indicates would prevail in actual practice. As machine costs weigh heavily in the net return calculations, the assumed custom rates probably cause the indicated net benefit from mechanization to be several percentage points lower than farmers actually could expect to realize.

Family labor savings due to mechanization do not figure into the net benefit calculations for any of the typical farms. Hired labor requirements are derived in the manner indicated in discussion of the national labor balance estimates in Chapter VI, i.e., as the difference between total labor requirements and the family labor supply available. The Farm Management Survey results indicate that large farms have a slightly larger supply of family workers on the average than do small farms due to the prevalence of extended-family operations of large units. Conversely, participation rates among family members other than adult males appear to be somewhat lower on large farms than on family-size units. Taking account of both these factors produced an estimated family labor force of about 2.5 man equivalents on the 2-feddan farms under present conditions and 2.7 man equivalents on both types of 8-feddan units. These same family labor supply factors were carried over to the fully mechanized situation models. That probably overstates what actually would happen under such

conditions as participation in farm work by women and children characteristically declines with mechanization.

In all situations, yields and farm-gate prices of the respective crops were taken at their 1977 national averages. The value of milk and meat production and that of loss due to working milk animals likewise are valued at 1977 farm-gate prices. Hired labor costs are derived from the calculated number of days of hired labor required and the 1977 average farm wage rate of 76 pt per day.

Effects of Mechanization

As the present analysis is concerned only with discerning the effects of mechanization upon the cash costs and returns of farm families operating typical units of different sizes and types, no attempt is made to estimate the overall net incomes of such families. Rather, changes in the respective cost and return components are, in each instance, calculated differences between their values in the non-mechanized and mechanized situation, respectively, derived on the basis of the assumptions stated above. These various changes are summarized in Table XXV. 7. Note that in all instances the value of milk and meat saved by not working milk animals makes up at least half of the increased value of farm production due to mechanization. This probably overstates reality somewhat as the cropping patterns used for the non-mechanized models come much closer to optimal land utilizations than farmers currently are achieving.

TABLE XXV. 7

IMPACT OF FULL MECHANIZATION ON
TYPICAL FARMS OF SPECIFIED TYPES AND SIZES

Item	Change Due To Mechanization			
	Rice Farms		Cotton-General Farms	
	2 Feddans	8 Feddans	2 Feddans	8 Feddans
Land Use[1]				
Cotton		-		-
Wheat	No	+1.1	No	+ .2
Rice[2]	Change	-	Change	-
Maize		-		+ .4
Berseem		+1.3		+1.0
Idle		-2.4		-1.6
Total Crops Grown		+2.4		+1.6
Value of Production				
Crops	+ 71	+184	+ 31	+134
Milk and Meat	+116	+378	+119	+377
Grain Saved	+ 15	+ 59	+ 6	+ 22
Total	+202	+621	+156	+533
Cash Costs				
Machine Hire	+101	+415	+ 91	+367
Hired Labor	+ 1	-138	+ 1	-110
Berseem Bought[3]	- 69	- 34	-	-
Total	+ 33	+243	+ 92	+257
Net Change				
Net Returns	+169	+378	+ 64	+276
Increase in Value Of Production	24%	20%	9%	13%
Return on Machine Hire	167%	91%	70%	75%

1 Both types of 2-feddan farm double crop all cultivated area under both non-mechanized and mechanized conditions. In non-mechanized situation the 8-feddan rice farm has 2.4 feddans idle during the winter season; the 8-feddan cotton-general farm has .40 feddans idle during summer season and 1.20 feddans idle during winter season.

2 Cotton-general farms grow no rice

3 Value of calculated berseem shortage under non-mechanized condition are: 2-feddan rice farms LE 69; 2-feddan cotton-general LE 132; 8-feddan rice LE 68; and 8-feddan cotton general none, i.e., production just meets needs in both situations.

Even under non-mechanized conditions, both types of 2-feddan farms are essentially labor self-sufficient. Under current practice, they actually woul hire several days of labor for picking leaf worm egg masses off cotton plants and for picking the cotton itself. However, as those practices are not related to mechanization, their effects upon hired labor usage are disregarded. As non-mechanized units, 8-feddan rice farms would, by present assumptions, require roughly 440 man equivalent days of hired labor per year; cotton-general farms of that size, 480 days. Full mechanization would reduce those totals to approximately 255 days in each case. These savings are less than might be expected due to the increase in cropping intensity made possible by mechanization - particularly of seedbed preparation.

The relatively small gain in crop production on 2-feddan farms results from the assumption that, even under non-mechanized conditions, farmers double crop their entire cultivated area. This also accounts for the small farms appearing to gain relatively less than large ones from increased crop production when fully mechanized. On both the 8-feddan farms, nearly sixty percent of the calculated increase in the value of crop production results from the increased crop intensity that would be practicable under full mechanization. The remaining forty percent would result from more timely planting. As indicated previously, this doubtlessly understates reality by a considerable margin as, under current conditions, both power and labor shortages appear to be delaying plantings on large farms well beyond their optimal dates.

The last line of Table XXV. 7 relate the calculated increases in net farm returns due to mechanization to the direct cost of achieving that mechanization, i.e., the assumed cost of machine hire. In effect, what those ratios imply is that under the simulated conditions portrayed in that table, the

operators of all four typical farms could well afford to borrow money at present interest rates to obtain the custom machine services included in the present analysis.

APPENDIX

APPENDIX

IMPROVING POST-HARVEST AVAILABILITY, UTILIZATION AND EXPORTS OF FARM PRODUCTS

Introduction

This report has dealt with various aspects of mechanization as a means of increasing agricultural output given limited resources of land and labor. This section considers methods for increasing usable agricultural output through reduction of post-harvest losses. In addition, it examines the possibility of increasing exports (as well as domestic nutritional availability) through extended shelf life as a result of further processing including alternative techniques for existing processing methods.

> When the world food problem is viewed in terms of a system of production, distribution and utilization, it becomes obvious that in our attempts to improve the system we have allocated most of our resources to the production component, while distribution and utilization have been comparatively neglected. But hunger and malnutrition can exist in spite of adequate food production. They can be the result of unequal distribution of food among nations, within nations, within communities, and even within families. Hence, maximum utilization of available food is absolutely essential. Loss and deterioration of available food resources further adds to the problem.*

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*Amer. Assoc. Cereal Chemists (AACC). Post-harvest grain loss assessment methods, draft 2, 1977.

In the United States about 20% of all food produced for human consumption is lost, while estimates of losses in developing countries vary from 20% to more than 50%.* In observing the situation in Egypt, one is immediately struck by the validity of the preceding statement, and particularly by the near total lack of mechanical aids to shelf life extension and preservation of harvested foodstuffs.

This chapter addresses itself to the problem of optimal handling of raw food materials grown in Egypt by the most appropriate techniques that will utilize total nutrients produced, first to provide an adequate diet for the Egyptian population, and second, to improve the hard-currency situation.

Nutritional Status

When judged on the basis of recent recommendations of the U.S. Senate select committee on food and nutrition, current Egyptian diets, on an average per capita basis, particularly of the rural population, are almost ideal. The high consumption of cereals, fruits and vegetables, plus a modest intake of meat and other animal products providing 65-70g of protein daily should be a healthful diet.** However, it may also be assumed that if the above is the average diet, which is now considered minimally adequate, nearly half the population may suffer from protein deficiency. Considering also the unequal

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* U.S. General Accounting Office report CED 77-118, Food Waste, An opportunity to improve resource use, 1977.

** El-Togby H.A. Contemporary Egyptian Agriculture, 2nd Ed., 1976. Cairo.

distribution of various foods, the "clear indications of a high incidence of nutritional (deficiencies)", particularly among rural children become understandable.*

The Egyptian Nutrition Institute's attempts to develop fortified flours and other nutritionally balanced food items for children is therefore work in the right direction as are efforts to increase nutritious food intake by farmers of their own produce. Reduction of post-harvest losses is equally important if major nutrient deficiencies occur in the urban population as well. Minimizing such loss on qualitative as well as quantitative basis is equally critical to producing the needed high-quality processed and raw food commodities for export and thus to realize opportunities to earn foreign exchange.

According to the planning department of the Ministry of Supply, total per capita calories available per day will increase from 3250 in 1975 to 3500 in 1980. While this appears to be more than adequate, allowing for waste and non-food uses of some commodities, per capita calorie intake is probably substantially less, perhaps not more than 2400 to 2700, which is still adequate provided it is equally distributed.

As may be noted from the data, the quantity of food resources that are largely carbohydrates is expected to remain essentially the same, but their percentage of the total food supply is expected to be reduced from 79% to 76% by 1980 (Tables AP. 1 and AP. 2).

The supply of pulses (beans, etc.) is also planned to remain the same, with the percentage reduced from 3.3 to 3.1. Because of the minimal quantities of protein available, it is suggested that the supply of beans be increased, per-

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* Egypt, Major constraints to increasing agricultural productivity USDA, For. Agr. Econ. Rept. No. 120, 1976.

TABLE AP. 1

CHANGES IN PREVAILING ALIMENTARY STANDARDS, 1975-1980

1980			1979			1978			1977			1976			1975 Transition Year			
Annual	Individual Share Per Day		Annual	Individual Share Per Day		Annual	Individual Share Per Day		Annual	Individual Share Per Day		Annual	Individual Share Per Day		Annual	Individual Share Per Day		Commodity
kg	Calories	gm	kg	Calories	gm	kg	Calories	gm	kg	Calories	gm	kg	Calories	gm	kg	Calories	gm	
109 500	1080	300 00	109 500	1080	300 00	109 500	1080	300.00	109 500	1080	300 00	109 500	1080	300 00	109 500	1080	300 00	Wheat
177 300	--	---	177.300	--	---	177.300	--	---	177.300	--	---	177 300	--	---	177 300	--	---	Wheat
11 300	111	31 00	11.300	111	31 00	11 300	111	31 00	11 300	111	31 00	11 300	111	31 00	11 300	111	31 00	Flour 72%
4 800	47	13 00	4 800	47	31 00	4 800	47	13 00	4 800	47	13 00	4 800	47	13.00	4 800	47	13 00	Flour 82%
76 000	749	208.00	76 000	749	208 00	76 000	749	208 00	76 000	749	208 00	76 000	749	208 00	76 000	724	208 00	Maize
4.100	--	---	4 100	--	---	4.100	--	---	4 100	--	---	4 100	--	---	4.100	--	---	Maize
37 400	371	103.00	37 400	371	103 00	37 400	371	103 00	37 400	371	101 00	37.400	371	103 00	37 400	371	103.00	Rice
12 000	26	33 00	12 000	26	33 00	12 000	26	33 00	12 000	26	33 00	12 000	26	33 00	12 000	26	33 00	Starch + Tubers
8 600	86	24 00	8 600	86	24 00	8 600	86	24 00	8 600	86	24 00	8 600	86	24 00	8 600	86	24.00	Beans
2 000	22	6.00	2.000	22	6 00	2.000	22	6 00	2 000	22	6 00	2 000	22	6 00	2.000	22	6 00	Lentils
2 100	--	6 00	1 900	--	5 00	1 800	--	5 00	1 700	--	4 20	1 600	--	4 10	1.400	--	4 00	Sesame
8 000	192	22.00	7 640	185	21.00	7 360	176	20 00	7.040	167	19 00	6.720	158	18 00	6 300	150	17.00	Oil
3.300	--	---	3 120	--	---	3 040	--	---	2 860	--	---	2.780	--	---	2 700	--	---	Oil
4.100	106	12 00	3.900	97	11 00	3 700	96	11 00	3 510	88	10 00	3 360	89	10 00	3 200	88	10 00	Artificial Fat
65 000	125	178.00	62.400	120	171 00	59 800	115	164 00	57 200	110	157 00	54 600	105	150 00	52 000	101	143.00	Pure Milk
12.500	79	34 00	12 000	76	33 00	11 500	37	32 00	11.000	69	30 00	10 000	67	29 00	10 000	62	27 00	Meat
1 900	12	5 00	1.710	11	5 00	1 520	9	4.00	1.330	9	4 00	1 140	7	3 00	0 950	7	3 00	Chicken
3 660	15	10 00	3.290	14	9.00	2.900	12	8 00	2.560	11	7 00	2.200	9	6 00	1.830	8	5 00	Eggs
26 250	259	72 00	24 500	241	67 00	22 750	223	62 00	21.000	209	58 00	19 250	191	53 00	17.100	173	47 00	Sugar
10.500	45	29 00	9.100	38	25.00	7 700	32	21 00	6.300	25	17.00	4.900	20	13.00	3.500	15	10 00	Fish
3 050	--	---	2.800	--	---	2.550	--	---	2.400	--	---	2.150	--	---	2 000	--	---	Sugar
2.430	22	7.30	2.240	22	6 00	2 08	22	6 00	1.810	18	5 00	1.760	18	5.00	1 600	14	4 00	Halewa
8 600	77	240.00	86.000	77	140 00	86 00	77	240.00	86.000	77	240.00	86 000	77	240.00	86 000	77	240 00	Vegetables
58.000	73	159 00	58.000	73	159 00	58.000	73	159.00	58.000	73	159.00	58 000	73	159.00	58.000	63	159 00	Fruits
1.600	--	3 00	1.365	--	3 00	1.300	--	3 00	1.260	--	3.00	1.200	--	3.00	1 144	--	3 00	Tea
0.213	--	0 05	0.213	--	0.05	0.204	--	0 05	0 195	--	0.05	0 186	--	0.05	0 177	--	0.05	Coffee
6.800	--	14.00	6.500	--	14 00	6 200	--	13.00	5.600	--	13.00	5.600	--	12.00	5.300	--	10.00	Soap
---	3497	---	---	3462	---	---	3416	---	---	3364	---	---	332[illegible]	---	---	3250	---	

TABLE AP. 2

SUGGESTED TOTAL CONSUMPTION TARGETS BASED ON
CHANGE OF PREVAILING CONSUMPTION STANDARDS UNTIL 1980
PER YEAR, (MINISTRY OF SUPPLY)

1980		1979		1978		1977		1976		1975 Transition Year		
Consumption Target 000 M.T.	Indiv. Share Kg.	Consumption Target 000 M.T.	Indiv. Share Kg.	Consumption Target 000 M.T.	Indiv. Share Kg.	Consumption Target 000 M.T.	Indiv. Share Kg.	Consumption Target 000 M.T.	Indiv. Share Kg.	Consumption Target 000 M.T.	Indiv. Share Kg.	Commodity
4814.0	117.3	4708.0	117.3	4605.0	117.3	4504.0	117.3	4405.0	117.3	4380.0	117.3	Wheat
465.0	11.3	445.0	11.3	445.0	11.3	435.0	11.3	425.0	11.3	425.0	11.3	Flour 72%
197.0	4.8	193.0	4.8	189.0	4.8	185.0	4.8	181.0	4.8	180.0	4.8	Flour 82%
3300.0	80.1	3277.0	80.1	3156.0	80.1	3801.0	80.1	3019.0	80.1	2990.0	80.1	Maize
1543.0	37.4	1509.0	37.4	1476.0	37.4	1444.0	37.4	1412.0	37.4	1397.0	37.0	Rice
493.0	12.0	483.0	12.0	473.0	12.0	462.0	12.0	452.0	12.0	445.0	12.0	Starch+Tubers
354.0	8.6	346.0	8.6	338.0	8.6	331.0	8.0	324.0	8.6	320.0	8.6	Beans
82.0	2.0	80.0	2.0	79.0	2.0	77.0	2.0	75.0	2.0	74.0	2.0	Lentils
86.0	2.1	76.0	1.9	71.0	1.8	65.0	1.7	60.0	1.6	52.0	1.4	Sesame
465.0	11.3	435.0	10.8	409.0	10.4	381.0	9.9	358.0	9.5	336.0	9.0	Oil
168.7	4.1	157.0	3.9	145.6	3.7	136.0	3.52	126.5	3.36	120.0	3.2	Artificial Fat
2674.0	65.0	2511.0	62.4	2353.0	59.8	2202.0	57.2	2056.0	54.6	1940.0	52.0	Pure Milk
514.0	12.5	483.0	12.0	453.0	11.5	423.0	11.0	395.0	10.5	375.0	10.0	Meat
151.0	3.66	132.0	3.29	114.0	2.9	98.5	2.56	83.0	2.2	68.3	1.83	Eggs
432.0	10.5	366.0	9.1	303.0	7.7	234.0	6.3	184.0	4.9	130.0	3.5	Fish
1203.0	29.3	1096.0	27.3	996.0	25.3	899.0	23.4	757.0	21.4	517.0	19.1	Sugar
99.0	2.4	90.0	2.24	82.0	2.08	74.0	1.92	66.0	1.76	61.0	1.6	Halawa
3538.0	86.0	3461.0	86.0	3384.0	86.0	3310.0	86.0	3238.0	86.0	3209.0	86.0	Vegetables
2386.0	58.0	2334.0	58.0	2282.0	58.0	2233.0	58.0	2184.0	58.0	2164.0	58.0	Fruits
57.6	1.4	55.0	1.365	51.2	1.3	48.5	1.26	45.2	1.2	42.7	1.144	Tea
9.1	0.222	8.6	0.213	8.0	0.204	7.5	0.195	7.0	0.186	6.6	0.177	Milk
279.8	276.8	261.6	266.65	244.0	6.2	227.0	5.9	211.0	5.6	198.0	5.3	Soap

haps primarily by utilizing defatted soybean meal, production of which is rapidly increasing from less than 10,000 feddans in 1972 to more than 100,000 in 1978. Defatted soy-cake could readily be processed for human consumption as a high-protein, inexpensive meat substitute and/or extender.

