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Egypt Water Use & Management Project
Consortium for International Development

WATERCOURSE IMPROVMENT EVALUATION

By:

Richard McConnen, David Marteila, Farouk Abdel-Al,

Gamal Ayad, Elia Sorial, Gamal Fawzy

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EGYPT WATER USE AND MANAGEMENT PROJECT

22 El Galaa St., Bulak, Cairo, Egypt

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EWUP PROJECT TECHNICAL REPORT NO. 63

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Colorado State University
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USA

Consortium for International
Development
5151 E. Broadway, Ste., 1500
Tucson, Arizona 85711 USA

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ABSTRACT

Several methods of evaluation are available for watercourse improvement projects. These evaluation methods include accountability, comparison of stated objectives with accomplishments, comparison of technical design with accomplishments, acceptability of the project by the client groups, financial evaluation of the activities, economic evaluation of the activities, integrative evaluation and evaluation of the lessons learned from the project.

Financial and economic evaluation were conducted for two study sites established within the Egypt Water Use and Management Project. Water course improvements on mesqa #10 at Mansuriya and mesqa #26 at Abyuha were used as examples in considering the methods of evaluation. Partial budgets of benefits and costs for the two study sites have been prepared in conjunction with determination of average crop yields per Feddan for the period 1973 to 1982.

In comparing stated objectives and accomplishments, provisions are necessary for collecting and recording data and information needed for evaluation on a "with" and "without" basis in advance of the project work. However, one of the principal benefits of such first-generation projects is to determine methodology for future projects. In assessing the technical design with accomplishments, the case studies have indicated that significant cost reductions in design and construction are needed if water course improvement projects are to be economically viable. Explicit attention must be paid to the farmers regarding acceptance of the project, timely completion of the work, minimum interference to the farmers and extensive dialogue with the farmers regarding the objectives of the project.

The two study areas have shown that although the projects were financially advantageous to the farmers, there was no consistent evidence of increases in yields due to water course improvement. However, other projects with longer data periods have indicated such increases. In economic terms the Ministry of Irrigation must search for more efficient designs, construction techniques, and maintenance programs if the projects are to be beneficial to Egypt.

In general, many lessons have been learned from the two study areas, and future water course improvement projects recognizing and adopting these results will assist in providing a resurgence of Egyptian agriculture.

مستخلص

يتوافر حاليا عدة طرق لتقييم المشاريع الخاصة بتطوير المجاري المائية ، وتتضمن هذه الطرق التطويرية الإحصاء والتقييم والمحاسبة ، المقارنة للأهداف والأغراض الموضوعة مع الإنجازات التي تمت ، مقارنة التصميمات الفنية مع الإنجازات ، مدى قابلية المشروع للعمل ، تقييم المصادر المالية والتحليل الإقتصادي للأنشطة ، وكذلك تقييم الدروس المستفادة من المشروع في المراحل المختلفة .

وقد تم عمل التقييم المالي والإقتصادي لمنطقتين للدراسة في مصر تحت نظام عمل مشروع تطوير استخدام مياه الري . وقد تم إعتبار تطوير المجاري المائية الخاص بمسقى رقم ١٠ في منطقة المنصورية ومسقى رقم ٢٦ في منطقة أبوحماد كأمثلة للتقييم . وقد تم عمل تحليل جزئي للتكاليف والفوائد العائدة للمنطقتين مع إنتاجية الفدان من المحاصيل في الفترة من عام ١٩٧٢ إلى عام ١٩٨٢ .

ومن خلال المقارنة بين الأهداف والإنجازات .. فقد وجد أنه ينبغي عمل الإستعدادات والتجهيزات اللازمة من ناحية الأفراد والمعدات والخاصة بتجميع وتسجيل كل البيانات والمعلومات وذلك قبل البدء في العمل بالمشروع حتى يتم التقييم مع إعتبار أو بدون إعتبار بعض العوامل المؤثرة في المشروع . وعلى كل حال فإن أساس الإستفادة من المرحلة الإبتدائية في مثل هذه المشاريع هو تحديد طرق العمل في مشاريع المستقبل .

وفي محاولة تقييم التصميم الفني والإنجازات .. أظهرت الدراسة الحاجة إلى تخفيضات واضحة لتكاليف التصميم والإنشاء اللازمة للمجاري المائية خاصة إذا

إذا ما ظهر أن التطوير المقدم في المشروع قابل للتطبيق اقتصاديا . كما أنه من الضروري اعطاء الاهتمام الخاص للمزارعين واستطلاع مدى تقبلهم للمشروع مع تحديد الوقت اللازم للإنجاز وكذلك اجراء حوار مكثف وواضح مع الفلاح لابراز أهداف ومنافع المشروع .. وبدون التدخل في شئون الفلاح الخاصة .

وبالرغم من أن الدراسة بالمنطقتين قد أظهرت منافع مالية للفلاحين ، فلم يكن هناك دليل واضح على زيادة المحاصيل نتيجة لتحسين كفاءة مجاري التوزيع .. مع أن المشاريع الأخرى المتوفر فيها بيانات لمدد أطول أظهرت تحسن واضح في إنتاجية المحاصيل . وفي عبارة اقتصادية أخرى .. فإن وزارة الري لابد أن تبحث عن تصميمات أكثر كفاءة وطرق أخرى فنية مع أحدث وسائل التطوير الحديث للانشاء وبرامج لتحسين الكفاءة والصيانة حتى تكون المشاريع نافعة لمصر .

وعموما ، فقد تم الاستفادة من الدراسات التي تمت بالمنطقتين .. ويمكن الاستفادة بالنتائج في المشاريع المستقبلة لتحسين المجاري المائية والتي سوف تساعد على نهضة الزراعة المصرية مرة أخرى .

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WATERCOURSE IMPROVEMENT EVALUATION

I. INTRODUCTION: TYPES OF EVALUATION

The MOI's implementation of a National Irrigation Improvement Program includes the goals of improving the management of irrigation water, improving water availability at the tail ends of canals and mesqas and increasing crop production. Within EWUP's approach, watercourse management programs were launched at each of three project sites in Giza, Kafr El-Sheikh and El-Minya Governates to develop an interdisciplinary model of the water delivery system and improve the on-farm irrigation management practices. The following paper considers the various types of evaluation applicable to a project of this nature and considers financial and economic evaluation of Mesqa #10 in Mansuriya and Mesqa #26 in Abyuha.

There is no single best method for evaluating the activities of a diverse project such as EWUP. The best method of evaluation will depend on the purpose of the evaluation. In most cases, at least several types of evaluation will need to be performed to appraise a particular activity such as a mesqa renovation.

It is important to distinguish between feasibility studies and evaluations. Feasibility studies must be done before the project or activity is initiated (pre-intervention) and must be based on expected outcomes. The purpose of feasibility studies, as the name implies, is to determine whether or not it is desirable to initiate the project or activity. Feasibility studies, however, can also be used as a learning process by which it becomes possible to improve the specifications of the projects and activities before they are initiated. Evaluations, on

the other hand, are done after the projects and activities are initiated. They are, in effect, post-intervention. In order to be able to perform good evaluations, project and activity work must include provisions for collecting and recording the data and information needed for each type of evaluation.

The range of evaluation was divided into eight principle types which are presented below. At this stage in the project cycle for EWUP, the types 3, 4, 5, 6 and 8 were the most important types of evaluation.

1. Accountability: Are the funds spent accounted for and were they spent in the manner approved? Were the expenditures legitimate? Are all assets, furniture, equipment, vehicles, etc., accounted for? This is basically an auditing type of evaluation.
2. Comparison of Stated Objectives and Accomplishments: This approach is often used in the evaluation c scientific work. Did the researcher (or project) accomplish the objectives established when the project was funded? Often, if this type of evaluation is done early in a project (such as mid-term), the evaluation results may be the basis for modifying the original objectives of the project.
3. Comparison of Technical Design with Accomplishments: This type of evaluation would be particularly useful to see if completed and in-process construction and manufacturing activities meet design standards. In many cases, performance may be poor because of either faulty execution of the design or design standards may be inappropriate. To learn from an activity such as constructing a mesqa, a technical evaluation will need to be made. For example, if a construction project does not meet contract specifications, it will not be possible to evaluate the adequacy of the design. If

there is an inadequacy, it is important to establish if the cause is either the need to improve the design or a faulty execution of the design.

4. Acceptability of Activity by Client Groups: Client groups may range from the farmers using a water course to the MOI personnel responsible for the water course. Acceptability has to do with how things are perceived as well as what in fact does exist. Perceptions and reality may differ, among other reasons, because of cultural heritage and the way in which activities are carried out. An activity may be unacceptable to farmers because of either bad design or poor construction. In other cases, the activity may not be acceptable to a group because the purpose of the activity is not fully understood.

