MAJOR CONSTRAINTS OF WATER MANAGEMENT IN EL-FAYOUM GOVERNORATE

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INTRODUCTION

Irrigation System in El-Fayoum Governorate:

The 360,000 feddans which are the agricultural area of Fayoum represent a unique case of fertile soil formation among other agricultural zones in Egypt. Long time ago, the fayoum area was a reservoir of the Nile River water during flood time. The successive floods, years after years, had formulated a good layer of fertile soil composed of mainly silt mixed with the original sandy soil. Ancient Egyptians have accelerated the formation of such soil by making walls of Palm-Date trees to slow down the speed of water stream, in order to protect the soil of the steep areas from erosion. Accordingly, more silt was stayed on the surface of El-Fayoum Agricultural Land.

However, such processes overtime, have formed step-wise levels of plateaus in many areas there. This was, mainly, behind the present complicated irrigation network in El-Fayoum Governorate. In spite of the very fertile soil that suppose to exist in such region, the absence of serious conservation of both irrigation and drainage system (till the last few years) has accelerated the deterioration over time, associated with intensive utilization of the land. Sever fragmentation of the land among very small holdings, due to land reform law made it impossible to have crop zones and/or economies of scale on farm level that would have helped in developing both irrigation and drainage system.

The topography of the area made the irrigation system very complicated. A given canal extends deeply far to irrigate a small remote area while the farms close to this canal are irrigated from a very far canal

or misqa. Drainage of some farms could not be established because the holders have to make drainage canal(s) through the land of other neighbor farms.

Problem Identification & Objectives:

The core of the problem is that there is a deficit between water supply and demand in El-Fayoum Governorate. The government irrigation authorities claim that such deficit is apparently, due to illegal practices by the farmers. They postulate that the farmers insist to irrigate by the day and neglect the nights hours. The farmers postulate that the water supply which is controlled by the ministry of irrigation is not able to be increased. Therefore, the objective of this study is to investigate the major constraints that face the management of water in El-Fayoum Governorate, not only at the farm level but it also extends to deal with it as a complex context.

METHODOLOGY & DATA

The study conducted a sample survey to investigate the water management on farm level. The sample frame was the farmers of an area in the eastern part of the governorate, called "SEILA" of 9,200 feddans. It was selected because it represents a profile of all irrigation problems in the region. The available reports and studies were consulted. The staff of the related governmental offices in the governorate were also interviewed through panel discussions. A purposive survey was conducted to test the hypothesis if there are farmers who lift underground water to get a supplementary water source. Although it is a diagnostic study of a positive approach it, also, has a normative theme in terms of a set of empirical recommendations.

Investigated Factors Affecting Water Management Practices:

The study's survey and interviews focused upon the following factors and aspects to be investigated:

(1) Physical system constraints which included major constraints at macro level and physical factors-related problems as identified through farmers view; (2) Farmers knowledge and information constraints and (3) Socio-ecnomic factors which includes areas of cooperation and areas

of conflicts among farmers for water management, role of water availablity and quality in farmers decisions for identification of cultivated crops and cropping pattern by season.

Sampling Technique:

The sampling technique was a multi-stage cluster random sample. It composed of three stages. Each one reflected certain criteria that fit the purpose of the survey. From a pilot cropping pattern survey of "SELLA", it was possible to classify it into 13 regions, as rectangular stripes, from north to south. The proportion of the land under fallow in each region (R) was detected. The fallow area ranged from 19% to 45% between regions. The administrative sites (villages....etc.) were located on this cropped-area map through another field survey.

First stage: The criteria of this stage were the proportion of land under fallow in the region (R), which may reflect relatively, the lack of water supply, irrigation facilities and soil fertility. This stage included 3 clusters. First cluster: Regions of a low proportion of fallow land (between 19% to less than 30%). Second cluster: Regions of medium proportion of fallow land (between 30% to 40%). Third cluster; Regions of a high proportion of fallow land (above 40%).

Second stage: The criteria of this stage expressed the geographic location (North, Middle and South regions) as well as the relative importance of the cropped acreage within each cluster of the first stage. Accordingly, six regions were selected as shown in Table 1.

Third stage: This stage concerned the selection of the farmer under the second stage to represent their farms location from the irrigation canal. Therefore it included two clusters. First cluster: farms are irrigated from a "Misqa" (final canal) branched at the beginning of a secondary irrigation canal. Second cluster: farms that are irrigated from a misqa at the end of a secondary canal. Three farmers were selected under each cluster of this stage. The total sample size was 36 farmers.

Table (1): Sample stages and clusters from the target site.

Proportion of the land under fallow	Selected regions on geographical base		
	North	Middle	South
Low	-	$R_{(6)}$	$R_{(12)}$, $R_{(13)}$
Medium	$R_{(1)}$	-	$R_{(11)}$
High	-	$R_{(4)}$	-

R = The region within the target area "SEILA".