Oils and fats are planned to be more available, increasing from 7.3 to 8.5% of the total food intake. While this increase is not essential it is still within good nutritional practice and will probably be welcome by the consumers, and should be readily achieved through increased production of various beans, soybeans, and other oilseeds.

While consumption of fruits and vegetables is also planned to remain the same at about 4.3% of total calorie intake, it is assumed that substantial increases in production will take place for the export market. Table AP. 3 summarizes the percent of the average diet from various types of products with total consumption in 1980 estimated at over 23 million tons.

TABLE AP. 3

PERCENT OF DIFFERENT TYPES OF FOODS
CONSUMED IN 1975, AND ANTICIPATED FOR 1980

Ministry of Supply Projections

Food Type	1975 Calories - %	1980 Calories - %
Carbohydrate (Incl. cereals, roots & tubers, starch, sugar)	2571 - 79.2	2665 - 76.2
Beans and Lentils	108 - 3.3	108 3.1
Fats and Oils	238 - 7.3	298 8.5
Animal Products (Incl. meat, poultry, eggs, fish, milk)	193 - 5.9	276 7.9
Fruits and Vegetables	140 - 4.3	150 4.3
TOTAL	3250 -100.0	3497 - 100.0

Product Mix to Satisfy Nutrient Requirements

While there are still occasional worldwide surpluses of animal foods (e.g., the current glut of dried skim milk), it has now been recognized that barring major breakthroughs in "synthetic" food production, the burden of adequately feeding the world population will fall on grain reserves, supplemented by high protein oil seeds, largely soya, and roots and tubers.*

Reducing Post-harvest Losses

Only in recent years has serious attention been given to the possibility of significantly and rapidly increasing the supply of foods (and nutrients) by post-harvest losses. While statements abound as to the extent of these losses in grains and other food crops, ranging from as low as 3-5 percent to as high as 70 percent, it is admitted that little hard data are available. A first priority is to carefully assess the extent of such losses, using scientific methods. ** Table AP. 4 summarizes findings by Brs. Khadr, Mari

* Research to meet U.S. and world food needs, Proc. Agric. Res. Policy Advisory Comm. (ARPAC) 2 Vol's. 1975.
* Cummings, R.W. Jr. Food Crops in the low-income countries, Rockefeller Foundation Working Paper, May 1976. N.Y.
* Pentzer, W.T. and A. Kramer. Recommendations on improving global food resources through refrigeration. The Refrigeration Research Foundation 1st fellowship report. 1976.
** Amer. Assoc. Cereal Chemists (AACC). Post-harvest grain loss assessment methods, draft 2, 1977.

TABLE AP. 4

POST-HARVEST LOSSES OF VARIOUS CROPS IN EGYPT, WHEN HANDLED UNDER OPTIMAL CONDITIONS

Crop	Percent Loss From	Percent Loss To
Grains		
Wheat	3	7
Barley	2	5
Rice	2	5
Pulses		
Beans	2	5
Vegetables		
Tomatoes	25	40
Potatoes	11	13
Cabbage	9	11
Squash	7	9
Egg Plant	8	9
Taro	2	4
Sweet Peas	9	16
Fruits		
Citrus	18	25
Others	5	20

Source: Khadr and Mari, Ministry of Agriculture

et al., Ministry of Agriculture as to potential reductions in losses under optimal conditions. In general, it may be stated that while substantial post-harvest losses may occur with all groups of commodities, they are likely to be less severe in grains than in other crops. In general, crops can be ranked as follows: grains < pulses < roots < tubers < vegetables < fruits. That is, grains incur the smallest losses while fruits incur the largest.

Yet, even for grains, it has been estimated that threshing with animals may result in 10 to 15% loss.* A further 3-5% loss may occur during transport to storage.

Storage Requirements

Grains: Depending on the nature of the storage facility there may well be a further 10% loss due to bird and rodent infestation, and a much greater potential loss from mold even in rat-proof storage if moisture levels of the harvested and stored gain are too high. Because of the limited rainfall, and presumed low relative humidities, it was reported that typical farm storages in Egypt are open at the top, permitting bird damage and are not built to withstand rodent infestation. In fact, much of the farm storage consists of nothing more than an elevated platform.

Dr. Mohamed Sabbah, Dept. of Agricultural Engineering, Alexandria University, stated that he has observed entire carlots of grain turn moldy. He and others in Egypt are prepared to investigate various methods of grain drying. Such an investigation may well be of substantial benefit particularly if it could be expanded to include other methods of preserving yields and nutritive and functional qualities. Thus, for example, not only drying by heating but also chemical treatment and cooling could be investigated.** While addition of acetates or propionates to high moisture grain for feed is being given serious consideration in the U.S., refrigerated storage is under study in Australia, Czechoslovakia, Israel and elsewhere. Japan is actually cold-

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* Gotch, C.H. Agricultural Mechanization in selected Middle Eastern Countries. USAID Contract No. NE-147-77-8, 1978.

** Pentzer, W.T. and A. Kramer. Recommendations on improving global food resources through refrigeration. The Refrigeration Research Foundation 1st Fellowship report. 1976.

storing ca.2 million tons of rice over the summer months at 12-15°C. The low temperatures maintain nutritional and functional quality and aid in retarding mold and insect infestation. In Egypt (as in Amazonian countries), it may be possible to provide grain storage that will maintain sufficiently low moisture content and temperatures to preserve grain without serious losses by ventilation, particularly with cool night air. However, a thorough investigation of improved storage procedures and facilities is urgently needed.

As to farm storage, certainly village-scale grain stores holding several hundred tons (bulk or bagged) equipped at least for ventilation, and perhaps also capable of applying drying, fumigation or other chemical treatment, would be preferable to individual farm-scale stores holding a few tons and subject to substantial losses. The problem here is not technical but sociological. The solution may be a farmer cooperative. But with government-controlled co-op's during the last 20 years, there appears to be great reluctance among farmers to entrust their crops to hands other than their own. By this time, however, several countries, with the aid of FAO, have established successful farm co-ops, where management and inspection of the grains to be stored is entirely in the hands of the co-op members themselves. It is therefore suggested that efforts be made to support such independent co-ops to construct adequate local grain storage in the village to hold all of each farmer's grain, both the portion to be sold to the government at the fixed price, and the portion to be retained by each farmer for his own use. Such an arrangement has proven to be workable in other countries when the acceptance, inspection and management of the stores is in the hands of the farmer-members themselves.

While bulk handling would be much more efficient, the 50-80 kg. burlap sack is so ubiquitous throughout the grain handling system that any change-

over to bulk handling should be done only following a thorough research and demonstration program and with the complete approval of the farmers involved.

Roots and Tubers: Despite the obvious favorable conditions for the production of various root and tuber crops, only the white potato is of importance in Egypt. For best preservation it requires special storage conditions. To our knowledge, however, only seed potatoes, purchased from abroad are stored in cold (5°C) storage in the summer before the fall planting. Having at least 2 crops per year reduces the requirement for special potato storage. There appears to be a highly satisfactory arrangement between Egypt and The Netherlands, for Egypt to supply The Netherlands with food potatoes in the spring, and The Netherlands to supply Egypt with seed potatoes in the fall.

Onions, a major crop, would benefit materially from cold storage, particularly for that part of the crop harvested at a high moisture content. Ventilation with dry air could replace low temperature storage.

Fats and Oils: Oils generally store better than fats. Cottonseed oil is particularly stable. Fats, however, are subject to oxidate rancidity unless stored at low temperatures and, preferably, packaged in air-tight containers.

Meat Products: While local consumption of all kinds of meats and meat products is expected to increase substantially, there is little expectation that any red meats, poultry, fish, milk or eggs will be substantial export items. If expected to remain in channels of trade more than one to two days for local consumption, all these products require chilling and refrigerated storage, sanitary slaughtering, collection and/or pasteurizing or sterilizing. As will be discussed under fruits and vegetables, however,

to be successful, a complete cold chain is needed from time of slaughter until consumption. To provide such a complete mechanized system would require an investment of at least $1.0 billion, which may not be a high priority item, since the present marketing system is a viable alternative.* In addition, such an investment is not essential for nutritional adequacy, and will not generate hard currency.

Fruits and Vegetables: The need for adequate storage, transportation, packaging and/or further processing of fruits and vegetables is a first priority because of the perishable nature of the product. This is particularly true because fruit and vegetable products have a readily expandable and profitable export market which demands compliance with international quality specifications.

Perhaps for the local market, the present system is a viable alternative. Farmers often harvest near-fully ripe produce at night, and transport (usually by donkey-cart) to the wholesale market where, upon payment of 8% commission, they dispose of their crop in the early morning hours at the full established (by government) price.

As time passes, with no refrigeration, any remaining produce is sold at a discount, and finally, buyers for the processing companies may purchase the remainder. Although it was indicated that this procedure may result in losses of 40% of the crop and reduced price for a substantial part of the remainder, personal observation indicated that such losses are rare and in fact the system is quite effective. For example, good quality Thompson Seedless grapes sold in the Cairo wholesale market for LE 0.16/kg, at a roadside stand direct from the farm for LE 0.25/kg, in retail shops in the city for LE. 0.35/kg,

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* Feiges, D.M. I.F.C. report on Egyptian refrigerated warehousing facilities, May, 1976.

and eventually wholesale for 0.17/kg.

Excellent quality, fully ripe tomatoes were priced at LE.0.055 officially, and the remainder purchased by cannery buyers while still usable at prices as low as 0.03/kg.

Often buyers purchase the entire crop in advance and handle it in a similar manner except that they may use trucks for transport to market or direct to the processing plant. These buyers or co-ops may lease a stall in the market, where they can at least keep produce under cover.

The only refrigerated facilities (for 1000 tons) were for banana ripening, and for storage of seed potatoes. There is no official inspection for quality. The government inspectors, who were very much in evidence, inspected for weight, compliance with the established price and collected the 8% commission.

While the above system is adequate for fresh produce marketing for local consumption, it falls short in many respects if the potential for exporting both fresh and processed produce is to be realized, as will be discussed later.

Storage Requirements - Summary and Conclusions

From Table AP. 5, it is clear that about 15% or about 3 million metric tons of the local food supply would require cold storage if it is to be in the channels of trade for more than one to two days. Assuming an average storage time of 18 days and a mean occupancy rate of 60%, cold storage space required would amount to about 700,000 cubic meters.

According to Table AP. 6, cold storage existing and under construction will handle 81,000 metric tons in coolers and 30,000 tons in freezers. Assuming again that a ton of produce requires 4 cubic meters, we may conclude that cur-

TABLE AP. 5

STORAGE REQUIREMENTS FOR FOODSTUFFS FOR LOCAL CONSUMPTION

(Total annual quantity for 1980 estimated at 23 million metric tons).

Food Type	Percent of Total	Storage requirements
Cereals and other mainly carbohydrate foods	76.2	Dry, rat and bird proof, preferable cooled to 12-15°C but adequate if ventilated with cool, dry night air.
Beans and other legumes and oil seeds	3.1	Same as above-more likely to require fumigation, humidity control.
Fats and oils	8.5	Common storage for refined, well-packaged oils, if not refined or if hydrogenated or animal fats, require cooler or freezer storage.
Meats, fish and products	7.9	Require refrigerated or frozen storage.
Fruits and vegetables	4.3	Require refrigerated, controlled atmosphere and/or frozen storage.

rent cold storage facilities are about 440,000 cubic meters, or about half of the refrigerated storage required to handle domestic comestibles.

However, this space is now largely allocated to imported or exported products. If the marketing system is to be changed so that perishables can survive in channels of trade for more than just one to two days, a complete network of refrigerated warehouses combining some 20 million cubic feet would be required. Such a network would cost approximately $200 million.

Assuming further that the value of the 3 million tons of food is $100/ton, and refrigerated storage would reduce losses by 10 percent, the invest-

TABLE AP. 6

COLD STORAGE FACILITIES IN EGYPT - IN METRIC TONS OF PRODUCT

GOVERNORATE/LOCATION		GERCO SUB.ZERO	GERCO +0°	PGC +0°	PRIVATE +0°			
CAIRO	-Ghamra	1500						
	Ramlet-Boulak	300	700					
	Misr-El-Gedidah	----	900					
	Rawda-Kaliub	9000	3000					
PORT-SAID	-Hod-Abbas	951	----					
	Marine-Army	650	----					
	Port-Said	160	----					
	Hod-Sherif	1000	----					
SUEZ	-New-Suez	1500	----					
	Ataka 1.	1200	----					
	Ataka 2.	1500	----					
	Ataka 3.	1200	----					
GIZA	-El-Shobak	----	----	3000				
	Barashein	----	----	4000*		Sers-El-Layan	Nassr Habib	1000 E
MENUFIA	-Chateaunef	----	----	3000	1500 Est.	Kafr-Rabii	Saiid-Abo-Houssen	1500 E
BEHEIRA	-Kafr-Bolin	----	----	3000	3000 Est.		El-Tahhan	
	Damanhur	----	----	4000*			Moharram-Bai	1000 E
SOHAG	-Souhag	50	50	----			El-Tartoussia	1000 E
ALEXANDRIA	-El-Sabatia	----	----	6000*	2000 Bt.		Saiid Abbas	1500
GHARBIA	-Kafr-El-Zaiyat	----	----	4000	4000 Est.		Abo-Allah Othman	1500 Est.
MINIA	-Minia	50	50	3000			El-Boradii	1000
QALUBIA	-Benha	50	50	----	4000 Est.	Shoubra	Fouad Mossaid	3000
	Shoubra	----	----	1500		Elkaeima	Abu-El-Gheit	1000 Est.
SHARKIA	-Zagazig	50	50	----				
DAKAHLIA	-Mansoura	100	----	----				
	El-Tawlla	----	----	3000				
DAMIETTA	-Damietta	50	50					
FAYUM	-Fayum	50	50					
BENI-SUEF	-Beni-Suef	50	50					
ASSIUT	-Assiut	50	50					
QUENA	-Quena	50	50					
ASWAN	-Aswan	100	100					
RED-SEA	-Safaga	100	----					
		19711	5150	40500	15,500	+ Min. 30,000 tons Under Construction Etc.		

* Under Construction

ment in such a warehouse network would be retired in about 7 years. Other benefits would include the improved quality and safety of the produce so stored.

Further processing of raw food materials may consist of no more than sorting, grading and packaging, or it may involve substantial alterations of the raw materials to produce relatively stabilized foods that may then be transported long distances and stored up to one year or more. Further processing is potentially a means of reducing food losses, but at a cost. It is therefore essential to study carefully the benefit/cost relationships to determine whether further processing more than pays for itself in terms of profit, gain in hard currency, improved quality or safety of the comestibles, or other benefits.

Historically, food processing develops when there occur surpluses of a commodity in a given region, and to avoid spoilage, the surpluses are "stabilized" so that they can be stored for later consumption locally, shipped to other regions, or enter international trade. Frequently, such surpluses are not the best plant variety or animal breed for processing so that eventually special varieties are grown primarily for processing purposes.* With a few notable exceptions, the current situation in Egypt is one in which the food industry is largely dependent on surpluses not utilized promptly for direct consumption in the local market. This situation is further aggravated by the small size of the farms on the "old lands" so that an adequate quantity and quality of raw materials at a reasonable price is difficult to assemble. In many instances the Study Team was informed that certain processing plants operate at 10 to 50 percent of capacity, simply because raw material of the

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* Kramer, A. Opportunities for producing a uniform finished product by process adjustments. Proceed. 18th International Congress Horticulture V, 131-139. 1970.

proper quality is not available. It is therefore recommended that before any food processing facility is approved, whether it is in the public or private sector, and whether it is wholly Egyptian capital or a joint venture, that an adequate source of raw material that will meet buyers' specifications be assured in advance.