5. Financial Evaluation of Activities: This involves a benefit-cost analysis based on prices actually paid and received by the appropriate client group. Usually these are based on market price and costs plus subsidies paid directly less direct tax payments affected by the activity. For example, a financial analysis at the farmer level would involve the prices they paid for purchased inputs and prices they received for output. If labor is hired, labor costs would be entered in the anaysis at the market value, but family labor would not be entered as a cost except at the financial opportunity cost level. The financial evaluation could also be for other client groups, such as the MOI.

6. Economic Evaluation of Activities: This involves a benefit-cost analysis based on economic values which may be different from the market prices and costs used in a financial evaluation. It may be

necessary to estimate shadow prices of some inputs and products. All prices and costs used in the analysis should reflect the full opportunity cost of all inputs used and products sold. For example, the financial cost to the Egyptian farmer for diesel is L.E. 0.03 per liter while the shadow price or full economic cost to the country has been estimated to be L.E. 0.24 per liter.[2] Shadow price, economic value and economic opportunity cost all have the same meaning. If the shadow price of diesel is L.E. 0.24 per liter, that means there is an opportunity to use the liter of diesel so that it would generate an economic value to Egypt of L.E. 0.24 per liter.

7. Integrative Evaluation: A single development project or development activity may have performed well when viewed separately from the development goals of either a nation or a region. However, the accomplishments of the project or activity may either fail to contribute to the accomplishment of the development goals or may actually be counter to the development goals. Therefore, each project and activity needs to be evaluated in terms of its contribution to the broad development goals of either a nation or a region.

8. Preparation for Follow-Up Work (Lessons Learned): The principle purpose of evaluation for purposes of follow-up work is to develop a realistic image of "what should be" or "what could be." The emphasis of such an evaluation should be to identify what has been learned rather than to merely determine if either a practice or a project is "good" or "bad." At this stage of the project cycle for EWUP, this type of evaluation is very important.

Evaluation may be carried out to check on performance; auditing of financial records and contract compliance with technical design specifications are examples of performance evaluation. In addition, evaluations may be performed to learn both how to do things more effectively and to identify what needs to be done.

Regardless of the type of evaluation, criteria must be established for evaluation. The criteria must be appropriate to the type of evaluation and the criteria needs to reflect a balance between the ideal and the possible.

The types of evaluations interact and are often complimentary. The most appropriate type or set of evaluations to perform will depend on the goals to be achieved by evaluation. Gittinger states, "There tends to be a natural sequence in the way projects are planned and carried out, and this sequence is often called the 'project cycle.' There are many ways - all equally valid - in which this cycle may be divided. Here we will divide it into identification, preparation and analysis, appraisal, implementation and evaluation". Egypt Water Use and Management Project activities will be completed June 1984, and the final phases of the project cycle have begun. Evaluation can have the goal of evaluating "What has been done." Evaluation types 1 through 6 are designed to accomplish this sort of evaluation. The eighth type of evaluation, preparation for follow-up activity, is largely concerned with evaluation aimed at learning about "What should be done." All of the first six types of evaluation can contribute towards the preparation of follow-up activities. Evaluation of EWUP activities should provide a basis for the activities of the new projects.

Implementation of knowledge gained from EWUP will permit both the empirical and conceptual results to serve as a basis for designing and executing a major long-term water course improvement program for Egypt.

Gittinger states, "Careful evaluation should precede any effort to plan follow-up projects.[5] Such an evaluation need not be restricted to quantitative analysis and should certainly go well beyond the usual benefit-cost analysis. Evaluation for the purpose of planning follow-up activity might well be presented as an answer to the question, "What have we learned so far which will help us in planning the most appropriate follow-up work?" Problems exist when "what is" differs significantly from "what should be." One of the main purposes of evaluation for the planning of follow-up work is to help establish a realistic image of "what should be."

The idea of an image of "what should be" is an equivalent concept to the idea of a hypothesis in research; a set of assumptions which can be subject to verification or proof. The phrase "image of what should be" is used in the context of irrigation improvement programs. Because of the nature of the actual verification process; constructing the physical works needed and then operating the new system in an environment with farmers striving to live under what are often demanding economic and social conditions, only a limited number of alternatives can be tested in a real world situation. Therefore, the cost of failure of a project can be both higher than for many other programs and the costs may be borne by people other than the beneficiaries. The image of "what should be" should, like a hypothesis, be treated as a tentative truth to be rejected, not accepted. Great care should be taken before an image

of "what should be" in terms of irrigation improvement programs is translated into a program of action because of both the magnitude and the incidence of the cost of failure.

In classical benefit-cost analysis, the importance of secondary as well as primary cost and benefits is stressed. While this report will not place a great deal of emphasis on secondary benefits and costs, such considerations are often significant and can have considerable impact of the type of information impact on the type of information gained from evaluation studies.

II. FINANCIAL AND ECONOMIC EVALUATION: CASE STUDIES OF MESQA #10 IN MANSURIYA AND MESQA #26 IN ABYUHA

Evaluation, in a narrow sense, is sometimes restricted to mean benefit-cost analysis. There are many controversies surrounding benefit-cost analysis, some of which are presented in EWUP Technical Report No. 12, hence the subject will not be pursued here. However, as pointed out above, it will often be important to consider additional types of evaluations. Regardless of the type of evaluation used, any intervention should be evaluated on a "with" and "without" basis. Since formal experimental controls seldom exist for larger scale irrigation interventions, estimates of the conditions under both the "with" or the "without" state of the system must be made. If a feasibility study is made in anticipation of implementing an activity, the parameters of the "without state" of the system can be observed while the parameters of the "with state" of the system must be estimated. When the evaluation of an activity which has already been implemented is to be made, the opposite condition exists; the parameters of the "with state" of the system can be observed while in most cases the parameters of the "without state" must be estimated. In the case of mesqa renovation which has already been completed, this means that the existing situation corresponds to the "with state" while the situation which would exist if the mesqa had not been renovated, the "without state," will have to be estimated.

Benefit-cost analysis can be of two major types: financial and economic. Gittinger provides a detailed distinction between economic and financial analysis.[2] In general terms, economic analysis is done using economic values which means the impact of using inputs and producing outputs needs to be evaluated in terms of the impact on the

general economic well being of the country as it interacts with the international economic system. Financial analysis is done using those prices which must be considered by the decision maker in deciding what needs to be done. Different decision makers may use different prices, that is those prices which reflect the financial impact on the decision maker's well being. Different decision makers may also have to consider a different range of inputs and outputs. For example, a financial analysis from the standpoint of the farmers of a mesqa improvement project involving pumping costs paid for the MOI would not consider pumping cost. However, a financial analysis from the MOI standpoint would consider such costs. The "market prices" may be determined in the market place or they may be administratively determined. In either case, the prices relevant to the decision maker in question should be used.

This presentation is based on the following ideas: (1) there is no single best method of evaluation and the most appropriate type of evaluation will depend on the purpose of evaluation; (2) while evaluations by economists are important, each discipline has responsibilities for evaluations and for the application of their professional judgments in a manner which will result in reproducible results; (3) at this stage in the project cycle for EWUP, considerable effort should be devoted to evaluations which are oriented toward the future. This means evaluation for purposes of planning follow-up work as discussed by Gittinger.[5] The principle purpose of such evaluations is to emphasize the importance of learning from EWUP experiences rather than merely judging if the results of a particular activity were "good" or "bad."

A. A Farm Level Financial Analysis of Mesqa 26-Abyuha

The basic method presented in EWUP Technical Report No. 12[4] will be used for both financial and economic analysis. The general approach is to use the partial budget format presented in Technical Report No. 12.[4] The analysis presented here is based on the changes which were recorded in EWUP farm records.