PHYSICAL SYSTEM-RELATED CONSTRAINTS

Major Constraints at Macro Level:

Four major constraints are controlling the whole system and make all current management policies to reform the efficiency, (to provide sufficient quantity of water for the area by crop in proper time) not significantly effective. These four physical constrains are:

Authorized quota Vs.actual quota (water supply): The water distribution is conducted in Fayoum Governorate according to the area cultivated. Seila is the main discharge point (Nasbet Seila) of the area concerned. It is to the south of the area of study. The discharge quota is at 30 cubic mater per feddan per day to the stream of the main canal and, then, to the secondary canals. The water level in the canals of the last year is taken as a guide for the current year.

Usually, there are complains from the farmers about getting the proper requirements. The authorities give response to some and have to ignore others. According to the data available during the sample survey the comparison between the actual and planned discharge of water in Wahbey Canal, the main canal (Bahr) which feeds Seila Canal, during the period January to May, 1991. It was shown that the actual discharge is less than the planned discharge as shown from Table (2).

Table (2): Planned VS. actual water discharge in Irrigation Cansls

	January	Feb.	March	April	May
Planned discharge (m^3/sec.)	13.9	15.15	17.53	17.16	15.66
% (Actual/Planned)	85.5%	87.4%	76.4%	79.9%	86.9%

Source: PWMDIP - Monitoring reports.

It is the result of a test made each 10 days, by measuring the actual discharge as cubic meter per second.

The conclusion is that the water distribution is according to norms for each feddan, in spite of the variation in actual cropping pattern and/or soil fertility.

The current policy does not consider the seasonality (summer requirements VS. winter requirements). From table (2), "May", suppose to be the month of the highest discharge because of the high evaporation rate and loss of water, but March is the month of the maximum discharge. This is because of the national sensitivity of the responsible people towards cotton as a crop of political interest. This high response to increase the water discharge at cotton cultivation time encourages the farmers to expand its area.

Limited capacity of the "KAROUN LAKE" for the drainage water: This is the most effective constraint. The Ministry of Irrigation is unable to increase the water level in main canals to provide adequate water for farms requirements because of the limitation of the lake capacity.

In some years when the Ministry delivered more water in the canals there was a flood in the lake. The water level in the lake flooded and dumped a significant area around the lake and damaged such area and crops on it.

There is an option currently under experiment. It is to make the drainage of excess irrigation water as an extra source for irrigating adjacent

desert land to the east of the governorate. About 15,000 feddans are cultivated snow under supervision of the Ministry of Agriculture. However, there would be some negative environmental externalities. These externalities stem from the expeced increase of salinity rate of the soil context in these areas over time which is a major constraint of the existing area. Obviously, this constraint is behind the conflicts between the farmers and the Ministry of Irrigation. The Ministry can not reply the requirements of the farmers to increase the water delivery beyond the current level because of the drainage constraint. Therefore, it is postulated that the fartmers management of the given supply of water on field are not rational.- They postulate that the attitudes and social behavior of the farmers community towards such common property resource (irrigation water) are not satisfactory.

There is another proposed alternative, which is to study a new escape for the lake with Rayan Low Land to have extra destination for excess drainage water. All these approaches are in need of funds beside the investigation of the expected negative environmental externalities.

It seems that the governmental authorities understand that the major constraint is the limited drainage destination, which makes it difficult to raise the water discharge in canals. The evidence for that is the drop and cancellation of several penalties that should be paid by farmers who violated the irrigation rules. It means that they recognize the shortage in water supply, which may dictate such violations.

High salinity of both water and soil context in Fayoum: There are evidences that the irrigation and drainage problems caused high salinity of both water and soil context. Groundwater level in Fayoum are very high. In Seila Pilot Area it reaches up to 30 cm below the soil surface (FWMDIP Tech. Rep. 4,5,6). The salinity of the groundwater is 16 ms/cm in 60% of the area. Mixing of irrigation water with drainage water causes such high to medium salinity of ground water. Currently, the water of (El-Batts) drain which is located in the western side of the pilot area (Seila) is used for being mixed with regular irrigation water for increasing water supply. Table (3) shows the salinity estimate of the water mix.

Table (3): Salinity of the drainage water & regular water mix.

Type of water	% in Mix.	Salinity p.p.m.
Drainage water	23.5%	1485
Irrigation water	76.5%	365
Aggregate mix	100 %	627

Source: FWMDIP, Tech Rep. 4,5 & 6.

Layers of accumulated salts are found, usually, below 1.40 m of the soil surface. Most of the Seila Pilot Area soil is light to heavy clay and some loamy layers are found within drainage depth. These features of the soil decrease its permeability which, in turn raise its salinity.

Need for irrigation network maintenance and lack of funds: The current network of irrigation system in Fayoum requires maintenance to improve the irrigation efficiency. However, there is a sever shortage in funds to finance the required maintenance scheme. The government budget suffers from deficit. Therefore, there are priorities in allocation. A foreign financial source should be convinced,to finance such maintenance processes.