Processing of Soy and Other High-Protein Oil Seeds

As noted above, the bulk (almost 80 percent) of the total food supply consists of carbohydrate-rich foods. These also supply a substantial part of the proteins and fats for human consumption so that with the addition of relatively small amounts of animal products and oil, the average Egyptian daily diet is only minimally adequate for protein (70-75g) and oil (45-50f).* The animal products are largely locally grown. Sixty percent of the feed is provided by berseem clover occupying over 2 million feddans of prime "Old Lands". Only about one-third of the oil supply is produced locally; nearly double that amount is imported. Thus, in 1975 production of cottonseed oil, by far the major source of food-oil, reached 161,192 tons, but it became necessary to import an additional 279,623 tons. ** The deficiency in food-grade oil and substantial improvements in protein availability could be met by crushing 300,000 tons of soybeans (or perhaps other oil seeds such as sunflower or safflower). While a number of studies have indicated difficulties in producing soybeans in Egypt, current reports from local farmers indicate satisfactory yields of 2 tons per feddan. (Ministry sampling studies thus far indicate yields of 1.1 tons per feddan.) Since it should not be difficult to extract 50 percent oil (by solvent if not by crushing method) and assuming a two-ton yield per feddan, the nation's

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* F.A.O. Per caput food supplies: Egypt. Information available as of 09/04/76.
** Federation of Egyptian Industries, Year Book, 1976, Cairo.

deficit in food-oil could be met by devoting 300,000 feddans to soybean production.

By paying farmers 50 percent more than world prices, 1978 plantings of soybeans reached about 80,000 feddans and are expected to rise to 200,000 over the next few years. Thus, the goal of self-sufficiency in food-oil via soybeans is already in sight. There remains the question of the desirability of allocating this land to soybean production when the same product could be imported at a 33 percent lower cost. In either event, if new facilities for oil extraction are to be erected, special attention should be given to solvent extraction, a method already in use for extraction of rice and linseed oil.

The soybean cake, after oil extraction, should contain nearly 50 percent protein. This can be used as a valuable constituent of animal feed, but could be further processed into a textured or powdered protein concentrate for human consumption. In this way, an additional 150,000 tons of protein would be provided, which if used entirely for human consumption, would add 10 grams/day of protein per capita to the Egyptian diet. It is suggested that this added protein be used either as a meat extender, or mixed with other flour products such as bread and pasta to improve their protein content. (One source indicated that the "Wimpy" hamburger and other purveyors of ground meat patties in Egypt are already extending their products with soy protein concentrate, presumably produced in Egypt). Such a quantity of soy protein concentrate could be produced in perhaps three plants in soy-producing regions, at the same location where the oil would be extracted. If the soybeans are to be imported, it would be logical to set up such combined oil and protein concentrating and refining plants near ports of entry.

Milling and Baking

Further processing of cereal crops through milling and baking received

considerable attention and capital allocations since they provide the bulk of the "daily bread" of the great majority of the population. Large investments are being made to establish new, modern, more efficient mills, and large automated bread and pasta factories. Some of the ancient stone mills have been retired, others improved.

Two suggestions are made to further improve the utilization of cereals. One is to improve nutritive value of the flour by incorporating small quantities (up to 5 percent) of soy or other protein concentrates.

The other is to investigate the possibility of chemical peeling, particularly of rice and barley instead of mechanical abrasive removal of bran and polishing. USDA research has indicated the possibility of increasing yields by chemical peeling by as much as 10-15 percent.*

Maximizing for Food or Feed

Perhaps the most serious drain on the utilization of cereal grains for food in Egypt is the tendency to divert food grains to feed. This became evident on several visits to poultry farms, mills, and bakeries. A good illustration is the method of handling rice in two mills near Alexa[illegible]. Dr. Amin, director of the larger and older mill, indicated that of the 2 million tons of rice produced annually on nearly 800,000 feddans of land, about half must be delivered to government cooperative collection centers for a fixed price. Each farmer is obliged to so market 1.5 tons per feddan. The excess is his to dispose of as he chooses. It is apparent that the part of the crop that remains on the farm undergoes substantial losses because of inadequate storage facilities. Further, a large portion of the kernel is removed and utilized as animal feed. But even the rice received in the mill is

* USDA-WRRL. Chemical peeling of rice and other cereals. Food Technol. 1970.

processed in such a manner that an estimated 40 percent is separated out as broken, germs, gran, etc., with the fraction for food being obviously excessively ground and polished. The remainder is shipped to another mill where the rice oil is solvent extracted. The remainder is used for feed. The other, newer mill was equipped with new Japanese rubber-coated polisher. It is estimated that the percent lost as human food is less than 20 percent.

A new public sector bakery has demonstrated the benefits to the Egyptian common man of the present policy of providing food for all. This new, ultra-modern bakery was operating most effectively on all but one line although it was put in operation just a few months prior to the visit to the plant. However, although constructed to provide low-cost nutritious subsidized bread, it was doing this as only one of three products. This is everyman's "Baladi" bread, made of 85 percent flour and water, yeast, and salt and is sold through Government stores at about 7¢ per kg. A similar but whiter and less nutritious "shammy" bread was made of the same ingredients, except for the use of 72 percent white flour but still sold at the subsidized price of about 10¢/kg. The same formulation plus some sugar rolled into a "French" bread is made to sell, at the unsubsidized price of about 50¢/kg.

Milk and Other Animal Products

Per capita daily calorie intake from all animal food sources (meat, poultry, fish, milk and eggs) was only 183 calories, or 5.6% of total daily caloric intake in 1975, and scneduled to rise to 276 calories or 7.9% of total calorie intake by 1980 (Table AP. 1). This increase is justified on the basis of improved nutrition primarily by increasing the quantity and quality of protein. However, from a strictly nutritional standpoint such increases in available protein, fat (oil) and related nutrients can be provided far more cheaply and at a substan-

tially lower cost in land, water, labor, and energy by processing oil and protein concentrates from soy and/or other oil-seeds. There remains, however, a need to maintain and perhaps increase present production of animal-food products to satisfy sensory preferences of the Egyptian population and to meet the requirements of tourists. As mechanization progresses, animals freed from draft requirements will yield increased meat and milk production. Additionally, in time, breeds will be developed that will be more efficient producers of meat and milk, further increasing the output of animal protein.

It may also be desirable to consider developing completely modern, sanitary facilities to supply limited quantities of high-quality, safe, well-packaged, animal products for those who can afford to pay the price.

Milk is by far the largest volume animal product in Egypt, with total production well over 2 million tons per year. However, two-thirds never leaves the farms. Thus, less than one million tons of milk are marketed. The public sector receives only 20 percent (146,200 tons) which goes largely into the production of pasteurized, condensed and dried milk. The 80 percent in the private sector is marketed in five-gallon tin cans as fresh milk or processed into a variety of cheeses (mostly soft, and processed) plus some butter and ice cream. This Study Team was unable to locate a single modern dairy plant which produces a whole gamut of dairy products including pasteurized milk.* Recent information indicates the State is allocating LE 1.6 million to establish a modern dairy processing plant in Cairo.

It is therefore recommended that a limited number of "milk sheds" be organized near the larger population centers, collecting milk on a daily basis in

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* Federation of Egyptian Industries, Year Book, 1976, Cairo.

stainless steel tank trucks from village centers to which individual farmers will deliver their milk into refrigerated collection tanks. Tank trucks would then deliver raw milk to a fully equipped modern dairy plant. There raw milk would be tested microbiologically, as well as for fat, total solids, odor, filth and promptly pasteurized before it is further processed and packaged into the various products needed in the particular area.

It is specifically recommended that special attention be given to the possibility of utilizing one of the new "High-Temperature Short Time" (HTST) sterilization processes instead of the conventional pasteurization process, and packaging the milk aseptically directly into plastic pouches. It is further suggested that the handling of milk by the above method be carried out as a complete system from farms to consumers. So that experience can be gained with the new system, it should be limited at first to two plants, each handling perhaps 100 tons of milk per day; but these plants should have the capacity of expanding to the processing of 500 tons daily. If prices of the aseptic product are controlled solely by what the consumer is willing to pay for such "safe and sanitary" products and demand grows, additional plants could be established or the new ones could be enlarged to handle larger quantities. On the other hand, if the consumers are not willing to pay the added cost of milk products so handled, the existing system would continue and the production from the two original plants could be channelled largely to the tourist market.

Red Meat consumption is scheduled to exceed 500,000 metric tons by 1980 and in 1975 was estimated at over 375,000 metric tons, of which 8,000 tons were imported and none exported, it is of interest to note that in 1974 when a small quantity of red meat was exported, value per ton exported was ca LE 1000, while value of the same imported products averaged less than LE 500/ton.

Further processing of meat products may be worthwhile. "Conserved Meats" to which milk powder, starch, etc., are added are now being produced at the rate of 25,000 tons annually, and are about as cheap as imported meat. Similar products, or simply ground meat extended with vegetable protein concentrate should be even cheaper and could be used to prepare a variety of meat products such as hamburgers or sausages.

Poultry and Eggs As in the case of larger animals, most poultry production until 1965 was in small farm flocks. With the establishment of the General Organization for Poultry in 1964, integrated broiler and egg producing operations were organized. In these installations, chicks, feed and other services are supplied to farmers who raise the chicks to 1.2-1.5 kg live weight in 45-50 days and return them to the organization for slaughter and marketing. This and a similar program for increasing egg production has moved ahead near schedule to everyone's satisfaction. As a result, by 1976, 45,000 tons of chicken meat was to be available for consumption target for 1980 is about 80,000 tons. Increases in egg consumption are planned: from 68,000 tons in 1975 to 151,000 tons in 1980 (Tables AP. 1 and AP. 2).

A visit to one of the two operating broiler processing plants revealed a production of 12,000 birds per day (about 12 tons), indicating that, as of 1978, this modern, sanitary poultry production from the two public sector plants has reached only about 8,000 tons per year. However, it was indicated that eight additional plants are under construction so that goal of 45,000 tons of chicken meat may be reached from the public sector plants alone. With the addition of private sector sources, total production could easily reach the goal of 80,000 tons by 1980.

The broiler plant that was observed was equal in equipment and efficiency of operation to the best available anywhere. The only variation from the usual process was that slaughtering was performed by knife according to Moslem ritual, and the birds were bled for 3-5 minutes. While this procedure aggravated the sanitation problem, it contributed to a unique and useful method of recycling all waste, including blood, feathers, culls and viscera as valuable feed (70% protein, dry weight basis). The collected waste was autoclaved, which not only sanitized the feed, but also made the proteins bio-available. Dressed birds were packaged individually in plastic film pouches, graded by size (from 0.5 to 1.2 kg), packed in cardboard crates and placed overnight in -40°C storage. If held longer than one day, they were transferred to -20°C storage for which 50 tons of space was available. Distribution was made via unrefrigerated non-insulated trucks. Since the birds were all purchased promptly while still cold and within 24 hours of removal from the freezer, this practice may not represent a major health hazard. While the recycling of waste into feed is a real contribution to the efficiency of the operation (developed by Dr. El Lakany of the University of Alexandria), the hard freezing of the poultry and distribution in uninsulated vehicles and containers as a continuing practice is open to question.

The success of this operation is due in no small measure to the provision of feed and other services at such low costs that grains such as wheat, which could provide food more economically when fed directly to humans, are diverted to poultry production. It is therefore suggested that further extension of poultry and egg production under subsidized conditions be watched carefully to test the wisdom of increasing the subsidy costs. While small quantities of poultry meat in the amount of 3,026 tons in 1975 were imported, there have

been no exports since 1974. This may indicate that regardless of the efficiency of poultry production and processing in Egypt, international competition may currently limit the export market for this commodity.

Sugar

Production of cane and sugar is well suited to Egypt, which is currently producing over half a million tons of refined and raw sugar, over 300 thousand tons of molasses and about 100,000 tons of confections annually for a total value of approximately LE 100 million. The export of sugar saw a substantial rise from an annual rate of about 40,000 tons to nearly 60,000 in 1977, but because of declining world prices for sugar, its value remained at about LE 11 million, a figure that accounts for about one-third of total value of processed food exports. Sugar is processed in seven well-equipped and efficiently operated plants.

With an average yield of 37 tons per feddan, cane sugar production in Egypt is as efficient and low cost as anywhere in the world.* However, Egyptian scientists are not satisfied with this accomplishment and indicate that yields of cane could be more than doubled. From the standpoint of by-product utilization (use of bagasse has not been determined) and water conservation, they are investigating the sugar beets as a partial replacement for sugar cane, which would also provide the opportunity to produce feed material in the form of the beet cake. Currently, the major problem facing the industry is a lack of raw material to keep existing processing

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* Federation of Egyptian Industries, Year Book, 1976, Cairo.

plants operating at full capacity. While the seven mills have a capacity of crushing 8 million tons, they will perhaps have utilized only seven million tons of cane during 1978. This will produce an all-time high total of 600,000 tons of sugar, but 1978 consumption is expected to reach 900,000 tons. Not only will exportable surpluses have disappeared, but imports of 2-300,000 tons are anticipated.

The beet processing plant, now under construction is expected to add 100,000 tons of sugar to the local supply by 1981. With the awaited Government approval for construction of an 8th cane processing plant, plus increased plantings and yields of raw material and more complete utilization of processing facilities, Egypt may become self-sufficient in sugar by 1982.

Concentrated in one mill, nearest to Cairo, is production of sufficient quantities (from cane) of alcohol, vinegar, yeast, and some other chemicals, to satisfy all local demands. There still exists a surplus of molasses, so that 1978 exports are expected to reach 140,000 tons, which at $50 per ton, should earn $7 million.

As for bagasse utilization, all but the Edfu mill use their bagasse plus some oil for fuel. Hence, the boilers of six of the seven mills would require substantial modification if the bagasse were to be used for other than burning purposes. At the Edfu mill, a substantial part of the bagasse is now used for manufacturing 50 tons of wood-like panels per day. This production is now in the process of being tripled, with the expansion costs expected to reach $120 million. A joint venture with Iran has been set up to produce furniture from these panels.

The new plant will have oil boilers and will therefore not use bagasse for fuel. Now that Mexico, Peru and Argentina have demonstrated the feasi-

bility of producing printing and writing paper from bagasse such manufacture will be scheduled for the new plant. It is anticipated there will be sufficient bagasse to eliminate completely the current import of more than 45,000 tons per year of printing and writing paper. Financing of this venture is estimated at $150 million. While more bagasse at additional locations can be converted to pulp and/or paper, there is some question about a market and availability of financing. However, with the cost of fuel oil for local manufacturing at only $11 per ton, pulp, or paper can be produced in Egypt at less cost than elsewhere.

It appears that more than adequate feasibility studies have been made of the cane sugar industry, and that current plans for expansion are logical. While use of bagasse for purposes other than fuel is strongly indicated because of the low cost of Aswan Dam electricity and local oil, high investment costs dictate the current proposals limiting expansion of sugar production by 100,000-200,000 from cane, and 100,000 from beets. An opportunity that should not be overlooked is manufacture of cartons and other packaging materials, including paper and cardboard from bagasse. This could replace those now obtained from Europe and would be used for fruit exports and other purposes. Approximately one-tenth of the available bagasse will provide all the wood paneling requirements for furniture. Another tenth, all the printing and writing paper now imported, and perhaps another tenth may be utilized for paper. pulp, board, etc., which altogether would require an investment of $3-400 million. This investment could probably be paid back in terms of hard currency savings in just two years. Even with further use of bagasse there may still be surpluses that may be difficult to justify, so that more than half of the bagasse should continue to be used for fuel.

Confectionary Industry includes manufacture of Halawa-Tehina, a very popular confection based on sesame. Local production is limited by availabilty of sesame and is augmented by imports of about 10,000 tons per year. Existing factories do not operate at full capacity and lack modern equipment for efficient processing and packaging.

Dry confections and chocolates both suffer from the same basic problem, an insufficient supply of basic raw materials other than sugar. It is therefore recommended that for all these confections, a realistic goal be established as to quantities to be produced, that adequate quantities of raw materials be supplied to the most efficient processors only, allowing them to operate at or near full capacity, that the less efficient older plants be gradually retired. Such a procedure was followed for the biscuit industry which was modernized by the State so that it now produces over 15,000 tons worth over LE 5 million of quality biscuits that meet international standards. The same factories also produce gaufruits, rusks, toast and pies. It should be pointed out that all raw ingredients are produced in Egypt.