1. Changes in Yields: Table 1 presents the yield data for Mesqa 26, Abyuha. The improvements in Mesqa 26 were completed in January, 1981. The mesqa was elevated, served by a single-point pumping station and the farmers were able to irrigate with an adequate head of water delivered by gravity. Table 1 was used as the basis for estimating the increases in Average Added Annual Benefits (I-A-1 Partial Budget). Using data from these EWUP Farm Records, there is no evidence of yields increasing as the result of mesqa improvement, on Mesqa 26. However, there were not enough observations to warrant a statistical analysis, and there is no evidence of a pattern of yield increases when compared to the yields of either other farmers on Abyuha or for fields of Mesqa 26 farmers which are located on other mesqas. While there was a shift to higher valued crops at the farm level as soybeans were substituted for cotton, this was the result of a change in government policies, not the result of irrigation improvements (I-A-2 Partial Budget). This is an example of why it is important to stress the "with" and "without" in evaluations rather than just the "before" and "after." Since water was not pumped into Mesqa 26

Table 1. The Impact of Improving Mesqa #26 - Abyuha (198) on Average Crop Yields for Farm Record Keepers

Years and Crops	Farm Records Mesqa #26 Fields Per Feddan	Farm Records Abyuha Per Feddan	Farm Records for Fields of Mesqa #26, Farmers Located on other Mesqas Per Feddan
Broad Beans	Ardab	Ardab	Ardab
1981/82	5.92	6.52	5.48
1980/81	5.37	5.40	6.00
1979/80	a/	4.92	a/
Wheat	Ardab	Ardab	Ardab
1981/82	10.79	10.43	10.86
1980/81	10.18	9.76	9.60
1979/80	a/	6.35	a/
Cotton	Kantar	Kantar	Kantar
1981/82	NA	5.64	4.85
1980/81	4.59	5.30	5.58
1979/80	a/	5.43	a/
Maize	Ardab	Ardab	Ardab
1981/82	7.72	8.89	7.55
1980/81	5.82	7.15	6.81
1979/80	a/	8.10	a/
Soybeans	Ton	Ton	Ton
1981/82	1.01	1.11	1.14
1980/81	NA	0.98	NA
1979/80	a/		

a/ No records for this crop on Mesqa 26 farms in 1979/80.

unless there was a demand for that water, less water would flow through the mesqa than under the condition without the improvement. The water diverted into Mesqa 26 decreased from about 20,000 m^3 per feddan without the improvement to less than 10,000 m^3 per feddan with the improvement. However, there is no indication that the decrease in water diverted resulted in any benefits to the farmers on Mesqa 26 (I-A-3). Based on the evidence provided by farm records, there is no evidence of added financial benefits to the farmers as the result of the improvements in Mesqa 26 which occurred in January, 1981. However, there were benefits to farmers because of cost savings. In addition, there may be future benefits, but this analysis is based only on those changes in income and expenses which have been recorded. Note should be made that in other EWUP studies[6] improvements in the irrigation system resulted in a 9 to 23 percent improvement in maize yields. The Egypt Major Cereals Improvement Project (EMCIP)[7] reports that an increase in water use efficiency of 22 percent was obtained in wheat production using corrugation type irrigation and upgraded Mesqas. Long field furrow irrigation techniques and a rehabilitated distribution system, with maize produced a saving of 11 percent of irrigation water and increased yield by 17 percent. For sorghum, the equivalent percentages were 25 percent savings and 61 percent increased yields. Similar increases in production yields and water savings were reported for lentils and soybeans.

WORKSHEETS

Evaluation of Water Distribution Projects

Date August, 1983

Partial Budget 1

Farm Level Financial Analysis of Mesqa 26-Abyuha

Basis for Comparison: Unimproved Mesqa 26

Proposed Change: Elevate Mesqa 26 and convert to gravity

Alternative Assumptions: Comparison of with and without the elevation based on actual performance on Mesqa 26. This is a financial analysis at the farm level.

I. Benefits

A. Average Annual Added Benefits

1. Increased gross profit from potential yield increases: no evidence of yield increases. See Table 1

2. Increased gross profits from shifts to higher valued crops: none

3. Value of water conserved: none

4. Annual value of land saved: _____

5. Other: _____

Total Average Annual Added Returns: No evidence of any added returns

B. Average Annual Reduced Costs	Financial Opportunity Cost of Family Labor	
	L.E. 0.00/Man Day	L.E. 2.25/Man Day
1. Pumping Conversion from poor gravity and tambour to gravity a/ b/	L.E. 507.77	L.E. 2,031.08
2. Mesqa maintenance		
3. Drain maintenance		
4. Labor for irrigation	0	L.E. 600.00
5. Transportation		
6. Other		
Total Average Annual Reduced Costs	L.E. 507.77	L.E. 2,631.08
Average Annual Total Benefits = Total Average Annual Reduced Costs + Total Averaged Annual Added Revenue	L.E. 507.77	L.E. 2,631.08

a/ See Table 1, Technical Report No. 12.

b/ On the average, 25 percent of the labor is hired and 75 percent is family labor which has no short-term cash opportunity cost in the Abyuha area. Ninety man days were saved from pumping and 267 man days irrigating.

II. Costs

C. Average Annual Added Costs[c/]

1. Average annual depreciation		NA
a. Earth work	_____	
b. Gates and control	_____	
c. Structures	_____	
d. Other equipment	_____	
e. Other	_____	
2. Maintenance[d/]		0.00
a. Earth work	_____	
b. Gates and control	_____	
c. Structures	_____	
d. Other equipment	_____	
e. Other	_____	

[c/] The elevated mesqa was constructed by the MOI and all pumping costs were paid by the MOI. Therefore, none of the associated costs involve a financial cost to the farmers.

[d/] The maintenance labor requirements are estimated to increase from 84 man days to 126 man days. However, maintenance work is usually done in conjunction with other work and the financial opportunity cost of such work is zero in both cases examined here.

3.	Interest on average investment		NA
	a. Construction	_____	
	b. Equipment	_____	
	c. Other	_____	
4.	Annual operating costs		NA
	a. Equipment	_____	
	b. System operation and maintenance	_____	
	c. Other	_____	
5.	Pumping costs		NA
	a. Fixed costs	_____	
	b. Operating costs	_____	
	c. Other costs	_____	
6.	Other costs		NA
Average Annual Total Added Costs			0

D. Average Annual Reduced Benefits

1. Annual value of land lost	L.E. 218.70
2. Other[e/]	
Total Average Annual Reduced Benefits	L.E. 218.70
Added Costs + Reduced Benefits	L.E. 218.70
Net Benefits (Costs)	L.E. 289.07/L.E. 2,412.08

Comments:

[e/] See Note 3, Technical Report No. 12. No new estimates were made of gross profits per feddan, but land values increased from L.E. 3,000 per feddan in 1981 to L.E. 5,000 per feddan by 1983. In 1981, the annual gross profit per feddan was 131.22. If gross profits increased (because price increases for cotton, other crops and livestock as well as the introduction of soybeans) by a ratio similar to the value of land, the gross profit on .6 feddan would be L.E. 218.70. This would be a loss to the farmer.

2. Labor Savings: It is evident that the farmers did benefit from reduced financial costs (I-B). Without the improvement of Mesqa 26, 15.2 feddans would have to be irrigated 15 times per year with water lifted by a tambour and another 5.0 feddans had to be supplied the same way for an average of 7.5 irrigations. This is equivalent to 17.7 feddans being irrigated 15 times per year with water lifted by a tambour. It would take an average of 3.4 man days for each feddan per irrigation. In 1981, the cost per man day was L.E. 1.000, but by 1983, the cost had risen to L.E. 2.250. In some areas of Egypt, 1983 agricultural wages were L.E. 3.000 per day. However, it is estimated that only 25 percent of the work was done by hired labor and the remaining 75 percent of the work was done by family labor. In the Abyuha area, farmers do not generally work off the farm for pay and in the short run, the financial opportunity cost for family labor is probably zero. Therefore, of the 902.7 man days (17.7 feddans x 3.4 man days x 15 irrigations) of labor used for pumping, only 25 percent or 225.7 man days involve a financial cost of L.E. 507.77 (I-B-1). If the financial opportunity cost of family labor is L.E. 2.25 per man day, the financial savings from the improvements would be L.E. 2,013.08. Maintenance work is done by family labor and since there is no net-decrease there are no financial savings for the farmer (I-B-2). The Mesqa 26 improvement had no financial impact on requirements for farmer drain maintenance (I-B-3). Labor required for irrigation without the improvement averaged 4.2 man hours per feddan while it was possible to reduce irrigation labor per irrigation per

feddan to 1.5 man hours with the improvements. However, all irrigation on Mesqa 26 was done with family labor, and as such, the financial advantage to the farmers of savings over 1600 man hours of labor is zero if the financial opportunity cost of family labor is zero (I-B-4). If labor is valued at L.E. 2.25 per man day (W/6 hours/man day), the labor saving of 267 man days of labor have a financial value of L.E. 600. The total average reduced financial cost which can be credited to the improvement of Mesqa 26 is L.E. 507.77 if the financial opportunity cost of family labor is zero and L.E. 2,631.08 if the financial opportunity cost of family labor is L.E. 2.25 per man day. If the financial opportunity cost of labor is zero the benefit of the Mesqa 26 improvement equals L.E. 507.77.

3. Net Financial Benefits to Farmers: If the annual value of land lost is L.E. 218.70 (II-D-1), the annual net benefit (when the financial opportunity cost of family labor is zero) is L.E. 289.07. When the opportunity cost of family labor is L.E. 2.25 per man day, the net benefit per feddan is L.E. 2,412.38.

If all of the labor saved would have been hired labor, the reduced cost of pumping at 1983 labor costs of L.E. 2.25 per man day would have been L.E. 2,031.08. However, even if this were the case, cheaper alternatives for pumping are presently available because of the sharp increase in relative labor costs. Diesel pumps, for example, can be hired for L.E. 5.000 per feddan per irrigation and the pumping costs using rented diesel pumps would be L.E. 1,327.50. Diesel pumps have a lower financial cost than tambours, but because a tambour can be used with family labor (75 percent of the time on average) and if this has a financial

opportunity cost of zero, tambours would probably continue to be used heavily without the improvement on Mesqa 26. This would be true despite an increase in the relative cost of hired labor of 2.25 times between 1981 and 1983.

There would be no added financial costs to the farmers (II-C) as all of these are either borne by the MOI or, as in the case of II-C-2, involve no financial costs to the farmers. The reduced financial benefits to the farmers are associated with the loss of 0.6 feddan of arable land. In 1980/81, the annual gross profit from land was worth about L.E. 131.22 per feddan and had increased in value to L.E. 218.70 per feddan by 1983.

4. A Lesson Learned: Design Alternatives and Land Savings: The farm level financial analysis of Mesqa 26-Abyuha yields some interesting and useful information. The total costs to the farmer are in terms of the 0.6 feddan of land which was lost. EWUP has already developed alternative mesqa designs which have resulted in a net gain in arable land under an improved mesqa at Abyuha. Two roads have been constructed between mesqas and their heavy use by local farmers suggests that they prefer the land saving design alternatives for mesqas without animal trails on both sides of the mesqa. (Such trails use considerable arable land.) But when a road between alternative mesqas is eliminated and the appropriate land leveling is done, this design alternative can result in net increases in the area of arable land. In other words, EWUP has learned from experience that improved mesqas performing the same function as Mesqa 26 can be developed with a net land savings rather than a net land loss as occurred on Mesqa 26. In addition, the access to the fields can also be improved considerably.

From these data there is no evidence of increased crop yields. This may occur at a later date as farmers learn to use the improved mesqa along with appropriate technology. However, farm records do not indicate that such increases have occurred to date. It would obviously be important to continue to monitor the site by analyzing farm records to see if such increases occur in the future.

5. Implications for the Future: To date, the principal financial benefits of improving Mesqa 26 to farmers has been the saving of labor. It is interesting to note that in the U.S. and other countries, the principle motivation to invest in irrigation systems such as sprinkler systems was to save labor. The increased irrigation efficiencies were merely a by-product of adopting such new systems of irrigation. This raises an interesting issue about the joint conservation of labor and water as a result of improvements in irrigation systems of the type tried by EWUP on old lands in Egypt.

As labor becomes relatively more expensive (hired labor increased from L.E. 1.00 per man day to as much as L.E. 3.00 per man day in three years while other prices increased more slowly) the relative economic value of saving labor will increase. The relative financial cost of labor to the farmer will depend on his use of hired labor and the financial opportunity cost of family labor. As labor becomes relatively more scarce, the financial opportunity cost of labor will tend to increase.

B. An MOI Level Financial Analysis Mesqa 26-Abyuha

The MOI assumed the financial responsibility for the Mesqa 26 improvements and for pumping the water from Abyuha into the improved mesqa. This analysis is presented in Partial Budget 2. It should be pointed out that the financial analysis at the MOI level will be considerably different from an economic analysis. The purpose of such an analysis at the MOI level would be to evaluate the financial impact on the MOI. This information can be used to construct budgets for the MOI if they decide to ask for funding of such projects in the future. As will be pointed out later, the joint examination of the financial evaluation at both the farm level and the MOI level can also serve as a basis for constructing reasonable alternatives for cost sharing for water course improvement projects.

It should be kept in mind that the purpose of installing a single point pumping station at the head of Mesqa 26 was to simulate the type of gravity system which would result as the consequence for improving and raising the level of water in the Abyuha Canal. While much of the work on Abyuha has been completed, neither cost estimates of the work nor a technical evaluation of the resulting improvements are available at the present time. If such information were available, the pumping costs used in the analysis in Partial Budget 2 should be replaced by the cost of delivering the water to Mesqa 26 with a gravity system from Abyuha. It is anticipated that the costs of gravity will be considerably less than the cost of pumping in the case of Abyuha Canal.

As can be seen by referring to Partial Budget 2, the average annual financial cost to the MOI is L.E. 2,105.73 or L.E. 52.64 per feddan. Pumping costs account for 57.5 percent of the total financial costs to

the MOI. If the costs of converting Abyuha to a gravity system are held in check, the financial cost to MOI of Mesqa 26 type improvements could be lowered. Mesqa 26's share of such costs can be represented as:

WORKSHEETS

Evaluation of Water Distribution Projects

Date August, 1983

Partial Budget 2

MOI Level Financial Analysis of Mesqa 26-Abyuha

Basis for Comparison: Improved Mesqa 26

Proposed Change: Elevate and convert to gravity with single point pumping

Alternative Assumptions: Comparison with and without the improvements based on actual performance records.

I. Benefits

A. Average Annual Added Benefits

1. Increased gross profit from potential yield increases _____

2. Increased gross profits from shifts to higher valued crops _____

3. Value of water conserved _____

4. Annual value of land saved _____

5. Other _____

Total Average Annual Added Returns No added returns

B. Average Annual Reduced Costs

1.	Pumping	No reduced costs[a]
2.	Mesqa maintenance	
3.	Drain maintenance	
4.	Labor for irrigation	No reduced cost[a]
5.	Transportation	
6.	Other	

Total Average Annual Reduced Costs _____

Average Annual Total Benefits =

Total Average Annual Reduced Costs +

Total Averaged Annual Added Revenue None

[a] While both pumping and irrigation labor is saved, there are no financial advantages to the MOI since all of these financial saving occur to the farmers.

II. Costs

C. Average Annual Added Costs

1.	Average annual depreciation		L.E. 596.41
	a. Earth work	L.E. 239.44[a]	
	b. Gates and control	L.E. 171.00[a]	
	c. Structures	L.E. 185.97[a]	
	d. Other equipment	L.E. 145.00[a]	
2.	Maintenance		None[b]
	a. Earth work		
	b. Gates and control		
	c. Structures		
	d. Other equipment		
	e. Other		

[a] Depreciation costs are based on the assumption of no salvage and a 10 year life with investment of: earth works, L.E. 2,394.40; gates and control, L.E. 1710; and structures, L.E. 1,859.67.

[b] While increased maintenance is required, this work is done by the farmers at no financial cost to the MOI.

3. Interest on average investment[c/]		L.E. 298.21
a. Construction	L.E. 298.21[d/]	
b. Equipment		
c. Other		
4. Annual operating costs		
a. Equipment		
b. System operation and maintenance		
c. Other		
5. Pumping costs		
a. Fixed costs[e/]	L.E. 217.50	
b. Operating costs[f/]	L.E. 393.60	
c. Other costs[g/]	L.E. 600.00	
6. Other costs		
Average Annual Total Added Costs		L.E. 2,105.73

[c/] An interest rate of 10 percent was used as an estimate of the financial cost of capital. See Technical Report No. 12 for a discussion of the choice of the proper charge for this purpose.

[d/] One half of the original investment of L.E. 5964.072 was used as a basis for calculations since no salvage value exists.

[e/] The average annual fixed costs include an annual depreciation of L.E. 145.00 plus a 10 percent charge on half the investment of L.E. 1450.

[f/] Based on L.E. .03 per liter cost of diesel fuel for a financial cost to the MOI, L.E. 9.84 per feddan.

[g/] The estimated maintenance costs are confusing, but EWUP's main office financial records show considerable expenses for major repairs and the L.E. 600.00 estimate seems to be a conservative record.

D. Average Annual Reduced Benefits

1. Annual value of land lost	0[h]
2. Other	
Total Average Annual Reduced Benefits	
Added Costs + Reduced Benefits	L.E. 2,105.73
Net Benefits (Costs)	L.E. (-2,105.73)

Comments:

[h] The decrease in arable land results in no financial cost to the MOI.

$$\left(\frac{\text{Investment Share}}{2}\right) (\text{Interest}) + \left(\frac{\text{Investment Share}}{\text{Life Span}}\right) + (\text{O} + \text{M Share})$$

If O & M costs were 12 percent of Abyuha share of the investment (I), life span of the improvements on Abyuha were to equal 20 years with no salvage value and an interest rate of 10 percent were used, a breakeven situation with pumping would exist when pumping costs are taken from II-C-5.

$$\text{L.E. } 1211.11 = \frac{I}{2} (.10) + \frac{I}{20} + (.12) (I)$$

When the investment in Abyuha is I = L.E. 5,505 or L.E. 137.63 per feddan a gravity system and a single point pumping station would have equal "water lifting" costs. That is, L.E. 137.63 per feddan could be invested in raising Abyuha and lifting costs would not exceed those incurred in using a single pumping station. If investment needed to raise Abyuha could be kept no higher than L.E. 50.00 per feddan, Mesqa 26's share of investment would be L.E. 2000. This would mean interest costs of L.E. 100, depreciation costs of L.E. 200 and if maintenance costs were L.E. 3.50 per feddan, the pumping costs equivalents to MOI would be L.E. 440. The financial burden to the MOI for Mesqa 26 could be reduced from L.E. 2105.73 to L.E. 1,334.62 (L.E. 440 + L.E. 298.21 + L.E. 596.41). This would amount to an average annual financial cost of L.E. 33.37 per feddan for Mesqa 26. Obviously, with limited MOI budgets, the MOI has an incentive to find the lowest financial costs of achieving a given level of irrigation improvement.