Fruits

The further processing of certain fruits and vegetables undoubtedly provides the greatest opportunity for expanding Egyptian exports profitably will help to meet growing local requirements and will further improve the nutritional and sensory quality of the general diet. Opportunities lie with marketing of both fresh and processed fruits and vegetables.

Oranges already occupy 200,000 feddans, which produce on the average 6 tons per feddan for a national total of 1.2 million tons. Of this amount, up to 200,000 tons are now exported as fresh fruit, and some 3,000 tons are proces-

sed largely as canned juice. Most of the fresh fruit goes through one of eleven well-equipped parking stations of the El Wadi Company. From these points they are shipped, mostly to east-European countries, but increasingly to Arab and Western countries. There is now underway a full scale investigation to determine opportunities for marketing Egyptian oranges in Western Europe and elsewhere. Present indications are that export of high-quality fresh oranges could be tripled to about 600,000 tons. Since little additional fruit is of prime export quality, such an export expansion will require new plantings of appropriate varieties. A new venture by Coca Cola is under consideration to plant 200,000 feddans of critrus which is expected to yield 20 tons per feddan. This would provide an additional 300,000 tons for fresh export. The balance is expected to be used for frozen concentrate. A complete line of by-products will also be produced, some of which will be for Coca Cola syrup.

Handling of current orange exports and planning for expansion on new land is being done in a thoroughly professional manner. The remaining question is: are the nearly million tons of old land oranges that are not exported being utilized to best advantage. Only 3,000 tons are allocated to the two major canning companies for canning single-strength orange juice, mostly in 6 or 8-ounce cans. It was suggested that Arab countries alone could absorb ten times that quantity. This was confirmed by the managers of the canning companies who claim to have adequate plant capacity, but cannot obtain additional raw fruit of satisfactory quality.

El Wadi Export Company is the government agency for exporting all fruits. It is also involved in marketing a large share of the fruit for the internal market. While much of the fruit on the market is currently obtained through middle-men, the company is now embarking on a program of direct contracting

with farmers, for the total crop. The farmer receives an advance of LE 20 per ton of oranges (average of 6 tons per feddan), comprehensive technical assistance and help in harvesting and delivering if he requests it.

Each lot of fruit is inspected on arrival at one of the eleven packing houses, for citrus or the six for onions, garlic, ground nuts or flax. Payment is made on a quality-grade basis apparently primarily on the basis of color, as determined during acceptance inspection. Quality control is maintained throughout the washing, sizing, dipping and waxing (mechanical), sorting, wrapping and packing (manual) into internationally standardized cartons, most of which are imported from Spain or Italy. The filled cartons are transported, usually not strapped or palletized, and trucked to Alexandria, Port Said or Suez. First grade (usually Washington Navel) is shipped to West European and Arab countries and a standard grade to East European countries. Grades are established in accordance with EEC regulations.

Oranges not selected for export are now usually returned to the farmer. However, there is a plan to package this portion of the crop in net bags for sale in government stores at fixed prices. Profits from all sales are to be shared by farmers as a bonus in addition to the original payment.

Exports to tropical countries are now shipped in reefers. Space is currently being sought for refrigerated storage during February-July to extend the shipping season by two to three months. From limited observation, it appears that very little cold storage space is now available, so that such stores will need to be constructed, adding 100,000 to 200,000 cubic meters to the refrigerated storage requirements indicated above (see Table AP. 6).

not suitable for further processing and export. On the other hand, the Study Team could not ascertain whether or not the proper techniques for harvesting, processing and marketing have been studied. It is therefore suggested that such an investigation be undertaken to determine the feasibility of using part of the existing crop for export or planting new varieties to develop a date industry in Egypt, on the model of one of the major date-producing countries.

Strawberries are beginning to be shipped by plane to European markets. If handled properly this could grow into a modest, but highly profitable export item.

Vegetables for Further Processing and Export

As of 1974, vegetable (including potatoes, but not onions) production was over 5.5 million tons, accounting for less than 3 percent of the caloric intake of the population. This represented over 12 percent of the total value of agricultural production, approximately double that of fruits.* However, with the rapid rise of orange production, particularly fresh fruit export, while local consumption rates remain the same, value, particularly in terms of hard currency may have been reversed.

Tomatoes represent an important export opportunity. However, processing of tomatoes (which constitutes 35-47% of all vegetable production) has been almost totally neglected, despite the fact that there is an excellent market both for exporting fresh tomatoes, particularly during the winter season, and processed canned and dehydrated tomato products during the summer season (July to November). Other Mediterranean countries actively export both fresh and processed tomatoes, frequently with government subsidies, to provide an ade-

* El-Togby H.A. Contemporary Egyptian Agriculture, 2nd ED., 1976. Cairo.

Exports

Export of fruit other than citrus is negligible at this time. Banana exports ended, due to the increased local demand, while export of grapes is meeting with considerable difficulties. There is an excellent opportunity for exporting early Sultana grapes during June-July, and methods of extending storage life to permit surface shipments by sulfiting and film packaging are available.

Of the four mango varieties suitable for export and widely grown in Egypt, El Wadi Company succeeded in collecting and shipping a total of only 200 tons because of the strong and increasing demand for the fruit on the local market. But before steps are taken to establish new extensive mango plantations devoted primarily to export, competition from Central Africa should be thoroughly investigated.

Surprisingly, avacado is not grown in Egypt, nor is it in demand in Egypt. Yet a limited local market could be developed and opportunities for profitable export would appear to be good. It is therefore recommended that avocado production for export be thoroughly investigated.

Dates, in contrast, are produced in great abundance (over 350,000 tons annually); yet they are not considered suitable for export. Because of the high caloric value of dates, the State has four modern dehydrating facilities, which are obviously not being utilized at capacity. Output of dehydrated dates has been declining steadily. For example, total dehydrated in 1975 was down to 1,737 tons, compared with 2,439 tons in 1974. Yet this valuable resource should not be permitted to dwindle further. True, date palms are scattered and collection and delivery to a central packing and/or processing plant poses special problems. It is also possible that some varieties are

quate price for the raw product. According to a study prepared by A.R. Persson of Norway, present methods of producing tomatoes in Egypt yield 7 tons per feddan at a production cost (1969) of LE 60 or less than LE 9 per ton. Even if costs are now double, and the price paid to the grower were LE 20 per ton, the farmer would make a good profit and cost to the processor would be substantially lower than world prices. To obtain the high quality needed for exports, the price paid for fresh tomatoes could be doubled, and with handling, packing and shipping, the cost per ton would total LE 92. However, there would still be a good margin since a selling price of LE 120, FOB, is easily obtainable.

It is therefore recommended that a substantial program be initiated immediately to develop a fresh and processed tomato export operation. This could be developed along lines similar to the El Wadi orange export, with central packing plants located at strategic points, including one in the Aswan area to provide early winter tomatoes.

Expansion of canned tomato production can be accomplished much more easily by simply providing existing canneries with up to ten times the quantity of tomatoes they are now receiving. Canned tomatoes can easily be increased from the current 3,000 tons with little added investment in equipment.

Potatoes are a poor second in value among the vegetables (about 12 percent). Attention is being given to proper storage to provide a steady supply year-round domestically, as well as to exports, at least in a volume sufficient to pay for the seed potatoes that are still imported. As the refrigerated storage facilities are improved and expanded, it may be possible to eliminate import of seed potatoes. At this time there is an arrangement with the

Netherlands for the import of seed potatoes and export of potatoes for consumption.

The Study Team found no potato processing industry in Egypt as contrasted with the U.S. where potatoes are by far the largest volume frozen product, substantial quantities are dehydrated into flakes and granules, and potatoes are canned in large number. Egypt may be in a unique position to export such products to Arab countries.

Watermelon of excellent quality is the third of the big three vegetable crops in Egypt. Although over a million tons are produced, export of watermelon and other higher quality melons has dwindled to practically zero because of the increasing local demand.

Other vegetables which could undoubtedly be further processed, with substantial quantities earmarked for export to Europe and Arab countries, both fresh and processed primarily as frozen or canned and in a few cases dehydrated, are listed in Table AP. 7 below.

TABLE AP. 7

VEGETABLES THAT COULD BE FURTHER PROCESSED PRIMARILY FOR EXPORT

Vegetable	Fresh	Frozen	Canned	Dehydrated
Cucumbers	X			
Eggplant	X			
Green(Bell)peppers	X	X		X
Okra	X	X		X
Green(or wax)beans	X	X	X	X
Peas	X	X	X	X
Cauliflower, Brussel sprouts, various greens including spinach	X	X		

Canning and Freezing Opportunities

Development and vast expansion of freezing and canning of various food products for export should be a first priority to improve the Egyptian trade balance. The opportunity exists but until now only a very small beginning has been made. The usual reason given for the small size of the food canning and freezing industry is the shortage of raw materials for which there is an increasing demand from the exploding population and the high cost of preparing new land (now estimated at LE 2000 per feddan). Both of these arguments can be challenged. Domestic demand for certain food staples could be met by low-cost imports, while other exportable items could be grown and processed in Egypt, and exported at a profit. Similarly returns from crops grown on new lands, specifically for processing and export, could return investment within 1-6 years.

Dr. Aly Zein El Abdeen, Chairman, Council for Foodstuffs Industries provided an example of each. He pointed out that watermelon export has disappeared, while close to 100,000 feddans of new land is being allocated to soybean production at a price that is 50 percent higher than the world market. Thus if the land were used for growing watermelon and other crops that could be packaged and/or processed and exported profitably, they would pay at least in part for the imported soybeans which would therefore cost a fraction of domestic production costs.

An example of quick return on investment in preparation of new lands is the Coca Cola venture which should double the citrus exports now collected from 200,000 feddans by use of only 20,000 feddans of new lands.

Today, only two companies (about six plants each) provide all the canned, frozen and some of the dehydrated foods produced in Egypt for domestic con-

sumption and for export. Quantities of different products and exported in 1974 and 1975 are given in Table AP. 8.

From these data, it appears that export at even these rather small quantities is generally on the decline. However, more current data provided by Dr. El Abdin indicated that the two canneries are now producing about 50,000 tons of canned foods annually, valued at LE 28 million. The canned products consist mostly of juice, jams, tomato products and green beans. The fish which consisted mainly of sardines caught off Damietta are no longer available because of the high dam. Canning of fish and meat is largely from frozen imports and is prepared largely for the military. Approximately 90 percent of the exports consists of canned juice, of which 80 percent is mango, with much smaller quantities of orange and tomato.

TABLE AP. 8

CANNED, FROZEN OR DEHYDRATED FOODS
PROCESSED IN EGYPT AND AMOUNTS EXPORTED

In Metric Tons

Commodity	Total Processed		Total Exported	
	1974	1975	1974	1975
Canned (Fruits, vegetables,juice)	26,000	30,000	5,400	4,000
Fish	2,400	2,700	90	110
Meat	2,100	2,800	10	--
Frozen foods (Incl. shrimp)	700	1,100	30	50
Dehydrated onions, garlic	6,600	4,900	4,500	2,800
Total value, 1,000 LE	16,787	18,507	11,370	9,929

There appears to be a ready market for ten times these exports of canned, and probably frozen foods as well, in Arab countries alone. A substantial increase at least in the canned products can be achieved with little added investment in equipment since existing plants are not being utilized to full capacity.

Apparently there is some lack of coordination between the various marketing organizations such as El Wadi and Nili, and processing companies such as Edfina and Kaha. A coordinated program is needed where all produce (except that marketed privately) would be collected or delivered to central sorting stations. Here, the portion that meets international quality standards as fresh, would be sorted out for that purpose, that part meeting quality standards as canned or frozen directed to processing plants and the balance marketed domestically. The beginnings of such a system are already being initiated by the El Wadi Company, except for the coordination with the canners and freezers. If additional refrigerated storage and freezing facilities should be required, all components could be produced in Egypt except for the compressors.

If such a coordinated system of allocating raw material cannot generate sufficient produce to satisfy the export market, additional plantings on new land should be considered for the primary purpose of providing produce for export.

Dehydration

All dehydration operations in Egypt are performed in the eight dehydration plants of El Nasr, a public sector company. Approximately 90 percent of total production is of onions.

Until 1970, onions were the third most important export crop (after

cotton and rice). As oranges move ahead, onions may still retain third place because of the rapid decline in rice exports. However, because of serious diseases for which there are as yet no resistant varieties, production of onions for export is also declining. Thus, fresh onion exports declined from 104,000 tons in 1974 to 70,000 in 1975, and dried onions from 5,150 tons to 3,570 tons. Obviously, onion exports need a revival. Some suggestions offered by the Federation of Egyptian Industries in addition to new disease resistant varieties that meet buyer's specifications, are direct contracting with growers or their association, improved packaging, dehydrating and storing methods.

According to El Nasr, the major problem with maintaining onion exports is that the bulk of the onion crop is harvested at too high a moisture level, and collected by El Wadi or El Nile, who sort out the raw material into three grades. The 1st grade is used for export as fresh, the 2nd for export or local comsumption, and only the 3rd and poorest grade shipped as far as 500 kilometers for immediate dehydration.

Despite the above, El Nasr state that they have been successful, maintaining an annual production level of 5,000-6,000 metric tons plus 1,000-1,500 tons from the private sector, practically all 95 percent going to export. If the Egyptian dehydrated onion industry is in a decline, the fact that mostly 3rd grade raw material is used is sufficient reason. However, it was also suggested that the dehydration equipment is antiquated, and no funds are available for new, efficient equipment. It is therefore suggested that at least part of the acreage devoted to onions be specifically allocated totally for dehydration, and irrigated sparingly before harvest. This, together with the use of high solids varieties could produce good-quality raw

material, which together with more efficient processing equipment, could revive and increase export of the traditional crop. El Nasr's reasonable proposals are for an annual 10 percent increase over the next few years with arrangements for purchase of new equipment to be paid for over a ten-year period.

Packaging Materials

As indicated above, practically all packaging materials, whether plastic, paper, wood, or metal, are imported. Even the raw materials for related products such as writing and printing paper are imported. With respect to the need for a feasibility study to determine what types of raw materials could be produced domestically, inquiries indicated that many such studies have been made and that now is the time to initiate action to produce both raw material and packages in Egypt. While some growth in requirements for both glass and metal containers is anticipated, their relatively high cost should discourage efforts to develop or substantially increase production capacity for such containers in Egypt.

Plastic Containers

Plastic film food packaging is increasing rapidly, as a low cost containing material in the United States. With the availability of raw materials as by-products of the oil industry, film pouches of various types could be produced in Egypt. The same is true for larger and/or rigid plastic containers. Production and use of insulated cartons, tote bins, or

containers could eliminate the need for freezing dressed poultry and other products before marketing and/or extend shelf-life of packaged foods.

Paper-Wood Containers

Egypt is notoriously short of trees, the basic ingredient for wood and wood products. The Department of Forestry is engaged in expanding roadside plantings with Eucalyptus and Casuarina for wind breaks. There is no expectation, however, that these plantings will provide any substantial quantities of wood for paper-pulp or box construction. A long-term project that may eventually lead to sizable quantities of pulp is the search for salt-tolerant trees and shrubs.

However, there is no shortage of cellulosic materials in Egypt, derived primarily from sugar cane. Other possible plant sources are papyrus, which provided the first writing paper, and the cotton plant. In fact, a first paper pulp operation from bagasse was initiated in 1964 to produce flash-dried pulp, to reduce transportation costs. This operation was not successful because of the poor quality of the paper.

As noted earlier, the new (8th) cane mill is scheduled to produce enough paper from bagasse to eliminate all imports for writing and printing paper in Egypt. Production of wood-panels is scheduled to triple in another cane mill. It is recommended that bagasse generated in a third mill be diverted to manufacture of pulp to produce Kraft board. If this one mill manufactures all the cartons and card-board boxes needed for Egypt, an export market should be available for any surplus, since there is now a growing shortage of paper and card-board for packaging worldwide.

Quality Assurance

While many of the food processing and handling operations examined were performed in satisfactory manner, there appeared to be a general absence of the concept of quality assurance as a distinct system. To every inquiry regarding regulations and/or inspection procedures, the response was always that such regulations and procedures existed. But even after specific requests to observe quality inspection, or to obtain copies of quality regulations, not a single specific procedure was observed, nor a copy of a standard, grade, or regulation received.

This situation may be the result of the fact that all agricultural produce is accepted, usually at a uniform price, and if accepted on a quality-grade basis, the criterion for establishing the grade is rarely more than size (weight or volume). Even this grading is performed by the workers themselves, under supervision, but not by trained quality control inspectors.