C. Cost Sharing Proposals Based on the Use of Financial Analysis

The parameters to be used in developing a cost sharing proposal between the MOI and farmers are presented in Table 2. These parameters are taken from the analysis presented above.

Table 2. Financial Benefits and Financial Costs per Feddan for Mesqa 26, Abyuha

Financial Benefits to Farmers		Financial Costs to MOI	
Financial Opportunity Cost of Family Labor		Point Pumping	Gravity of Investment Cost of L.E. 50/fed
Zero	L.E. 2.25/day		
L.E. 7.23	L.E. 60.30	L.E. 52.64	L.E. 33.37

If the financial opportunity cost of family labor is zero, the financial benefits of L.E. 7.23 establishes an upper limit on the added financial burden farmers would be willing to pay. If the financial opportunity cost of labor is L.E. 2.25 per day, the upper limit on the added financial burden farmers would be willing to pay is L.E. 60.30 per feddan. However, as a practical matter, the cost sharing should be considerably less than these upper limits; perhaps no more than 25 percent of these limits. Since the benefits to farmers are primarily in the form of saved labor, the crucial value to establish is the financial opportunity cost of labor to farmers. The financial advantage after financial cost sharing to the farmer has to be significant enough so that the farmer perceives it to be in his interest to accept proposed irrigation improvement programs. While calculations of cost sharing plans can not be precise, it is important that they be based on a comparative study of financial evaluations for both the farmers and the

MOI. If farmers do not perceive the irrigation improvement program to be in their interest after payment of their assigned share of the cost, the program will probably not be successful.

The maximum possible shares for farmers and the minimum shares for the MOI are presented in Figure 1. It is obvious by looking at Figure 1 that the net financial cost to the MOI will depend on the net financial benefits to farmers as well as the financial costs born initially by the MOI. Cost sharing proposals by the MOI should not be determined solely by MOI costs. The financial impact on the farmers must also be considered.

Figure 1. Maximum Farmer Share and Minimum MOI Share of Mesqa 26 Costs

Farmer Net Financial Benefits per Feddan	L.E. 7.23 No Financial Opportunity Cost for Family Labor	L.E. 60.30 Opportunity Cost for Family Labor L.E. 2.25/day
MOI Financial Cost Per Feddan		
L.E. 52.64 Single Point Pumping	Maximum Farmer Share L.E. 7.23 Minimum MOI Share L.E. 45.51 Net Financial Benefit - L.E. 45.51	Maximum Farmer Share L.E. 52.64 Minimum MOI Share 0.00 Net Financial Benefit + L.E. 7.66
L.E. 33.37 Efficiently Designed and Constructed Abyuha Elevation	Maximum Farmer Share L.E. 7.23 Minimum MOI Share L.E. 26.17 Net Financial Benefit - L.E. 26.17	Maximum Farmer Share L.E. 33.37 Minimum MOI Share 0.00 Net Financial Benefit + L.E. 26.93

If the financial opportunity cost for family labor is L.E. 2.25 per day, it might appear from Figure 1 that all of the financial cost could be borne by the farmers. However, this may not be the correct decision

for several reasons. First, one of the legitimate goals of such water course improvement programs might be to increase the net income of a group in Egypt which has relatively low incomes; small farmers. In such cases, one of the benefits of such programs, not to the MOI, but to the country, would be to increase the income of small farmers. Second, if MOI costs are high, the benefits perceived by farmers could be decreased to the level where the farmers no longer regard the program as acceptable. Finally, the financial analysis of a project may be an imperfect indicator of the economic value of the program to the country. While the financial requirements of the program must be satisfied, i.e., the MOI must be able to undertake the program, if the economic advantage to the country is great enough, other means of financing the program, such as use of general tax revenues, may be justified. Before decisions are made on cost sharing policies, an economic analysis of the program needs to be completed.

D. An Economic Analysis of Mesqa 26-Abyuha

The decision whether or not Egypt is better off as the result of an irrigation improvement program such as Mesqa 26 should be based on an economic evaluation of that program. In an economic analysis, the costs of inputs and values of the outputs should be in terms of the costs and benefits which accrue to the nation. An economic evaluation of Mesqa 26 Abyuha is presented in Partial Budget 3.

The initial results of this economic evaluation are not encouraging if single point pumping is used, but it is important to add that an economic evaluation of such projects in the future should yield different results for at least three reasons. First, EWUP water course

WORKSHEETS

Evaluation of Water Distribution Projects

Date August, 1983

Partial Budget 3

Economic Analysis of Mesqa 26-Abyuha

Basis for Comparison: Unimproved Mesqa 26

Proposed Change: Elevate Mesqa 26 and convert to gravity

Alternative Assumptions: Comparison of with and without the elevation based on actual performance with alternatives of single point pumping and elevation of Abyuha

I. Benefits

A. Average Annual Added Benefits

1. Increased gross profit from potential yield increases _____

2. Increased gross profits from shifts to higher valued crops _____

3. Value of water conserved _____

4. Annual value of land saved _____

5. Other _____

Total Average Annual Added Returns No evidence of added returns

B. Average Annual Reduced Costs

1.	Pumping	L.E. 2,031.08[a]
2.	*Mesqa* maintenance	
3.	Drain maintenance	
4.	Labor for irrigation	L.E. 600.00[a]
5.	Transportation	
6.	Other	
	Total Average Annual Reduced Costs	

Average Annual Total Benefits =

Total Average Annual Reduced Costs +

Total Averaged Annual Added Revenue L.E. 2,631.08

[a] It is assumed that if the irrigation improvement program were in place for some period of time, there would be an adjustment in the supply of labor and that the long-term economic value to Egypt of labor saves is L.E. 2.25 per day.

II. Costs

C. Average Annual Added Costs

1.	Average annual depreciation		L.E. 596.41
	a. Earth work	L.E. 239.44[a]	
	b. Gates and control	L.E. 171.00[a]	
	c. Structures	L.E. 185.97[a]	
	d. Other equipment Pump	L.E. 145.00[a]	
	e. Other		
2.	Maintenance (126 man days of farmer labor)[b]		L.E. 283.50
	a. Earth work		
	b. Gates and control		
	c. Structures		
	d. Other equipment		
	e. Other		

[a] Depreciation costs are based on the assumption of no salvage value and a 10 year life with investments of: earth works, L.E. 2394.40; gates and control, L.E. 1710; and structures, L.E. 1859.67. The investment totals L.E. 5,964.07.

[b] The economic value of labor is estimated at L.E. 2.25 per man day. This issue is discussed in greater detail in the text accompanying this partial budget.

3. Interest on average investment[c/]		L.E. 98.21
a. Construction L.E. 5964.07	L.E. 298.21[d/]	
b. Equipment		
c. Other		
4. Annual operating costs		
a. Equipment		
b. System operation and maintenance		
c. Other		
5. Pumping costs		L.E. 1,941.00
a. Fixed costs[e/]	L.E. 217.50	
b. Operating costs	L.E. 1,323.50[f/]	
c. Other costs Maintenance	L.E. 600.000[g/]	
6. Other costs		L.E. 3,119.12
Average Annual Total Added Costs		L.E. 3,119.12

[c/] An interest rate of 10 percent is used. See Technical Report No. 12 for a discussion of the choice of an appropriate interest rate. See footnote a/ for investment components.

[d/] Since the investments are depreciated with no salvage value, average annual interest costs are calculated using one half the value of the original investment.

[e/] The average annual fixed cost of the pump include an average depreciation of L.E. 145.00 plus 10 percent interest on one half the value of the original cost of L.E. 1450.

[f/] Based on L.E. .24 per liter diesel fuel with a cost per feddan of L.E. 33.093.

[g/] The maintenance records on the pump are not good. However, several major repairs were made and the L.E. 600 is probably a conservative estimate.

D. Average Annual Reduced Benefits

1. Annual value of land lost[g/]	L.E. 218.70
2. Other	
Total Average Annual Reduced Benefits	L.E. 218.70
Added Costs + Reduced Benefits	L.E. 3,337.82
Net Benefits (Costs)	L. E. (-706.74)

Comments:

[g/] See finanical analysis Partial Budget 1.

improvement designs have improved and arable land can be increased as the result of irrigation improvement programs rather than decreased as was the case for Mesqa 26. Second, the cost of agricultural labor continues to increase and evaluations of Mesqa 26 show that such water course improvements tend to save considerable labor. Third, it is now possible to carry out the same kind of mesqa improvement program at much lower cost because of better design and the implementation of mechanical methods of construction. One of the principle benefits of the experiences gained on Mesqa 26 has been the lessons learned which have already led to both better designs and implementation programs for mesqa improvements.

1. Average Added Economic Returns: I-A of Partial Budget 3 deals with Average Annual Benefits. As discussed in connection with the financial analysis at the farm level, EWUP records provide no evidence of either increased yields nor a shift to higher valued crops which is the result of the improvements done on Mesqa 26. This is contrary to the hopes expressed for such water course improvement programs and some results from research plots. While there exists an unexploited potential for yield increases on lands such as those lands found under Mesqa 26, it appears that mesqa improvement by itself will bring neither increased yields nor a shift to higher valued crops under conditions found on Mesqa 26. However, water course improvement when combined with other changes such as improved internal access, higher farm-gate prices for crops and better access to technology, would probably permit the development of a farming system which would produce greater output per feddan. In fact, while a water course improvement in and by itself

apparently won't normally bring about increased production, such improvement may well be necessary in order to implement farming systems which will permit significant increases in yields. Farming systems which will result in yields which are 150 to 200 percent of the already high yields in Egypt will have to be very intensive systems. The key to such systems is precise control of inputs including water. Control of water is not possible without the significant improvement of water courses such as Mesqa 26 prior to the improvement program. One of the unquantified benefits of irrigation improvement programs such as that carried out on Mesqa 26 is the realization of the potential for a more intensive farming system.

Mesqa improvements, like those on Mesqa 26, will permit required water diversion to decrease from 20,000 m^3 per feddan to perhaps less than 10,000 m^3 per feddan. While the amount of water saved is considerable, there is no evidence at the present time that this water would be used elsewhere to increase the production of goods. If the expansion in the area of New Lands continues, a point will be reached where water rather than land is the scarce resource. At such time, the value of water conserved will have a positive value. If the MOI is convinced that a condition of water scarcity relative to land will exist in the near future, one of the obvious benefits of irrigation improvement programs are the lessons learned on how both the MOI and farmers can operate an irrigation system which will result in significant water conservation. At the

present time, however, it does not seem appropriate to assign an economic value to the water saved.

2. Average Annual Reduced Economic Costs: The reduced economic costs are presented in section I-B of Partial Budget 3. Once again, the savings occur because of reduced labor. In calculating the economic value of this labor, it was assumed that the local supply of labor would respond to its opportunity cost over time. It seems probable that the L.E. 2.25 per day value is a conservative economic value of labor over the longer run. The total average annual economic benefits of the Mesqa 26 improvement amount to L.E. 2,631.08.

3. Average Annual Added Economic Costs: It is this section of Partial Budget 3 which merits the most discussion because it is this area that the greatest potential for improved performance exists. In fact, the lessons learned in part from Mesqa 26 have already led to changes in design and construction procedures which would lower the added economic cost of L.E. 3,119.12 to perhaps half of that amount.

The average annual depreciation (C-1) accounts for about one-fifth of the added economic cost. The construction costs could be reduced significantly by using mechanized methods already being tested. Permanent gates and structures can probably be replaced by cheaper alternatives which would be consistent with a mechanized system of maintenance. The single point pumping station could be replaced by relying on gravity flow from an elevated Abyuha canal.

The maintenance of a system such as the one which presently exists on the improved Mesqa 26 must be done by hand because of the

design. The maintenance cost of this system will undoubtedly escalate rapidly as the economic cost of labor increases. One reasonable conclusion, already reached by the MOI with regards to main canals and main drainage ditches, is that the cost of maintenance labor will continue to increase and that maintenance work must be mechanized. In fact, it is likely that irrigation improvement projects for mesqas will have to be designed in the future so that most mesqa maintenance work can be done mechanically in order to hold down the economic cost. If this is not done, it is likely that it will not be feasible to maintain elevated mesqas in a condition which will permit effective operation.

The interest cost on average investment (C-3) obviously depends on the interest rate charged and the investment cost. As discussed in Technical Report No. 12, the interest rate is a highly simplified way, and, some would argue a misleading way, of calculating the economic opportunity cost of the resources committed to the irrigation improvement project. The other component used in calculating C-3 is the investment cost. As discussed earlier, EWUP has already developed design and construction alternatives which can significantly lower the investment cost.

The pumping costs (C-5) account for 62 percent of the total added economic costs. The economic costs of pumping (L.E. 1941) are considerably more than the financial cost of pumping to the MOI (L.E. 1211.11, C-5, Partial Budget 2). The financial and economic fixed costs to the MOI (C-5-a) are estimated to be the same. However, the economic operating costs are L.E. 1,323.50 compared with the financial operating costs to the MOI of L.E. 393.60 (C-5-b,

Partial Budget 2). The pumping costs must be expressed in economic rather than merely financial terms. The terms economic value, economic opportunity cost and shadow prices are all assumed to have the same meaning. The difference can be explained by using the example of diesel fuel. The financial cost to the farmer and MOI is L.E. 0.03 per liter. One estimate of the shadow price of diesel fuel is L.E. 0.24 per liter.[2] Cuddihy shows a lower rate of subsidization, but his figures are for diesel fuel in general and for the year 1976 when the world price of oil was about U.S. $11.00 per barrel.[3]

The "other costs" (C-5-c) are maintenance costs of the single point pumping operation. It is unfortunate that good records were not kept of pump maintenance costs. There were at least two major repair bills and at least one other significant bill and other regular maintenance costs which were incurred to keep the single point pumping station operating. It is for these reasons that the L.E. 600 should be considered a very conservative estimate of maintenance costs. The experience of an MOI operated single point pumping station on Mesqa 26 indicates two lessons that the MOI must learn if it is to make widespread use of single point pumping stations. First lesson: a maintenance program must be developed which will keep maintenance costs far below those experienced on Mesqa 26. This is an excellent example of a case where evaluations should be done in order to prepare for follow-up work. (See evaluation type #8). Unfortunately, if complete records on items such as maintenance costs are perceived as a means of judging if a practice or project is "good" or "bad," it's unlikely that such

records will be kept voluntarily. Yet, it is only on the basis of such records that problems can be identified and the potential for correcting such problems can be realized. Second lesson: a pumping station must be a reliable source of water and the Mesqa 26 experience shows that if maintenance costs are to be kept down, pumps will probably need to be replaced on a rotation basis to permit proper maintenance and reliability of water delivery.

4. Reduced Benefits: The average annual reduced economic benefit only involves land lost from cultivation (D-1). As discussed earlier, the more recent designs developed by EWUP would actually result in increasing the area under cultivation.

   The average annual net decrease in economic benefits for Mesqa 26 would amount to -L.E. 706.74. This conclusions is not encouraging. However, there have been lessons learned as the result of EWUP's work and if all these lessons were applied, the outcome could be different as indicated below.

5. An Alternative Economic Evaluation of Mesqa 26: In the alternate case, it will be assumed that average annual added economic benefits would remain at zero and average annual reduced economic costs would remain at L.E. 2,631.08. The average annual added economic costs could be reduced significantly by applying the lessons learned by EWUP personnel as the result of their experience. In addition, as already discussed under financial analysis, using new designs, it is possible to increase the area under cultivation as the result of lessons learned from EWUP's work. However, in the alternate economic evaluation, it will be assumed that the cultivated area does not change as the result of an irrigation improvement program.

With new design criteria and implementation of recommendations over larger study areas, the cost of the mesqa improvements could be reduced sharply. However, at this stage, only rough estimates of the cost of the new system can be made. It is assumed that construction costs could be cut in half. The results of this alternative economic analysis is presented in Partial Budget 4 - Summary of Changes.

Total Average Added Economic Revenue would remain the same as that used in the initial economic analysis. As mentioned earlier, in the long run, the value of added economic benefits could probably be increased above L.E. 2,631.08 because of: (a) a shift to more intensive farming systems, (b) an increased economic value of the labor saved and (c) the net cultivated area could be increased with the newer EWUP designs for water course improvements.

Average Annual Added Economic Costs were decreased from L.E. 3,119.12 to L.E. 1,029.06. This decrease occurred because of a projected decrease in construction and maintenance costs and a shift from the use of diesel pumps to a gravity flow system made possible by elevating the canal at Abyuha. It should be noted again that the economic cost of diesel fuel is about eight times the financial cost. This is one of the main causes for the high economic costs of operating single point pumping stations.