If the food-trade balance is to be reversed by substantial increases in exports of selected foods, a sense of quality mindedness must be developed and a complete system of quality assurance installed by professional specialists.

Summary and Conclusions

As mechanization in the field progresses and the full potential of the land is realized, the marketing system will become an increasingly serious bottleneck. Improved storage and handling facilities can reduce post-harvest losses. Some of these changes will require original research to determine

the most economic alternative suitable for Egyptian agriculture. In other cases, the technology is well documented in other countries and can be readily transferred with an adequate investment. However, some changes will require the emergence of new organizations (e.g., marketing cooperatives) and new attitudes (e.g., quality assurance) in order to realize the potential of increasing Egypt's usable agricultural output. A number of opportunities to utilize present and potential production through further processing into products for both domestic and international markets have been identified. These would provide benefits to farmers in the form of income from increased utilization of their production, to the population from an improved diet and to the nation from greater export earnings.

CHAPTER XXII

AGRICULTURAL FINANCE AND CREDIT

Purpose

This chapter will (1) describe the banking system and institutions, their sources of funds and lending practices, (2) identify the additional financing and credit needs that will result from further mechanization of agriculture in Egypt, (3) determine the impact of such needs on the existing agricultural financial structure, (4) determine the feasibility of such financing for the farmer, the Cooperatives, Agricultural Societies and the agribusiness infrastructure and (5) recommend actions in the area of finance and credit mechanization that will help as to assist Egyptian agricultural production develop in a sound manner.

Sources of Agricultural Credit

The Principal Bank

The dominant source of funds for agriculture is "The Principal Bank for Development and Agricultural Credit" (The Principal Bank) and its nationwide system. The system includes 17 "Agricultural Development Banks" with 130 branches located in the agricultural governorates, 740 Village Banks, each serving several villages and about 4,200 agencies (generally, one-man operations) serving the farmers and cooperatives in the individual villages.

The Agricultural Credit Bank of Egypt was formed in 1931. Its purpose was to grant short-term loans to small land owners and cooperatives for a period not exceeding 14 months for crop production and medium-term loans to 10 years for

acquiring farm animals, purchasing machinery or developing irrigation and drainage ditches. Long-term loans could be made for as much as 20 years, for land reclamation. This Bank incorporated with 51% of the stock owned by the government and 49% by a number of commercial banks, land banks and individuals.

In 1948 the Bank was transformed into a cooperative bank under the name of "Agricultural Credit and Cooperative Bank". The capital was increased to LE 1.5 million, one-half of which was subscribed by the cooperative societies and the other one-half by the Government.

The third stage started in 1964 when the head office of the Bank was converted to a public organization named the "Egyptian General Organization for Agricultural and Cooperative Credit", while the branches in the governorates were made autonomous agricultural and cooperative credit banks, with branches in each district. This action served to decentralize much of the decision making to the local levels. The governorate banks then issued credit through their Cooperative Societies while the Organization's task was to tailor agricultural credit within the state's economic policy, finance the Governorate Banks, supervise their operations and make the farm inputs available.

The last stage came as a result of Law No. 117 of 1976. Under this law, the rural financing system was broadened to include the entire system as a public holding company with 100% of the Governorate Banks share capital owned by the "Principal Bank for Development and Agricultural Credit". The Principal Bank, through its Board of Directors, controls the agricultural financing and credit activities of the entire system. Law No. 117 consists of 27 Articles which, in effect, give full control of all "in kind" and cash credit extention and servicing activities directly to the Principal Bank system. Article 6 states that:

"The Resources of the Principal Bank shall consist of:

1. The proceeds of its activities.

2. The proceeds of the debentures which may be issued and of the loans concluded according to approved rules.

3. The funds allocated yearly for it in the State Budget.

4. The proceeds of loans which it may conclude with foreign banks and institutions and international organizations.

5. The net profits of the affiliated banks after deducting the approved reserves and provisions."

Through its subsidiaries, the Principal Bank makes loans to agricultural societies, institutions active in agricultural development, farmers and members of agricultural cooperative societies. It offers bank services and accepts deposits and savings for clients, cooperative societies, and their members and serves "the purposes of farmers' crop disposal in a manner ensuring the public interests" and makes loans in kind or cash for production purposes. Long-term loans are also made to agribusiness.

Cooperative and Farmer Financing

These sources of capital can use their current cash reserves or savings for recurring operating expenses or for down payments on equipment. Such funds are adequate for some farmers to operate from season to season without additional credit. Most of the small farmers must borrow funds and supplies on a regular basis However, such borrowings are now directly from the "Principal Bank" system or from other lenders, not ordinarily from the Cooperative Societies. Some of the financially strong specialty crop cooperatives such as fruit and vegetable societies have sufficient assets to make loans to

some of their members.

Equipment Dealers

In general, equipment dealers lack sufficient excess funds to permit them to extend credit to the farmers. Some will sell on a term contract, however, but they usually sell the contract to a bank which then services the loan. Some private dealers reportedly sell to farmers on agreed-upon repayment terms.

Commercial Banks

The Egyptian banks are owned and controlled by the government, and although commercial banks have historically had little interest in financing machines, this is changing. Commercial banks now normally finance machinery dealers and business which service machinery and repair parts. General or "bulk" loans are made usually on a yearly basis to the larger farmers, sugar cane companies and some specialty crop growers.

Bank Misr was established in 1920. It is the largest bank in Egypt with approximately 200 branches encompassing 25 governorates. In 1965, the Bank became a joint stock company with all of its shares held by the Central Bank of Egypt. It is managed by a nine-member board, all of whom are its employees. The Chairman, Vice Chairman and three other directors (senior officials of the bank) are appointed by the President on recommendation of the Governor of the Central Bank of Egypt. Although 100% government-owned, the bank is operated as a private, commercial bank without interference. Bank Misr is in excellent financial condition, its resources deriving almost entirely from deposits, capital, reserves and provisions. It is reportedly in a position to finance any sound project presented to it for study. Its lending policies are conservative and according to reliable sources of information, its loans are based on sound appraisa

and review processes.

Recently, an agricultural department was organized, primarily for the purpose of administering a World Bank Loan of about LE 34 million. This department makes loans to large speciality operations such as those for fruit, vegetables and sugar cane. These loans cover machinery, equipment and capital items, but are bulk loans rather than for individually specified items.

Substantial loans are made for imports, to processors, merchants, marketing organizations and equipment dealers. Such loans are made on a short-term basis (up to one year) but are renewable from year-to-year as warranted. Interest rates are in the area of 11%. It was anticipated that the maximum rate would rise to 13% on January 1, 1979.

Bank Misr finances the Principal Bank for Development and Agricultural Credit whose loans currently total LE 100 million. These are lump sum advances with no record of individual machines that the borrower may purchase or subsequently finance for individuals. An interview at this institution indicated that dealers such as General Engineering and Tractor Engineering finance tractor purchases.

Officials indicated that if USAID or other foreign government proposed a special fund for upgrading dealerships and service centers, the bank would like to handle such funds. If they were for agricultural purposes, they would likely be serviced by the new agricultural department. The bank prefers to serve agriculture through indirect loans, but appears to have no interest in small farmer loans. Sound agribusinesses are appealing to the bank, which is currently involved in the new joint venture in the Kukor Valley New Lands project in which Agro Company of California and Acme of New York are the U.S. partners. These partners may become 52% owners rather than 40% as originally planned and reported by the Chairman of the High Dam Authority at Aswan.

Nasr Social Bank

This bank was established as a social bank by the government in 1972. It is a public sector bank, owned entirely by the government. Its purpose is to help low-income people obtain financing for private enterprise endeavors. The bank works with people in the cities and in 1974 started to finance machinery for use in agriculture. The bank makes "loans in the form of contracts or leases for equipment which when fully paid becomes the property of the purchaser. The bank has branches in 23 governorates equipped to prepare the contracts, which require approval at the head office in Cairo, and make collections. This organizaton is also inaugurating a system of 10 mobile units to make regular calls at various villages.

The Nasr Bank is an important agency with respect to the entire mechanization effort in Egypt. For example, in 1977, it agreed to finance purchases of 600 tractors by farmers, primarily for the purpose of doing custom work for small farmers who were unable to afford their own equipment. Approximately 550 tractors had been contracted for at the time of the Team's field study. About 300 of the tractors were IMT and an equal number were Massey Ferguson. The bank expected to sell another 700 of the Massey Ferguson units already in stock by the end of 1978.

With respect to funds, the President of the bank indicated he expected to have LE 50 million to work with over the next 5 years, of which LE 5 million would be from USAID each year. However, this commitment by AID is for only one year.

The bank plans to establish 50 custom service units, with private individuals, to serve 1,000 villages; these would be equipped with spare parts to service their own equipment as well as to sell to others. It also planned to form a joint venture manufacturing plant, possibly including participation by Kuwait, (for an assembly operation at the start) with NASCO and Massey Ferguson. It was

expected that the contract will be signed in the latter part of 1978. The bank has authority to sell to cooperatives but since those groups often buy through direct government arrangements, it has not so far been feasible. The organization is currently exempted from the Central Bank's regulations.

It was indicated that the bank is equipped to handle financing for a major increase in tractor and major equipment sales. The bank reported that the lag in time of delivery was a major impediment in dealing with bi-lateral agreement countries. The import duty factor was expected to be equalized after January 1, 1979, when all would operate on the official rate. The President stated that, in the bank's experience, farmers were more concerned about buying a high quality tractor than they were with the price. Equipment down time was cited to the bank as one of the most serious problems with mechanization at this time. The bank anticipated that loses on their lease contracts would not exceed 5%.

Joint Venture Banks in Egypt

There are four major joint venture banks in Egypt: Chase National Bank (Egypt) S.A.E., Egyptian American Bank, Bank of America N.E. & S.A. and Misr International Bank S.A.E. There are a number of others as well. All of these have been organized since 1975 under Law 43. In the last 5 or 6 months a few new Egyptian banks have been formed. Additionally, there are a number of off-shore banks, such as Citi Bank, which can deal only in foreign currencies.

It was reported that there was a shortage of Egyptian pounds as a result of government action to restrict the supply - an effort to control inflation. Under these circumstances, foreign investors are unable to obtain enough Egyptian pounds to enter into large business investments. They are, in effect, limited to the smaller businesses requiring LE one-half million or less. Central Bank policy limiting credit as a means of controlling inflation is an important

deterrent to the Central Bank's authorizing more funding for the Principal Bank system for agriculture. These efforts to control inflation are counter-productive to any major expansion of credit to accommodate sale of more agricultural equipment. This means that the entire mechanization program, its funding and credit requirements must be reviewed and weighed in light of the nation's economic policies and plans for the future.

Development Industrial Bank

The Development Industrial Bank is owned completely by the Government of Egypt. Until about two-and-one-half years ago, it was a section of the Bank of Alexandria. It is involved in economically sound "hard" loans only, with very little involvement in the agricultural sector. However, the bank has an agro-industrial loan of approximately $32 million from USAID. These funds are restricted to purchases from the U.S. only and are utilized through the issuance of letters of credit. The only agro-industrial projects DIB is involved in are cold storage facilities and a few poultry projects. The bank provides consulting, senior advisory services and training programs. Some World Bank funds and various funds from other countries are currently serviced through this bank.

General Terms Of Financing

The Principal Bank through its subsidiaries makes short-term (to 14 months) at 4 1/2%, intermediate-term (3 to 5 years) and long-term loans (5 to 10 years) at 10 1/2%. Short-term loans are most often production loans to cover advances in kind, such as fertilizer, seeds, insecticides, feed supplements and fuel or cash advances for labor, custom work and other

production needs. The current 4 1/2% rate is subsidized by the government to the cost of money (currently about 8%). These loans are generally secured by the crop to be produced. The bank's agent is required to assure that the credit in kind and cash is used for the production purpose for which it is advanced.

The production loan-making process in dealing with the Principal system involves three steps; as follows:

a. Once each year an "agricultural engineer" representing the Ministry of Agriculture (often the manager of the Local Cooperative) collects information from the farmer showing all his assets, liabilities, cropping plans (adjusted to the government requirements) operating needs and other details involving his farming operation. This statement and operating plan is reviewed by an agricultural committee at the governorate level and revised or approved.

b. The approved Statement and plan is delivered to the Village Bank where it becomes the base document for credit extension.

c. The bank's agent at the local agency, upon the farmer's signing a loan request and loan contract in accordance with the approved plan, extends the "in kind" credit items and authorizes the cash advances.

Production loans are due when the crops or agricultural products are ready for market. Controlled crops, such as cotton, are delivered to designated collection centers where they are graded by a government inspector and the price is established. The first portion of the payment is made to the bank to cover the credits extended and the rest is paid to the farmer. In the event the returns from the crop are less than enough to meet an established minimum to the farmer, the bank may find it necessary to carry a balance forward to the next crop. If the shortage is due to fraud or other unacceptable reason, the loan may be treated as a defaulted loan.

Intermediate-term loans are normally approved at the governorate level

upon recommendations from the District Branch Bank. These loans are currently made at 10 1/2% interest and up to five-year terms. For loans of LE 1,000 or more, a 25 % down payment is required. Loans are made to individual farmers or groups and to cooperatives.

One Governorate bank reported that when tractor loans are made to a Co-operative, the Bank requires that the co-op establish a special account for all tractor income to avoid dissipating the funds needed for repayment. The banks visited all indicated that 30 to 35 feddans is normally considered a minimum farm size that can support a tractor. Some have agreed, however, that they will consider tractor loans to any farmer who has reasonable assurance of getting a substantial amount of custom work and has a satisfactory bank record. Others say the farmer must have a minimum of 10 feddans. Loans can be made to groups of farmers for tractors, threshers, other large machines and irrigating pumpsets.

Collection of past-due loans is quite effective due to the fact that borrowers with such accounts are required to pay 2 1/2% additional interest on borrowings for the next crop in addition to forfeiting the subsidies normally issued on "in kind" advances (up to 50%). If a loan is declared in default, collection is turned over to a government collector. Each Governorate has a "tax collector" hired by the Ministry of Finance who collects delinquent public debts including loans for the Principal Bank. This individual, as well as bank employees, has the right to seizure in the event of failure to pay or make satisfactory extension arrangements according to Article 19 of Law 117.

The control of inputs and collection of commissions is a normal practice for the bank system. The Principal Bank distributes the "in kind"

production items for the next crop. It also collects a commission on the items it finances (plus or minus 5%). These commissions are needed to cover administration costs and to build the required reserves. The bank normally must approve the machines it finances. It collects its commissions from the seller on the basis of prearranged percentages and thereby controls the purchase of tractors, irrigation pumps and other major equipment. This requirement serves to assure that advances are used for the purposes intended and that the machines are of accepted quality.

Cooperatives do not ordinarily make credit advances or cash loans; however, some of the financially strong specialty-crop cooperatives have sufficient assets and do make loans to some of their members. The entire credit-lending function was transferred to the Principal Bank for Development and Agricultural Credit upon the enactment of Law 117 in August 1976. Cooperatives use their own accumulated capital and borrowings from the Principal Banks and affiliates for purchase of equipment or operating and production needs. The banks often utilize the Cooperatives' facilities for housing production items and sometimes for storing crops. Occasionally, village bank agents are housed at the Cooperative as are some of the agricultural agents representing the Ministry of Agriculture. It is one of these agents (often the Cooperative manager) that instructs the farmer as to the amount of the controlled crops he is to grow (cotton, wheat and rice); he also collects information from the farmer as to his assests, liabilities and cropping program. It is from this information and the farmers' approved cropping and lifestock plan that the banks determine the distribution of "in kind" production items and operating cash needs of the farmers. Individual loans are tailored to the size of the farm, the number of animals and crop acreages.

No specific terms for the financing of machines by dealers have been reported. Most dealers sell for cash. Consequently, the customer who needs credit borrows from the Principal Bank or a commercial bank at 3 to 5 -year terms and the interest rate of 10 to 11%.

Commercial banks make loans generally as "all purpose" loans on a short-term basis. Interest rates in late 1978 were in the area of 11%. Short-term notes are generally renewable.

At the Nassr Social Bank farmers are now considered eligible applicants to purchase tractors on contract if they have lease holdings on several feddans of land and have appropriate opportunities to do custom work for others. The bank requires up to 25% down payment on tractors. For financially strong applicants, less will be accepted. Terms are for a three-year period, but the farmer obtains title only after payment in full is received. Interest as such is not charged, but a 10% mark-up is made on the purchase price, and a 10% charge for the three-year term is added into the purchase price.