Partial Budget 4 - Summary of Changes

Alternative Economic Evaluation of Mesqa 26

I.	Total Average Added Economic Revenue	L.E.	2,631.08
II.	Costs		
	C. Average Annual Added Economic Costs		
	1. Average annual depreciation	L.E.	298.205[a]
	2. Maintenance	L.E.	141.750[b]
	3. Interest on investment	L.E.	149.105[c]
	4. Pumping cost		0.0 [d]
	5. Other costs[e]	L.E.	440.00
	Average Annual Total Added Economic Costs	L.E.	1,029.06
	D. Average Added Reduced Economic Benefits		
	1. Value of land lost		0.0 [f]
	Total Average Annual Reduced Economic Benefits		0.0
	Added Costs & Reduced Benefits	L.E.	1,029.06
	Net Economic Benefits (Costs)	+ L.E.	1,602.02

[a] Investment costs on Mesqa 26 would be cut in half and a single point pumping station would not be needed.

[b] Maintenance would be mechanized and the cost halved.

[c] Cut in half since investment halved.

[d] Since the area would be served by gravity flow from Abyuha, there would be no pumping cost.

[e] Based on annual economic costs of L.E. 11.00 per feddan for elevating and maintaining Abyuha, interest cost L.E. 2.50, depreciation L.E. 5.00 and Abyuha maintenance cost L.E. 3.50 per feddan.

[f] The net change in cultivated area.

The Net Economic Benefits increase from an economic loss of L.E. 17.67 per feddan (-L.E. 706.74 - Partial Budget 3) to an economic gain of L.E. 40.05 per feddan (+L.E. 1,602.02 - Partial Budget 4). It remains to be seen if costs can be held to the levels presented in Partial Budget 4. It is clear that the MOI must keep economic costs below those experienced on Mesqa 26 if water course improvement programs are to be economically beneficial to Egypt. Based on EWUP's recent experience with alternative designs and construction methods, it is also clear that economic costs can be decreased sharply, probably to the levels presented in Partial Budget 4. However, it is also apparent that a sharp reduction in costs can only be achieved if contractors make certain that construction is consistent with design and that they perform in a manner which will permit cost containment. Accomplishment of these objectives will require that considerable discipline be exercised by the MOI.

Unless full and true economic costs for water course improvements can be decreased below the levels presented in Partial Budget 3, it does not appear that the Mesqa 26 experience supports the idea that water course improvement programs alone will improve economic conditions in Egypt. However, lessons learned from EWUP experience also makes it clear that it is possible to hold down the economic costs of water course improvement projects so that water course improvement programs can be highly economically advantageous to Egypt.

E. An Analysis of Mesqa 10 - Beni Magdul

Mesqa 10 - Beni Magdul was converted to a lined elevated mesqa, designed to be served by a single point pump from Beni Magdul Canal and to be capable of delivering water to the 54.6 feddans by gravity from the elevated mesqa. The improved mesqa became operational in 1982. As it developed, there was often too little water in the tail end of Beni Magdul and adequate water could not be pumped into the elevated mesqa. A new well was drilled with private funds on the mesqa, water was pumped from the drain and an old well at the end of the mesqa into both the old below ground mesqa and the new mesqa during winter closure and during the period of high water demand in June and July. As can be seen in Table 3, there is no evidence from farm records that there has been any increase in yields as the result of the improvement of the mesqa. There were not enough observations to warrant a statistical analysis of the comparison of yield with and without the improvement and of yields between on Mesqa 10 record keepers and either all other record keepers on Beni Magdul or the fields of Mesqa 10 farmers located on other mesqas. The financial yields as well as the physical yields are included in Table 3 since quality as well as quantity of vegetable yields need to be considered.

The farm records also indicate that there is no change in the rotation as the result of the improvement of Mesqa 10 (I-A-1 and I-A-2). The improvement in the mesqa should have resulted in less water diverted to the mesqa since no water is pumped unless the the water is used for irrigation. Previously, water flowed from Beni Magdul through the mesqa

Table 3. The Impact of Improving Mesqa 10 - Beni Magdul (1981/82) on Average Crop Yields Per Feddan for Farm Record Keepers

Years and Years and Data Source and Yield Crops	Farm Records Mesqa 10 Fields		Farm Records Beni Magdul		Farm Records for Fields of Mesqa 10, Farmers Located on other Mesqas b/	
	Physical Yields	Physical Yields	Physical Yields	Physical Yields	Physical Yields	Physical Yields
Leek	K. Cut	L.E.	K. Cut	L.E.	K. Cut	L.E.
1981/82*	181.6	512.7	182.8	589.8	115.4	207.70
1980/81	202.17	570.2	200.2	586.30	138.5	469.20
1979/80	180.4	746.80	180.4 a/	746.80		
Parsley	K. Cut	L.E.	K. Cut	L.E.	K. Cut	L.E.
1981/82*	125.2	431.73	124.5	438.1	161.50	384.6
1980/81	148.2	552.93	146.80	667.20	161.50	630.80
1979/80	205.9	770.60	200.75	716.11		
Cabbage	Head	L.E.	Head	L.E.	Head	L.E.
1981/82*	455.4	383.95	8107	858.8	NA	NA
1980/81	4086.5	402.41	2946	303.40	1530.5	403.90
1979/80	NA	NA	NA	NA		
Egyplant	Kg.	L.E.	Kg.	L.E.	Kg.	L.E.
1981/82*	6000	665.80	4901.6	410.6		
1980/81	7500	541.70	6166	404.40		
1979/80	20,000	1200	20,000 a/	1200		
Berseem long	K. Cut	L.E.	K. Cut	L.E.	K. Cut	L.E.
1981/82*	141.43	612.10	136.54	611.10	144.4	686.10
1980/81	119.2	496.50	129.6	610.80	143.7	642.2
1979/80	120.4	389.00	104.13	438.50	0.0	432.00
Garden Rocket	K. Cut	L.E.	K. Cut	L.E.	K. Cut	L.E.
1981/82*	26.6	200.10	25.93	215.10	24.24	242.40
1980/81	31.30	146.4	29.62	138.50	24.0	110.20
1979/80	31.9	132.23	26.94	192.54	24.4	106.50
Maize	Ardab (bundle)	L.E.	Ardab (bundle)	L.E.	Ardab (bundle)	L.E.
1981/82*	15.6 (719)	262.00	12.67 (607)	202.20	13.57 (640)	223.84
1980/81	13.9 (496)	241.00	11.50 (488.9)	200.75	14.22 (578.5)	249.75
1979/80	14.1 (603)	259.25	10.59 (571.4)	208.11	12.12 (606.1)	222.10
Dit and Corender	K. Cut	L.E.	K. Cut	L.E.	K. Cut	L.E.
1981/82	24.5	208.80	24.04	286.60	24.2	212.10
1980/81	23.9	174.70	24.0	202.03	23.54	196.20
1979/80	47.0	147.06	31.65	233.70	23.80	47.60

a/ Produced only on Mesqa 10 in 1979/80.

b/ Two farmers in this category.

on a continuous basis. However, the farmers did not realize a financial benefit for any decrease in water which flows through the mesqa and though no quantitative measurements of the water saved are available (I-A-3). Originally, it was estimated that 0.05 feddan of the areas occupied by saqias would be added and cultivated as the result of closure of the old mesqa. However, the saqia have been retained and the farmers retained the old mesqa as a drain, as a wider trail, and as a supplement flow of irrigation water during low flows in Beni Magdul. Low flows can supply a saqia, but not the pump at the head of Mesqa 10. Hence, there was no net savings of land as the result of the mesqa improvement (I-A-4). In fact, there was probably a net loss of land as the result of widening the trail along side the old mesqa. These kinds of actions indicate the farmers are willing to incur a cost in order to obtain both better field access and better drainage.

The estimated financial cost of lifting water 0.75 meters with a cow operated 2 meter saqia is LE 25.04 per feddan.[1] The same report estimates that the financial cost to serve the same area using a 5 H.P. diesel pump is to be LE 16.90 per feddan. The area under Mesqa 10 is being served by pumps, including one pump which was associated with a new well developed to provide a reliable source of irrigation water for high valued crops. At the present time this is being done largely because of a seasonally unreliable source of water from the pumps from Beni Magdul. Therefore, it is not possible to sort out the change in pumping costs associated with the elevation of Mesqa 10 from the change in pumping costs associated with a change in the method used to obtain water from added diesel pumps and an added well. It was originally estimated that drain maintenance labor would decrease by 60 man days

which cost L.E. 2.00 per day. Farm records show no change. It was estimated originally that labor required to distribute irrigation water would decrease by 62 percent or by 6,334 hours which were valued at L.E. 0.25 per hour or a total value of labor saved of L.E. 1583.50. The labor rates in the Beni Magdul area increased sharply by 1983. The financial opportunity cost of family labor in the Beni Magdul area is high, but no estimates are available.