Availability of funds for financing tractors appears to be critical for determining the rate at which tractors move into the hands of farmers and other users. Personnel at nearly every bank or branch of the Principal Bank reportedly cut off taking applications for tractor loans because of insufficient funds. A long-term operations office in the PBDAC stated in late October 1978 that with a few exceptions, no further applications will be taken from all governorate, district and village banks. The exceptions were in areas where very few or no tractor loans had been made.

The Principal Bank system made 350 tractor loans in 1977 compared

with an estimated 1,000 in the first ten months of 1978. The Nassr Social Bank reported having distributed 600 tractors in 1977 through three-year contract sales. As noted earlier, this bank had sold 550 tractors and the President of the bank expected that 700 more would be moved before the end of the year. Tractors are also being financed to a limited extent indirectly by commercial banks such as Bank Misr, The Bank of Alexandria, The National Bank and directly by authorized dealers such as General Engineering and Tractor Engineering Company.

The Principal Bank officials estimated that their bank system could handle 2,000 tractors of the 6,000 that the Supreme Machinery Board of Egypt says are needed annually over the next ten years. The Board estimates a requirement for 5,000 additional and 1,000 replacement machines each year. The bank would require an additional LE 10 million to LE 12 million additional funds annually to be in position to make all of these tractor loans. Bank officials stated that if the funds were made available, the terms could be adjusted downward to accommodate the machinery needs of many of the financially weaker but potentially very capable farmers.

Bank Misr and Nasser Social Bank officially indicated no particular concern for fund needs except that personnel of both indicated interest in handling any USAID funds that were made available for machine purchases.

A variety of other sources indicated a requirement for equipment and attendant financing. For example, cooperatives stated their greatest needs were for more tractors and spare parts for the machines they already have. Dealers emphasized needs for more spare parts and service centers. Farmers want more machinery, according to the team survey. Although very little opportunity was afforded them to report through the credit interviews, applications on hand waiting to be processed at many of the bank locations,

attested to their need for tractor and machinery financing.

Improving The Agricultural Credit System

Weaknesses in the Existing Agricultural Credit System

Review of the Agricultural Credit System has revealed a number of problem areas in providing credit for farmers. Since the Principal Bank for Development and Agricultural Credit system is the primary source of such credit, most of the comments that follow refer to this banking system. Also, some of the problems noted had already been recognized by the Principal Bank and action was already under way to make corrective changes. It should be recognized that Law 117, under which the system operates, has been in effect only since August 1976, a relatively short time for making the required major changes. Some of the problems discussed later were also noted by the World Bank appraisal report of May 31, 1978 on the Minufiya - Sohag project.

The intent of Law 117 was clearly to decentralize the activities of the Principal Bank and to strengthen its capacity to make medium and long-term loans. It also was intended that provision of "in kind" credit to farmers was a function to be transferred from the cooperatives to the Principal Bank.

Following are recommendations and problem areas identified as important to financing a mechanization program:

1. Timeliness and eligibility: Decentralization of loan-making authority to governorate and village-level banks would simplify and enhance the timeliness of loan-making to the farmer for mechanized equipment and for production items. Authorization of some flexibility with respect to loan eligibility based on ability and earning capacity of the individual applicant, as contrasted with current requirements that the farmer own specific acreage and provide a high level of security, would make it possible for new or young farmers and older farmers with good credit records to acquire equipment needed for farming and custom service operations.

2. Loan terms: In most instances, the purchaser of a tractor or major piece of farm equipment currently is required to make a 25% cash down payment and is given three to five years for repayment. A reduction in the required cash payment to 10% and extending the loan period to seven years would reduce the first year's cost requirement by more than 40 percent. This would enable many additional reliable farmers to purchase needed equipment.

3. Management assistance: The bank system does little to help the farmer develop budgets and appraisals or improve his financial management. The provision of such assistance would greatly accelerate the rate at which many young or "start up" farmers could use credit to build a profitable operation.

4. Internal equipment needs of the Principal Bank System: The severe lack of adding machines, typewriters, copy machines and other equipment normally considered minimal for any banking operation may become a serious deterrant to the bank's ability to handle a rapidly increasing lending level resulting from the mechanization of agriculture.

5. Financial condition of the Principal Bank: At the end of 1976, the bank was in poor financial condition. Losses were LE 60 million; against this were capital and reserves reported at only a little more than LE 2 million. Under Law 117, improvements occurred. For example, collection of accounts due increased from 70 percent in 1970 to 85 percent in 1977. The reported delays in the Central Bank's reimbursement for subsidy deficiencies and losses places an extreme burden on the system. As a result, the study team was concerned about the bank's ability to maintain a strong position for financing agriculture in the long run.

6. In-kind distribution of farm inputs and marketing control: The procurement and supply of inputs and collection and disposal of crops appear to be the Principal Bank's dominant operation in both physical and financial terms. Because such work occupies the bulk of the staff time, it may severely curtail the institution's ability to handle a major increase in lending activities that could result from implementation of a large-scale agricultural mechanization program

7. Role of private enterprise and cooperatives: It appears that government control of all inputs and regulation of marketing and the general lack of adequate spare parts and service facilities could exert a strong negative influence on accomplishment of the desired improvement in mechanization and machinery management. On the other

hand, regulations and actions that encourage cooperatives and private entrepreneurs to run well-managed supply and service facilities could have an important impact in this area.

8. Lenders for agribusiness: Very little activity is evident on the part of other banks in this area. Enlarging the role of other lenders may help provide sources of credit that would greatly improve establishment of a network of agricultural supply and service centers.

9. New lands reclamation and development: The increasing activity in the development of new lands will place an additional load on the banking system. Sources of credit for mechanization as well as for production inputs will be essential to ensure its success.

Credit Management

Steps that might be suggested to the Principal Bank management to improve the agricultural credit system are found below:

1. Management should analyze in depth the needs of the agricultural credit system to provide an efficient full credit service to farmers for present and future needs.

   As part of this effort, top-level credit officials, including the PBDAC board of directors, should determine what the system is to accomplish for the long term and make such changes for improvement as can be implemented immediately within the existing bank structure. These executives should decide the extent to which they will work with governorate, district and village bank officials and/or outside expert management and training specialists to diagnose existing weaknesses in the system and to implement corrective measures.

   If PBDAC directors and other top-level officials agree, delegate a team of technical credit experts in the rural lending field to work with personnel at various levels in the system and with local USAID officials to determine the character of detailed changes and/or additional needs of the system. The team should consist of two or three

individuals who are thoroughly familiar and experienced in agricultural credit operations. We suggest the team include one member each from the U.S. Farmers Home Administration and the Farm Credit System with high-level experience in these organizations. These are the two largest and most experienced U.S. agencies dealing exclusively with farmers at all levels as well as with cooperatives and agribusiness. This team should be assigned the additional responsibility of supervising the development of an ongoing training system for the governorate, district and village bank levels. The district bank officials should be centrally involved in this process, as they are essentially supervisory units in the existing organization. On the assumption that a need for basic management training will be found, we recommend using the American Management Association training for key Egyptian bank employees.

2. The bank system should divest itself of "in-kind" procurement and storage, distribution and marketing responsibilities. Complete control of the above appears to take up an inordinate amount of time by bank personnel with the result that the private sector is given little opportunity to present its case for profitable agrobusiness. Equally important is the fact that with expansion of mechanization and land development programs, the full attention of bank personnel will be required to handle the relat[illegible]nking procedures.

   To open these businesses to private individuals and to well-managed cooperatives, incentives and better services to farmers are required. Actions such as the following would be useful:

   a. Select three or four cooperatives and several individuals who are interested in developing well-managed machinery custom services, spare parts and maintenance services, marketing services, fertilizer, feed, seed and other farm input stores or other farm services as pilot projects. Choose areas that appear to be particularly deficient in providing services and, therefore, have the greatest need for improvement. Such selection would help enhance the possibility of success of the pilot organization.

   b. Keep the functions of these supply stores separate from the bank system if the co-op or business is in financial position to grant direct credit.

c. Provide government support for the new stores by providing favorable loans, stock ownership or other means with the privilege and encouragement to reimburse the government upon success of the organization.

d. Provide expert organizational and management advisory service to help the organizations determine suitable locations, appropriate facilities and start-up plans for the operations.

e. Provide 3- to 5-year support for these operations if they continue to show promising results.

f. On the basis of experience with the pilot projects, plan to enlarge the entire program for other borrowers.

g. Provide regulatory changes to encourage commercial banks to become involved in financing these and other agrobusinesses required to provide full service to all agricultural production and processing operations. As the infrastructure is improved, more businesses are likely to develop in rural areas, thereby employing more people and providing better services and opportunity for improving living standards.

CHAPTER XXIII

ECONOMIC EVALUATION OF THE PROJECT

Analytic Framework

The economic appraisal of the Farm Mechanization Project includes both the national and the farm levels. The first aims to determine the project' advantages to the national economy while the second attempts to measure the benefits that would accrue to farmers who are the primary beneficiaries of the project. For this reason the evaluation at the national level considers any subsidies granted in the course of its implementation as elements of costs since they represent, in fact, expenditures of national resources. On the other hand, all major identifiable taxes and customs duties are excluded from costs as they merely represent a transfer of funds within the economy. At the farm level, all cost items appropriately are taken at the prices actually paid by farmers, irrespective of whether such prices include any subsidies, on the one hand, or any taxes or customs duties, on the other. The present chapter concentrates upon prospective returns from farm mechanization from the standpoint of the Egyptian economy as a whole. Chapter XXV explores that question from the perspective of typical farm operators.

Basic Assumptions

Since the prices received by farmers for their products do not necessarily represent the real value of such products to the economy, "shadow prices" are used

for valuing incremental production to arrive at estimates of the social internal rates of return to investments in the respective components of the recommended program. The period of implementation is taken as varying from one to five years depending upon the specific component under consideration A ten-year period beyond the last year in which investment takes place has been selected for evaluation purposes to allow sufficient time for generation of benefits. This assumes that the major types of farm equipment recommended become neither obsolete during that period nor have an economic life of more than ten years.

The first year of implementation is taken as 1980. Prices and costs are assumed to remain constant at their 1977 levels throughout the entire 1980-1994 period. This, of course, is not likely to be the case. However, it was not deemed feasible to project both over such a long span of time. Consequently, there is the implicit assumption that such changes as do occur will be parallel. Should changes in prices and costs differ greatly in the meantime, the profitability of the project will obviously be affected, thereby requiring a reappraisal at that time. The assumption of constant prices and costs is not uncommon in the evaluation of projects whose development stretches over a long period.

To evaluate the benefit of the investment, the economic or social internal rate of return was calculated for each program component for which benefits could be quantified. In the calculation of costs and benefits, only incremental values were used. Thus the cost items include only those supplementary expenses attributable to the proposed Farm Mechanization Program; benefits include the value of supplementary outputs which this program is expected to generate and the cost savings resulting from mechanization of particular farm operations.

Internal Rate of Return

The internal rate of return measures the average annual return on total invested capital, both equity and borrowed, during the entire period of evaluation. The mechanics of calculating the internal rate of return consist of: (1) aggregating all the benefits and all the costs, by individual years for the entire period of evaluation, into two respective columns, and (2) taking the difference between total benefits and total costs for each year of the evaluation period. The internal rate of return is determined by finding an interest rate which, when used to discount the difference between total benefits and total costs, brings the sum of discounted values to zero. The discounting is done to bring all the figures to a "present" value basis.

Opportunity Cost of Capital

According to the U. S. Agency for International Development in Egypt and several Egyptian sources, it appears that no studies of the opportunity cost of capital in Egypt have been made. USAID, as a "rule of thumb", assumes that in Egypt, development projects yielding a calculated internal rate of return less than 15 percent are not economically justifiable.

In a completely free enterprise economy, commercial lending rates provide a reasonably good indication of the "opportunity cost of capital" or "marginal efficiency of capital", as it is sometimes called. Although the Egyptian economy does not fit the free enterprise model in several significant respects, the prevailing interest rate still gives some indication of the general contribution of added investment to the economy. Since 1975, when the statutory

limit on interest rates was removed, there has been a growing recognition in the Egyptian Government circles of the necessity for a continued adjustment and gradual revision of both borrowing and lending interest rates. There were several motivations which led to the changes of interest rate policy. First, evidence that interest rates in Egypt are not competitive internationally is given by the fact that one-half of the increase in commercial deposits during the first nine months of 1977 was in foreign currency deposits. Interest rates on foreign currency deposits are not regulated by the Central Bank and are set instead by the commercial banks on the basis of Eurocurrency deposit rates. Also, higher interest rates are needed to encourage conversion into Egyptian pounds of workers' remittances from abroad, now held in foreign exchange and, more generally, to encourage private savings and investment. Moreover, since investment is not currently constrained by a lack of investment opportunities, higher interest rates should improve the efficiency of investment without reducing its level.

At the same time, accepting the need for a higher structure of interest rates, the authorities are concerned that a sudden rise in interest rates may adversely affect the financial position of the public economic sector. They also fear that economic reform has not yet proceeded to the point where interest rates can carry the full burden of allocating financial resources. Therefore ARE intends to adjust interest rates upward gradually with the object of achieving by the end of a three-year period (presumably beginning with 1978) a rate structure appropriate for the task of mobilizing and allocating financial resources.

Since 1975, interest rates have been raised one percent across-the-board three times on January 1, 1976, March 1, 1977 and June 17, 1978. Another one percentage point increase was scheduled to be implemented by January 1, 1979.

There were anticipations in financial circles that this increase might amount to two percentage points. In light of the declared intention to adjust interest rates over a three-year period, one additional increase of one percent across-the-board may be anticipated in 1980.

TABLE XXIII. 1

LENDING INTEREST RATES, BY EFFECTIVE DATE**

	Jan 1, 1976	March 1, 1977	June 17, 1978	Jan 1, 1979*
Maximum	8	9	10	11
Minimum	7	8	9	10
Cotton financing rate	6.75	7.75	8.75	9.75
Penalty for arrears	1	1	1	1

*Based on one percent across-the-board scheduled increase

For housing, the effective interest rate of 12 percent per annum already prevailed by the first half of 1977.

As regards investment returns in the agricultural sector, farmers are currently paying an effective rate of 11-12 percent per annum for loans to acquire

** Sources:
1. Egypt -- Limited Financial Sector Survey, by IFC Capital Market Department of IBRD, September 17, 1976.
2. Arab Republic -- Recent Economic Developments, International Monetary Fund Document SM/78/21, January 23, 1978.
3. Arab Republic of Egypt -- Use of Fund Resources, Document of IMF, EBS/78/358, July 7, 1978.
4. Housing and Community Upgrading for Low Income Egyptian, a Report by Joint Housing and Community Upgrading Team, Ministry of Housing and Reconstruction, Arab Republic of Egypt, and Office of Housing USAID.
5. Ministry of Agriculture, ARE.
6. Principal Bank for Development and Agricultural Credit.
7. USAID/Cairo, Program Office.

farm machinery, according to Ministry of Agriculture sources and inquiries made by members of the Study Team in various parts of the country. In the Upper Nile region, it was reported that in some instances the interest rate charged by commercial banks was as high as 13 percent. The interest rate on working capital was said to be about 8 percent. In addition to stated interest rates, the banks charge administrative fees on loans of 0.5-1.0 percent. The effective lending rate is further raised by such other means as compensating balances, the details of which are not available.

Prices of Agricultural Commodities*

Price Policy

The price mechanism currently operative in Egypt does not reflect, at least insofar as some of the major agricultural products are concerned, the true value of such commodities to the economy of the country. Farmers are obligated to sell part of their production to the government, at prices which it sets. The surplus is then sold in the free market at higher prices. Quotas for selling at controlled prices and the prices themselves may change from one period to another. Thus, for example, prior to 1977 all cotton, 27.6 percent of wheat and 66.0 percent of rice had to be sold at prices fixed by the Government. In 1977, wheat quotas were dropped largely because, with a rise in prices in the free market, farmers responded by placing larger areas under wheat cultivation.

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* Sources of Information Included:

Farmgate prices actually received by farmers, and export and import prices: Ministry of Agriculture.
Rice: Mr. Mustafa Hathout, Rice Marketing Company.
Maize and Wheat: Mr. Mohamed Aly and Mr. Yehia Hagag, Principal Bank for Development and Agricultural Credit.
Cotton: Mr. Mohamed Badr El Din, Cotton Council.

There have been a number of reasons -- political, social and economic -- for this dual and sometimes multiple price system. Cotton and rice, Egypt's two principal agricultural exports, are purchased by the government from the farmers at prices well below their export prices. This is done evidently to help subsidize farm inputs, such as fertilizers and pesticides, as well as consumer prices of other commodities such as wheat and corn, both import items. Consumer prices of these and a number of other products are kept artificially low to satisfy the needs of the poorer population. Both controlled and free market prices of most of such products have been kept considerably below their import costs.

Shadow Prices

The prevailing multiple and artificial price system can hardly be taken as a measure of the real value to the economy of the country of the products that farmers produce. In order to arrive at meaningful estimates of the social return on mechanization investments, it is necessary to rely on "shadow" prices. Consequently, in the present analysis all incremental production of field crops is considered a replacement for potential exports or imports. Then the incremental outputs appropriately can be valued at export or import prices brought down to the farmgate level. Basically, such an adjustment involves a deduction from export prices or an addition to import prices of all losses between the farm and the port, inland transport costs, loading or unloading charges, warehouse storage costs, packaging costs, and other handling costs, including commissions, overhead, etc. Insofar as losses are concerned, only those are deducted which occur between the delivery of, say, bagged grain by farmers to the Agricultural Bank's open storage depots and the port.

The methodology involved at arriving at the "shadow" price estimates for each of the major crops is described below.

Rice

Unhulled rice is delivered by farmers to open storage village collection centers or depots maintained by regional branches of the Principal Bank for Development and Agricultural Credit (Agricultural Bank). It is then picked up by one of three rice marketing companies, all owned by the government. Unhulled rice is brought by farmers in either new or used 80-85 kg burlap bags. One ton of rice requires 12-13 sacks, for which the cost of new sacks is 48.5 pt per sack and that of used is 35.0 pt. The farmer absorbs the cost of delivery to the depot if the distance does not exceed 5 km. For any excess distance, the Bank reimburses the farmer but later passes this cost to the rice marketing company. This cost averages 7 pt per sack, or about 88 pt per ton of unhulled rice.

Upon delivery to the collection center, the rice is unloaded on scales, weighed, examined for quality and then placed in open storage. Charges for loading on the scales and unloading into storage are 6 pt per ton. The cost of weighing is 12 pt per ton, with one-half of this cost absorbed by the farmer and the other half by the rice marketing company. The rice remains in the Bank's storage for up to three days before it is picked up by the rice marketing company. Losses in the Bank's storage are reported not to exceed three percent.

The Bank charges the former for its services 15 pt per ton and the rice marketing company 67.5 pt per ton. The latter figure includes the cost of loading on the scales and unloading, one-half of the weighing cost, examination for quality of rice, storage, fumigation and disinfection and all other services performed by the Bank for the rice marketing company, with the Bank's overhead included.

After the rice is picked up, the marketing company transports it to mills for dehulling and polishing, an average distance of 50 km, at a cost of 8 pt per sack, or about one LE per ton, including the cost of loading and unloading and placing rice into storage at the mill. It is kept in storage up to 10 months, at a cost ranging from 25 pt to 50 pt per ton. There are eight companies operating rice mills in Egypt, both government and privately owned.

In milling, one ton of unhulled rice yields on the average 670 kg of polished rice and 330 kg of by-products, namely: 180 kg of hulls, 70 kg of bran, 60 kg of broken grains and 20 kg of germ. The value of by-products was given as: hulls-- 5.0 LE per ton; bran-- 5.5 LE per ton; broken grain-- 8.7 LE per ton, and germ-- 15 LE per ton. Thus, the value of by-products amounts to about 2.11 LE per ton of unhulled rice, with an average value of 6.40 LE per ton. Hulls and bran are sold for animal feed, while broken rice is used for production of starch and glucose and for beer brewing.

The cost of milling and polishing is reported as 2.00 LE per ton of unhulled rice. The export rice is packed in new 100 kg burlap sacks, shipped to warehouses in Alexandria where it is stored until it is ready for export. The weighted average distance between the rice mills and warehouses in Alexandria is about 250 km and the average freight rate is 1.5 pt per ton-km.

Upon receipt of orders for shipment of rice for export, rice is moved from warehouses to the dock and then loaded into ships at a cost of about 1.50 LE per ton. The total cost of shipping polished rice from the mills to warehouses in Alexandria, storage, moving the rice to the docks, loading into ships, insurance, overhead, etc. was reported by the rice marketing company to amount, on the average, to 5.40 LE per ton of polished (white) rice.

Total losses involved in storage at various points and in transport, from the time the rice is delivered by farmers to the Bank's village depots until it is loaded into the ship's hold, are reported to be about five percent. This figure already includes the losses of up to three percent at the Agricultural Bank's open storage at collection centers as already mentioned.

Based on the above information, it is possible to approximate all the expenses and costs involved in rice movement from the village collection centers until it is loaded for export. The "shadow" price is then derived from the reported FOB price for 1977, taking into account milling costs, value of by-products, bagging costs, storage and transport costs, losses in storage and transport and all other expenses already mentioned.

Inasmuch as some of the costs and expenses involved between the farmgate price that the farmers receive and the FOB export prices are given in terms of unhulled rice while others are shown for polished white rice, it might be helpful if all these costs were given in some detail and the totals are then reduced to a common denominator, that is, per ton of unhulled rice. For this reason, the first group of costs is given for the stages involved until after the unhulled rice is milled, while the second covers all stages after the milled, or polished, rice leaves the mill until it is loaded into the ship (Table XXIII. 2).

Since one ton of unhulled rice yields 670 kg of polished rice, that is, it takes nearly 1.5 tons of unhulled rice to produce one ton of polished rice, the 10.25 LE per ton of polished rice is equivalent to 6.83 LE per ton of unhulled rice. Thus, the total costs between the farmgate and the FOB export prices amount to 11.94 LE per ton of unhulled rice (6.83 plus 5.11). This figure, however, must be reduced by credit for by-products in milling rice (hulls, bran, broken grain and germ) of 2.11 LE per ton of unhulled rice, thus reducing the total costs to just 9.83 LE per ton of unhulled rice.

TABLE XXIII. 2

EXPENSES THROUGH THE MILLING STAGE

Type of expense	LE per ton of unhulled rice
Payment to farmers for transport in excess of 5 km	0.88
Difference of 13.5 pt per sack between the cost of new and old sacks, 12½ sacks per ton	0.17
Payment to Agr. Bank by the rice company for the Bank's services	0.68
Transport to rice mill, 8 pt per sack, 12½ sacks per ton, 50 km	1.00
Storage at the mill (up to 10 months, at 25-50 pt per ton)	0.38
Milling and polishing	2.00
Total	5.11

EXPENSES AFTER MILLING TO FOB

Type of expense		LE per ton of polished rice
Cost of new sacks, 10 sacks per ton at 48.5 pt per sack		4.85
Transport from mill to Alexandria warehouse, 250 km	3.75	
From Alexandria warehouse into the ship	1.50	
Other rice company costs	0.15	
sub-total	5.40	5.40
Total		10.25

The export FOB price in 1977 for polished rice was 108.00 LE per ton. Since it takes 1.5 tons of unhulled rice to produce one ton of polished rice, the equivalent FOB price for unhulled rice would theoretically be 72.00 LE per ton. The overall losses in storage and transport are reported at about five percent, equivalent to 3.60 LE per ton. Deducting this amount and the total expenses, as estimated above, of 9.83 LE per ton, the farmgate "shadow" price is approximated at 58.57 LE, or, in round figures, at 59.00 LE per ton. This can be compared with the weighted average price actually received by farmers in 1977 of 56.18 LE per ton, or about 4.8 percent below what may be considered as the real value of unhulled rice to the economy the country.

Maize

Maize is imported in bulk and loaded into 100 kg new burlap sacks on the ship. After unloading from the ship, it is reloaded into freight cars or trucks for transport to the Agricultural Bank's open storage depots. From there, it is sold to various groups of consumers with the price of maize sold at the government-controlled prices which vary from 27 LE to 60 LE per ton, depending upon type of consumer. The greater part of the imported maize is sold to oil and oil cake producers and as feed for poultry and animals.

Virtually all of the locally grown maize is consumed at the farm, mostly as food for human consumption. In some instances, it may also be used in payment for services and in exchange for other farm products which the farmer does not produce himself.

The cost of unloading imported maize from the ship and loading into freight cars or trucks is about one LE per ton. New sacks cost 58 pt per sack, or 5.80 LE per ton. The average weighted distance from the port to the Bank's storage depots is approximately 250 km, with an average freight rate of 1.5 pt per ton-km. The Agricultural bank receives a commission for its services of 63 pt per ton. The Bank's services include storage, weighting, disinfection, fumigation, overhead costs, etc. Total losses in transportation and storage are estimated at about five percent.

On the basis of the above data, total expenses involved in bringing maize from the ship to the Bank's storage depots are estimated at 11.60 LE per ton, of which 5.80 LE represents the cost of sacks and 3.75 LE the average cost of haulage.

The cif price of maize in 1977 was reported as 50.70 LE per ton. With five percent added to this price to account for losses and 11.60 LE per ton for

all expenses in bringing maize to storage depots, the total cost of maize imports is estimated at 64.84 LE per ton, or in round figures 65 LE. This figure is taken as the "shadow" farmgate price. The actual price received by farmers in 1977 was 76.00 LE per ton. This difference may be attributable to local maize being used for human consumption, whereas imported maize is for feed.

Wheat

Wheat is imported by the Ministry of Supplies through a government-owned silo company. All wheat is imported in bulk and bagged at the port into 100 kg new burlap sacks, each costing 58 pt or 5.80 LE per ton. Some of the wheat, however, is transported in bulk from the port to the silos. The bags are then hauled to the Agricultural Bank's regional open storage depots from which it is later shipped to wheat mills, both government and privately owned. The losses, in the form of bran, at the mills amount to about 24 percent.* Polished wheat is then sold to flour mills.

Locally grown wheat is brought by farmers to the Agricultural Bank's open storage village depots where the services performed by the Bank in handling the wheat are essentially the same as those already described for rice and maize. The wheat is kept at the Bank's depots for up to 10 months and shipped to mills, much as the imported wheat is. Losses in storage during this period are said not to exceed three percent. For its services, the Bank charges, as in the case of maize, 63 pt per ton. Total losses in transport and storage are said to be about six percent.

To arrive at the "shadow" farmgate prices, the procedure consists of adding

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*U.S. Agricultural Statistics Yearbook, Grain Statistics, as quoted in Farm Mechanization Program for Korea, Ecotech System, Inc., p. IX. 8, 1972.

to the cif price all the expenses involved in moving wheat from the ship to the Bank's storage depots, the Bank's commissions, plus the cost of hauling wheat from farms to the Bank's storage for a distance in excess of 5 km. As already mentioned, the expense involved is small and averages 88 pt per ton of wheat. To this must be added the expense represented by the six percent loss, and the total amount so calculated is then added to the cif price of wheat.

In 1977 the cif price of wheat was 53.16 LE per ton. The six percent loss would amount to 3.19 LE per ton. All the remaining expenses are essentially the same as for maize, namely 11.60 LE per ton, of which the cost of sacks amounts to 5.80 LE and the average cost of haulage 3.75 LE. To this must be added the extra haulage cost of 0.88 per ton paid to the farmers. Thus, the "shadow" farmgate price for wheat is estimated at 68.83 LE or, in round figures, 69.00 LE per ton. In 1977, the farmgate price actually received by farmers was 54.00 LE per ton, that is 21.7 percent below its value to the economy.

Cotton

Seed cotton is brought by farmers to the Agricultural Bank's village depot in sacks, each sack containing about one kantar (157.5 kg). The new sacks cost 95 pt each, used ones 60 pt per sack. After the sacks are weighed, the Bank advances to farmers 20 LE per kantar for long staple cotton and 17 LE per kantar for short staple. Within two or three days, cotton is graded by government inspectors, price is determined accordingly, and the farmer is paid the balance due him. Arrangements for paying the farmer for haulage in excess of 5 km and for charging him for weighing the cotton are somewhat similar to those for rice. Cotton remains in the Bank's depot for another two days or so, at which time it is picked up by one of the six cotton marketing companies, all government owned.

For its services the Bank charges the cotton companies 10 pt per kantar of raw cotton, equivalent to about 63.5 pt per ton.

The cotton companies remove the seed cotton from the Bank's depots to cotton gins. One kantar of raw cotton (157.5 kg) yields on the average 55.5 kg of lint, 99 kg of seeds and 2.2 kg of scarto (lint waste). This is equivalent to one ton of raw cotton yielding approximately 352 kg of lint, 628 kg of cotton seed and about 14 kg of scarto. The loss in ginning is small and amounts to only 0.6 percent of raw cotton.

About 20 percent of the seed is used for planting and 80 percent for production of oil and oil cakes. When sold for planting, the cotton seed is priced somewhat higher than when sold to oil and oil cake producers. The average weighted price is about 0.9 pt per kg of seed. Scarto is priced at 22.5 LE per kantar (50 kg), that is at 0.45 LE per kg. With a ton of raw cotton yielding 629 kg of seed and 14 kg of scarto, the value of both per ton of seed cotton amounts to 11.95 LE.

The ginning cost is 1.5 LE per kantar (157.5 kg) of raw cotton, which is equivalent to 9.5 LE per ton of raw cotton. This figure includes the cost of storing ginned cotton at the gin. Thus, the value of seed and scarto more than covers the cost of ginning. After ginning, lint cotton is baled, each bale weighing 400 kg. The cost of burlap and steel bands is included in the ginning cost. Lint cotton intended for domestic use is then shipped to textile mills in Egypt.

Baled lint cotton intended for export is transported to warehouses in Alexandria, an average distance of 140 km. There lint cotton is unbaled, any foreign material from baling and storage at the gin and during transport to Alexandria is removed, lint cotton is sorted and treated, and finally the lint

is compressed hydraulically into bales of 320-350 kg each. The bale is covered with new jute and banded with new steel bands. It is then ready for export. When shipping instructions are received, bales are moved from warehouses to the dock and loaded aboard ship.

Total losses are given as 1.0 percent of seed cotton and an additional 0.5 percent of ginned cotton shipped for export. The expenses involved from the time the ginned cotton arrives at the Alexandria warehouses until it is loaded into the ship, including insurance, amount to 5-6 LE per bale of pressed cotton (320-350 kg).

There are a number of individual expense items borne by the cotton company from the time it picks up raw cotton at the Agricultural Bank's collecting centers until bales of lint cotton, processed, sorted and treated, are loaded for export. Some have already been mentioned but others have not. Many of the costs are expressed in terms of various measures of volume or weight, which sometimes are difficult to follow. Moreover, some refer to raw cotton, while others to ginned cotton. For a clearer understanding, these various costs need to be considered in some detail in two groups: (1) those pertaining to raw cotton, and (2) those pertaining to ginned or lint cotton (Table XXIII. 3). The two totals are reduced to a common denomination, that is, an equivalent cost per ton of raw cotton.

TABLE XXIII. 3

EXPENSES PERTAINING TO RAW (SEED) COTTON

Expense Item	LE per ton of raw cotton
Payment to farmers for haulage in excess of 5 km	0.88
Payment to Agricultural Bank for its services, 10 pt per kantar	0.63
Loading and transport from collection centers to gin, 26 pt per kantar	1.65
Difference between cost of new and old bags after using during the season 35 pt per bag of one kantar	2.22
Ginning cost	9.50
Abstraction of seeds, 7 pt per kantar	0.43
Total	15.31

EXPENSES PERTAINING TO GINNED COTTON

Expense Item	LE per ton of lint cotton
Baling, 5 pt per kantar (50 kg), or 40 pt per bale of 400 kg	1.00
Dressing of bales (includes jute from unusable old bags and steel bands) 4 pt per bale (400 kg)	0.10
Head office overhead, 50 pt per kantar (50 kg)	10.00
Insurance, 3 pt per kantar (50 kg)	0.60
Use of cleaning machine, 2.5 pt per kantar (50 kg)	0.50
Transport from gin to Alexandria warehouse, 225 pt per bale (400 kg), average distance 140 km at 1.6 pt per bale-km	5.63
Miscellaneous charges, 150 pt per bale (400 kg)	3.75
Interest payable to banks (9 percent annual rate), 50 pt per kantar (50 kg)	10.00
Expenses from the time the lint cotton arrives in Alexandria warehouse until it is loaded into the ship (includes storage in Alexandria of 0.94 LE per ton and insurance), 5-6 LE per bale of pressed lint cotton (320-350 kg), taken at 5.5 LE per 335 kg	18.45
Total	50.03

Since a ton of raw cotton yields 352 kg of lint cotton, the 50.03 LE cost per ton of lint cotton is equivalent to 17.61 LE per ton of raw cotton. With the expenses attributable to raw cotton of 15.31 LE per ton, the total cost per ton

of raw cotton is 32.92 LE per ton. This figure must be reduced by credit for seed and scarto of 11.95 LE per ton of raw cotton, thus reducing the total cost to 20.97 LE per ton.