The Average Annual Added Costs in terms of financial costs to the farmer or the result of improving Mesqa 10 thus far are zero. It is planned to have Mesqa 10 farmers pay part of the pumping cost, but as of late, the system has not performed well enough to make this practical.

Despite some problems (primarily the need for added gates) the elevated mesqa has been able to deliver water to the farmer for good gravity irrigation once the water gets into Mesqa 10. At the present time, farm records do not indicate any reduced financial benefits to the farmers on Mesqa 10 at Beni Magdul.

The net financial benefits to farmers, as in the case of Mesqa 26 at Abyuha are largely determined by the amount of labor saved, but good labor records were not available.

No partial budgets were constructed for Mesqa 10 as it was not possible to develop good information on the "with" and "without" conditions. While Mesqa 10 was elevated (hence costs of the elevation are available), the work was delayed for a long period and several changes, including a new well, took place during this delay. In addition, the mesqa was not able to perform as the design originally anticipated. However, lessons of considerable value were learned from Mesqa 10; elevated lined mesqas will work. More care must be given to the

placement of discharge gates and the potential patterns of irrigation under the mesqa. Contrary to earlier expectations, farmers feel a need for drainage even though technically, it might be possible to get by without drainage. Farmers need to be consulted during the design process to develop an operational system. The consideration of flows in the delivery canal (Beni Magdul in this case) must be considered. Finally, large single point pumping stations require an adequate supply of water and when the discharge of such a station is high, farmers must be organized to use the water once it becomes available to understand an "on-off" system.

III. SUMMARY AND CONCLUSIONS

Eight principle types of evaluation were presented at the beginning of this report. While most of the explicit evaluation dealt with financial and economic evaluations of EWUP projects, those evaluations had implication for the other six types of evaluations.

1. Accountability: While no attempt was made to discuss this type of evaluation, a good set of records which would permit an adequate audit would also permit the recovery of relevant financial and economic information. For example, it is likely that EWUP accounting and financial records contain enough information to permit a reconstruction of most of the actual maintenance costs for the single point pumping station on Mesqa 26 at Abyuha. No detailed examination of those records was made, but it is clear that the EWUP records contain such information. As mentioned earlier, the ability to perform one type of evaluation will often relate to the ability to perform other types of evaluation.

2. Comparison of Stated Objectives and Accomplishments: If this type of evaluation is to be carried out, criteria and standards must be developed to permit such a comparison. Criteria are value-free indicators of performance while standards describe and define achievable levels of performance corresponding to the criteria. The criteria and standards which existed for the two projects examined in this report were primarily implicit rather than explicit. If such criteria and standards had been more explicit and established in advance of the project work, it would have been easier to establish provisions for collecting and recording the data and information needed for evaluation on a "with" and "without" basis. However, since both Mesqa 26 and Mesqa 10 represented first generation projects which involved significant departures from normal irrigation practices, certain approaches are acceptable which would not be acceptable for second and third generation projects. One of the principle benefits of such first generation projects is to find out what to look for.

3. Comparison of Technical Design with Accomplishment: Several on-site problems for the two projects evaluated developed because of an inability to ensure that construction was both timely and consistent with design. In some cases, this resulted in cost increases and in other cases, it made it difficult to pursue cost containment and cost reduction methods. As pointed out during the discussion of the economic evaluation of Mesqa 26, cost reductions are needed if water course improvement projects are to be economically feasible.

4. Acceptability of Activity by Client Groups: No direct evaluation of this type has been made in this report. However, field work by EWUP sociologists has shown this to be a significant issue. In some cases, dissatisfaction has led to a cessation of construction work until difficulties could be dealt with. Often time delays, lack of understanding of project objectives by farmers and in some cases failure to follow design criteria have caused farmers to question the value of some EWUP work. One of the lessons learned as the result of EWUP work is that explicit attention must be paid to doing those things which must be done to make the activity acceptable to farmers. Among the things which must be done are timely completion of work, minimum interference with the work the farmers must complete (under time deadlines) and an information process which will help farmers understand what the objectives of the project are. EWUP work has also shown that if farmers understand what the purpose of the project is and when a bond of trust exists between farmers and project personnel, farmers will go to great lengths to bring the project to completion.

5. Financial Evaluation of Activities: The financial evaluation of EWUP projects showed that the projects were advantageous to farmers. Contrary to expectations, there was no consistant evidence of increases in yields made possible by water course improvement. However, there was a considerable saving of labor and the financial advantages of a water course improvement project to farmers largely depends on the financial value of labor to farmers. While water dimensions to a mesqa could be decreased significantly, there is no evidence that water conservation is financially

advantageous to the farmers. A great majority of the costs of the water course improvement projects are borne by the MOI. High financial costs severely limit MOI's ability to implement water course improvement projects. There are two ways to expand the MOI ability to implement such projects: (a) implement a cost sharing program with farmers and (b) implement programs and procedures to lower the financial costs of such projects. At first glance, it may seem easiest to implement cost sharing programs. However, for those farmers who perceive themselves as having a low financial opportunity cost for labor, the perceived financial advantage of water course improvement programs is limited. Any significant cost sharing improvised by the MOI would eliminate such financial advantages as perceived by farmers and the project would no longer be acceptable to the farmers. Before implementing cost sharing programs, MOI must pay careful attention to the financial incentives to farmers. It seems apparent that cost sharing should be used as a last resort and not implemented until every effort has been made by the MOI to reduce MOI financial costs by developing efficient designs, construction techniques and maintenance programs.

6. Economic Evaluation of Activities: These types of evaluations are aimed at determining the impact of water course improvement projects on Egypt. Such evaluations need to consider a wider range of interest groups than just the farmers and the MOI. One way to approximate a broader view is to use economic rather than financial values. In addition, economic evaluations can benefit from a longer term view which includes the changes which are taking place in the economy. For example, it seems likely that the relative

economic value of labor will continue to increase. The economic evaluations on actual EWUP projects point out the same basic lessons learned in the financial lessons. For water course improvement projects to be economically beneficial to Egypt, it is important to keep economic costs as low as possible. Once again, this means that the MOI must search for efficient designs, construction techniques and maintenance programs. One of the major differences between financial and economic evaluations involves the economic values for energy inputs which can be up to eight times higher than the financial costs of energy.

7. Integrative Evaluation: No serious attempt was made in this report to link the EWUP projects to national and regional goals although there is no evidence of any conflict existing other than those implied in the economic analysis.

8. Preparation for Follow-Up Work (Lessons Learned): Based on evidence of actual changes for which there is objective information, Mesqa 26 improvements were financially beneficial to farmers, financially expensive to the MOI and of questionable economic value to Egypt.

In the case of Mesqa 10, too little objective information exists to permit evaluation. If Mesqas 26 and 10 were judged to be either "good" or "bad," the results would not be encouraging. However, it would be a serious mistake to reach such a conclusion. Important lessons were learned from these projects and there was probably no other way such lessons could be learned short of actual implementation. Some of the lessons learned from these water course improvement projects are:

1. If the improvement projects provided for a means of increased water control, considerable water could be conserved. At the present time, however, there appears to be neither financial nor economic gains to farmers or the MOI from water conservation. While this may change in the future if water becomes more scarce relative to land, at the present time water conservation does not provide an incentive for farmers to participate with the MOI in such projects.
2. Water course improvement projects which make water available to farmers with an adequate gravity head can result in significant savings in pumping costs (often labor) and labor requirements for water application.
3. Water course improvement projects do not automatically lead to new farming systems which result in increased production. Many other changes must also take place if there is to be a change to a farming system which results in significant increases in production. Water course improvement projects with increased control of water is probably, however, a necessary change if higher production is to be achieved.
4. Based on an examination of both financial and economic evaluations at the MOI level, it is clear that a key to the success of water course improvement projects will be efficient designs, construction techniques and maintenance programs. Costs must be kept lower than those experienced to date.
5. Water delivery and internal access systems must be addressed simultaneously. Since the completion of the Mesqa 26 project, EWUP experience in Abyuha gives some indication of how

important such an approach can be in terms of land conservation, mechanization, the movement of livestock and alternative designs for construction.

EWUP's work has been rich in terms of lessons learned and in terms of a significant increase in the ability to develop a realistic image of "what should be" on the irrigated lands of Egypt. Water course improvement projects based on these images can not only yield results which are highly beneficial to Egypt but also provide a means for a resurgence of Egyptian agriculture.

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

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

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

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

EGYPTIAN UNITS OF FIELD CROPS

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

EGYPTIAN FARMING AND IRRIGATION TERMS

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

EGYPT WATER USE AND MANAGEMENT PROJECT

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