The FOB export price in 1977 was 1,257.20 LE per ton of ginned (lint) cotton, which would be equivalent to 442.53 LE per ton of raw cotton, excluding intermediate losses. This figure must be reduced by overall losses of 1.0 percent for raw cotton and 0.5 percent for ginned cotton, the latter figure being equivalent to 0.18 percent for raw cotton. Thus, the total loss is equal to 1.18 percent of raw cotton.

The starting FOB cost of raw cotton of 442.53 LE per ton, less 1.18 percent loss (5.22 LE total) would equal 437.31 per ton. This must be further reduced by the amount of total expenses of 20.97 per ton, resulting in the "shadow" farmgate price of 416.34 LE per ton, or in round figures, 416 LE per ton of raw cotton.

In 1977 the farmers were actually paid 218.00 LE per ton, that is 52.3 percent of what appears to be the real farmgate value of raw cotton. The World Bank Report of May 1978 states in one place that the farmers receive less than 60 percent and in another that they have been receiving 45 percent of the real value of raw cotton.*

Recapitulation

The above findings relative to the estimates of the "shadow" farmgate prices of major crops are summarized in the following Table XXIII. 4. In some cases, prices paid to farmers in 1977 for their crops were found to be below the value

*IBRD -- Arab Republic of Egypt, Economic Management in a Period of Transition, May 8, 1978, in 6 volumes. Report No. 1815 EGT. Vol. I, pp. 15 and 33.

TABLE XXIII. 4

FARMGATE, EXPORT AND IMPORT PRICES FOR MAJOR FIELD CROPS, 1977

In Egyptian Pounds per Metric Ton

Type of crop or product	Actually received	Shadow price	Percent of actually received of shadow price	Export fob price	Import cif price
Rice	56.18	59.00	92.2	108.00	
Maize	76.00	65.00	116.9		50.70
Wheat	54.00	69.00	78.3		53.16
Cotton, raw	218.00	416.00	52.4		
Cotton, ginned				1,257.40	

Source: Farmgate prices actually received by farmers, and export and import prices were supplied by the Ministry of Agriculture. "Shadow" farmgate prices are estimates made by Farm Mechanization Project Team.

of these crops to the economy of the country. For cotton in particular, farmers received only slightly more than one-half of its estimated real value. For rice they received about 92 percent, and for wheat 78 percent of the estimated real value of these products. In the case of maize, however, the situation was different. For maize, farmers received in 1977 about 17 percent more than the estimated real value of maize to the economy.

RETURNS TO PROJECT COMPONENTS

Table XXIV. 5 summarizes the calculated social internal rate of return (IRR) for each project component whose benefits can be quantified. Omitted from that summary are six of the recommended sub-projects: Research and Development, Machinery Management Extension, Local Manufacture, Participant Training, Apprenticeship Training and Planning and Evaluation. The prospective benefits from five of these activities can be quantified only by assumptions for which neither Egyptian, US, nor IBRD experience provides useful guidance. Determining the prospective IRR for local manufacture of farm implements other than tractors is a priority objective of the recommended separate feasibility study. Mower-binders are omitted from the Machinery Introduction calculations as estimating their benefits involves assumptions about changes in cropping patterns over time, which would affect their calculated IRR to a much greater extent than is true of other machinery items.

General Assumptions

The following procedural and substantive assumptions were applied in all of the IRR calculations:

1. The internal rate of return is the interest rate which will satisfy the following equation:

$$0 = R_0 + \frac{R_1}{(1+i)} + \frac{R_2}{(1+i)^2} + \frac{R_3}{(1+i)^3} + \cdots + \frac{R_t}{(1+i)^t}$$

Where: R_j = Net Return (positive or negative) in year j

i = interest rate

T = life of the project in years.

2. No adjustment has been made for inflation. To the extent that inflation is universal and both costs and returns rise at the same rate, there is no effect on the internal rate of return. If one were rising and the other not, it would be proper to adjust for the inflation-adjusted higher values. No information suggests that the latter is the case.
3. All costs are assumed to occur at the beginning of the year.
4. All returns are assumed to be realized at the end of the year in which they occur. (For analytical purposes, the end of one year is the same as the beginning of the following year.) This method of handling returns simulates the lag in receipt of the returns associated with costs which occur at the beginning of the year.
5. No benefits are attributed to mechanization-generated labor savings, i.e., such labor savings are assumed to create no additional resources from the standpoint of the Egyptian economy as a whole. Although this probably reflects short-run reality under existing conditions, disregarding the resource value of farm labor savings causes the calculated IRRs to be conservative for a period as long as 10-15 years.
6. Amounts and base prices of the various equipment items as well as the sources and quantities of increased production expected from their use are those detailed in the respective chapters of the overall report devoted to the different program components.
7. Investment costs include only the machinery items recommended in this report. This is to say that no account is taken of either the incremental MOA manpower and organizational overhead requirements for implementing the respective sub-projects nor of the AID-financed technical assistance which the Study Team recommends be provided to several parts of the overall mechanization program.

8. No account is taken of the ancillary benefits that would flow from machinery introduction per se. As a prime purpose of machinery introduction is the building of a market for improved technology, those benefits should be substantial over a period of time.

TABLE XXIV. 5

INTERNAL RATES OF RETURN ON INVESTED CAPITAL BY PROGRAM COMPONENTS

Item	IRR	Equipment Price	Number Purchased	Expected Life
Tractor	78%	LE 3,500 ea	6,000	10 years
Tractor/Harrow*	83%	LE 5,000 ea	500	10 years
Subsoiling Equipment	--	NA	NA	10 years
Tractor/Scraper for Land Leveling	37%	LE 4,500 ea	150	10 years
Service Centers	33%	LE 250,000 ea (large) LE 24,400 ea (small)	20 50	15 years 15 years
Sakia Replacement**	17%	LE 887 ea plus LE 403 after 10 yrs.	10,000	20 years
Thresher***	31%	LE 6,500	100	20 years
Mechanical Planter	41%	LE 2,300 ea	100	20 years

NA - not applicable
* Disc/spire/tooth harrow combination
** Pumpset requires engine replacement after 10 years
*** High-capacity (2.5 mt/hr) used for two crops per year, e.g., wheat and rice

Estimated IRRs

Tables XXIII. 6 - 13 show that the calculated IRR for the respective sub-projects and explain the principal bases for the respective calculations. To test the sensitivity of the IRR to machinery purchase price or/and level of projected benefits, multiple IRR estimates based upon alternative assumptions are shown fo

particular points where altering those factors would make a significant difference in the IRR estimate. In that context it must be emphasized that the factor costs and returns underlying the estimates shown in Table XXIII. 6 represent those which extensive Study Team analysis indicated probably will be realized.

TABLE XXIII. 6

SOCIAL INTERNAL RATE OF RETURN
FROM INTRODUCING ADDITIONAL TRACTORS (65 Hp)[a]

Capital Costs [b] (Alternatives)	Anticipated Benefits [c]	Reduced Benefits[d]
$ 5,000 ea. (LE 3,500)	78%	34%
$10,000 ea. (LE 7,000)	44%	21%
$15,000 ea. (LE 10,500)	29%	11%

[a] Assumes 6,000 tractors will be introduced; 3,000 in year 0 and 3,000 in year 1 of the program

[b] Anticipated capital costs is $5,000 per tractor

[c] Each tractor is assumed to operate 900 hours per year with an effective life of 10 years. The annual operating hours are utilized as follows:

Plowing	350 hours
Threshing	300 hours
Transportation	150 hours
Other	100 hours

This utilization reflects present practice. Consequently, the IRR calculation assumes additional tractors would be used in the same ways as existing machines.

1. Benefits from plowing are an approximately 9% increase in yield due to more timely operations.
2. Increased meat and milk production from not using animals for plowing: LE 2.16/feddan plowed.
3. No benefit is calculated for human labor saved.
4. Threshing, transportation and other uses have an assumed benefit of LE 1.50/hr after subtracting the variable cost of tractor operation (i.e., LE 2.92/hr.). In other words, it is assumed that the marginal value product of tractor time is at least LE 1.50/hr. These are rather neutral rates employed to avoid overestimating the value of additional tractor power.

[d] Benefits due to timeliness of operations are reduced by 50%. All other benefits are left unchanged.

TABLE XXIII. 7

SOCIAL INTERNAL RATE OF RETURN
FOR TRACTOR/HARROW COMBINATION[a]

Capital costs[b] (Alternatives)	Anticipated Benefits [c]	Reduced Benefits[d]
500 Tractors @ LE 3,500 500 Harrows @ LE 1,500	83%	57%
500 Tractors @ LE 7,000 500 Harrows @ LE 3,000	50%	35%
500 Tractors @ LE 10,500 500 Harrows @ LE 4,500	36%	25%

[a] Assumes 500 of the additional 3,000 65 hp tractors will be teamed with 500 disk/spike-tooth harrow units in the first year of the program.

[b] Anticipated cost cost is LE 3,500 per tractor plus LE 1,500 per harrow unit.

[c] Each tractor is assumed to operate 900 hours per year with an effective life for the tractor and harrow of 10 years. The annual operating hours are utilized by function as follows:

Plowing	350 hours
Harrowing	387 hours
Threshing	163 hours

Since there is no previous experience for the use of harrows in Egypt, harrowing time was based on feddans plowed with transportation, threshing and other uses reduced to leave total annual hours of use unchanged.

1. Benefits from plowing are an approximately 9% increase in yield due to more timely operation.
2. Increased meat and milk production from not using animals for plowing of LE 2.16/feddan plowed.
3. No benefit is calculated for human labor saved.
4. Threshing time is valued at LE 1.50 per hour with a variable cost of operation of LE 1.292 per hour.
5. Benefits from harrowing are increased yield resulting from improved seedbed preparation. Yield increases are phased in starting with zero benefits in the first year to full benefits after 8 years as farmers learn how to use the equipment through trial and error. Maximum yield increase projected is: Cotton, 22%; Maize, 23%; Wheat, 15%; Berseem, 10%; Miscellaneous Crops, 13%.

[d] Benefits from timeliness of tractor plowing reduced by 50%. All other benefits unchanged.

TABLE XXIII. 8

SOCIAL INTERNAL RATE OF RETURN
FROM SUBSOILING[a]

Capital Costs[b] (Alternatives)	Internal Rate of Return[c]
LE 2,646,700	207%
LE 5,293,400	130%
LE 7,940,100	98%

[a] Assumes 150 units capable of working 120 days per year and subsoiling 216,000 feddans per year.

[b] Capital costs varied to reflect alternative assumptions concerning acquisition cost.

[c] Since subsoiling is only performed on poorly drained soils, base yields used in this analysis are 50% of current yields in Egypt.

1. Subsoiling increases yields, with the improvement declining over time. This analysis assumes the following yield increases:

	Year				
Crops	1	2	3	4	5
Cotton	50%	48%	40%	30%	15%
Maize	15%	5%	-	-	-
Berseem	4.6%	4.6%	-	-	-

2. Subsoiling one feddan of land impacts .24 feddans of cotton; .30 feddans of maize and .48 feddans of berseem. Yields of other crops are little affected by subsoiling.

TABLE XXIII. 9

SOCIAL INTERNAL RATE OF RETURN
FROM PRECISION LAND LEVELING [a]

Capital Costs[b] (Alternatives)	Internal Rate of Return [c]
Tractor and Scraper $ 6,400 ea. (LE 4,500)	37%
Tractor and Scraper $12,800 ea. (LE 9,000)	27%
Tractor and Scraper $19,200 ea. (LE 13,500)	22%

[a] Assumes 150 65 hp tractor/scraper units, 50 introduced at the beginning of the program; the other 100 at the beginning of the second year.

[b] Unit prices varied to reflect alternative assumptions with respect to purchase price.

[c] Assumes land level will produce a combination of crops typical of Upper Egypt. Land once leveled will remain level indefinitely with minor periodic touch-up which farmers can do themselves.

TABLE XXIII. 10

SOCIAL INTERNAL RATE OF RETURN
FROM SERVICE CENTERS

Internal Rate of Return: 33%

Assumptions:

1. Twenty large service centers at a total cost of LE 5,000,000.
2. Fifty local service centers at a total cost of LE 1,220,000.
3. Cost of repairing one tractor equals LE 400.
4. Cost of rebuilding one tractor equals LE 1,200.
5. Number repaired increases to a maximum of 700 tractors per year.
6. Number rebuilt increases to a maximum of 200 per year.
7. Repaired tractor operates for 2 years.
8. Rebuilt tractor operates for 5 years.
9. Benefits from a repaired or rebuilt tractor are identical to the benefits from a new tractor (i.e., increased yield due to timeliness, use for threshing, transportation and other use).

TABLE XXIII. 11

SOCIAL INTERNAL RATE OF RETURN
FOR SAKIA REPLACEMENT

Internal Rate of Return: 17%

Assumptions:

1. Pumps purchased as follows:

Year	Number of Pumps
0	500
1	2,000
2	3,000
3	3,500
4	1,000

2. Cost for each pumpset is LE 886.91
   a. Engine life is 10 years
   b. Pump life is 20 years

3. Each pumpset irrigates the following areas and has the costs shown:

Year	Feddans Irrigated	Machine Operating Cost	Operator Cost
0	30	LE 210.30	40.20
1	30	210.30	40.20
2	45	338.00	61.50
3	45	338.00	61.50
4+	60	375.50	82.80

4. Benefits result from increased meat and milk production from not working animals. One sakia irrigates 15 feddans. For each sakia replaced, milk savings equal LE 151.20; meat savings equal LE 43.50.

5. No benefit is calculated for irrigation labor saved.

TABLE XXIII. 12

SOCIAL INTERNAL RATE OF RETURN
FROM HIGH-CAPACITY GRAIN THRESHERS[a]

Capital Cost[b]	Wheat Areas[c]	Rice Areas[d]
LE 455,000	12%	31%
LE 650,000	8%	22%

[a] Assumes 100 high-capacity 2.5 ton/hour threshers will be introduced.

[b] Capital costs varied to reflect alternative assumptions of acquisition costs.

[c] Assumes all threshers placed in a wheat area (i.e.,Upper Delta or Middle Egypt) where only a single crop will be threshed each year. Benefits are calculated separately for replacing a norag (40% of the crop) and for replacing a small tractor-powered drum thresher (60% of the crop). Benefits from replacing a norag include grain saved (9.5%) and increased meat and milk production from not working the animals. Benefits from replacing a small tractor-powered drum thresher include increased yield due to improve timeliness of operations (i.e., threshing takes two weeks instead of four, thereby freeing the tractor operating time since the crop is threshed with half the tractor hours).

Total benefits are LE 1,431.72 when replacing a norag and LE 896.80 when replacing a drum thresher for a weighted average of LE 1,110.77 per thresher.

[d] Assumes all threshers placed in a rice area where the thresher can be used on both wheat and rice.

Benefits are calculated separately for replacing a norag (50% of the crop) and a tractor drawn sledge (50% of the crop).

Benefits from replacing a norag include grain saved (9.5%0 and increased meat and milk production from not working the animals. Benefits from replacing a tractor-drawn sledge include grain saved (9.5%0; increased yield due to improved timeliness of operations (i.e., it takes two weeks instead of four for threshing, thereby freeing the tractor for plowing) and reduced hours of tractor operation. Benefits total LE 1,160.11 when replacing a norag and LE 1,629.91 when replacing a tractor drawn sledge for a weighted average of LE 1,395.01 per thresher. Since the rice area permits the thresher to be used in wheat and rice, total benefits are LE 2,505.78 (i.e.,LE 1,110.77 plus LE 1,395.01) per thresher.

Similar results could be expected in the grain sorghum/bean growing areas of Upper Egypt as those crops together with wheat would permit threshers being used for two crops per year.

TABLE XXIII. 13

SOCIAL INTERNAL RATE OF RETURN
FROM MECHANICAL FOUR ROW PLANTERS

Internal Rate of Return: 41%

Assumptions:

1. One hundred planters purchased in first year of program @ LE 2,300 for initial investment of LE 230,000.
2. Planter useful life is 10 years.
3. Operating costs (tractors, driver, repairs, etc.) equal LE 2.442/hr.
4. Planters used on cotton and maize and will plant 40 feddans of each crop each year.
5. Benefit from planter is 10% increase in yield for cotton and maize as as result of improved and more uniform stand.