Physical Factors-Related Problems as Identified Through Farmers View:

From the official point of view, there is a dominant postulated assumption that the farmers are miss-using the allocated water quota for their fields and they are not cooperating in utilizing the available water efficiently. The sample survey was designed to investigate the farmers attitudes and traditions concerning water use, as well as the problem identification from their point of view. The proposed solutions by the farmers were also investigated.

The problem are identified according to two ways of classification (a) according to the frequency distribution of Ithe farmers in the sample (Table 4) and (b) according to the sample's regions.

Problems identifications according to the frequency distribution of the farmers answers:

1. Land taken for urban use: The water is allocated on base of area holding. However, a significant proportion of agricultural land has been taken over time for urban use and infrastructure construction. Even though such area is still recorded as agricultural land, which is accounted in water discharge allocation. Accordingly, such regions or holdings receive excess of water beyondtheir requirements, at the expense of others whose farms are suffering from deficit in water supply.

2. Seasonality of water shortage: The deficit in water supply occurs, only, in summer, particularly, from mid. of May to end of July. In winter there is surplus of water above requirements. The problem's magnitude deceases from August when the irrigation of cotton field stops.

3. Some "weirs" are broken or blocked by farmers and some "Gessr Bank" are opened.

4. Location of the Misqa: The Misqa located at the end of the irrigation Canal (Primary Canal) receives the residual of the other "Misqa" at the beginning of the Primary Canal.

5. Water quality: Mixing the pure water with drainage water increases water salinity and soil salinity which, in turn, requires leaching of alt with excess of water, i.e. magnifies the water eficit problem.

6. Social prestige of the formers: Some farmers have power to affect the decision of the man who is responsible for water distribution at village level (Al-Bahar). Therefore, they get more than their quota and even they canal the penalties due to violations made by the farmers.

7. Deficit in water delivery: Violations of the irrigation rules by the farmers are results and not causes of water deficit. The farmers violate the quota and time schedule regime because of the original shortage of water delivered by the Ministry of Irrigation.

8. Mising dnairage water with regular water: Although the farmrs are aware of mixing the water of drainage with regular water for irrigation, some of them, whose farms are located at (E) Batss drain are lifting its water for direct irrgation.

9. Selling water: There is a current limited market for selling water, due to problems (1) and (4). Table No. (4) provides the frequency distribution of the farmers answers about the problem identification as indicators for the weight of each dimension of the problem.

10. Arbitrasy irrigation schedule among farmers: The survey showed that the farms(150 feds.) which are irrigated from a Mesqa called "Al-Bardia" located at the end of the main canal (old Rodda) has a quota of 2 hrs feddan. recieve only 80 months/feddan. The farms at the end of the mesqa with 30% losses. They probably, will get water enough only for on-half or two-thirds of their farm. Therefore, the farmers recommed to re-schedule the water distrubtion system among farmers on a base of successive location of the farms, i.e. the first turn for the farm at the beginning of the mesqa, followed by the one next to it...etc, up to the last farm at the end of the mesqa secondingly, the loss in water will be distributed equally among farmers.

Table (4): Problem identification of water use in Fayoum according to frequency distribution of farmers answers.

Code of the problem *	No. farmers (Observations)	Relative frequency of farmers answers
1	14	40%
2	35	100%
3	14	40%
4	11	30%
5	9	26.6%
6	21	60%
7	14	40%
8	11	30%
9	7	20%
10	35	100%

* Problems definitions under the some cades are shown under the preceeding section.

Underground water as supplementary source for irrigation: As shown in the section of sample survey, an additional purposive survey was made to identify a number of farmers who are using underground water as supplementary source for irrigation. None of the farmers in the pilot area (Seila) are using such source. Raising such inquiries among the interviewees of the sample survey result in the following answers shown in Table (5).

Table (5): Reasons of not using underground water for irrigation.

Reasons	Frequency Distribution
1. They heard that it is very salient water.	23.3%
2. They tried but it was not founded at depth up to 40 m, because the underground layers are of rocky context.	50.0%
3. They heard historically that the underground water is not entirely available in this area.	26.6%

Farmers attitudes towards drainage sub-system: Table (6) presents the farmers attitudes towards three major issues of drainage subsystem and its impacts on water management on field.

FARMER'S KNOWLEDGE AND INFORMATION CONSTRAINTS

All farmers of the sample had proper knowledge about irrigation management on farm. They summarize their experience as follows: "Proper distribution of water all over the field surface. No dry land and no dumping of water on hand. Optimum time of irrigation is determined by the plant growth and morphology". Accordingly, their irrigation knowledge is not a constraint efficient water use.

However, they raised three major issues (a) 83% cited that land levelling of each plot of the farm is important to get optimum irrigation efficiency. They do that by themselves. (b) 13% of the farmers cited that Fayoum

Table (6): Farmers attitudes towards drainage subsystem.

Farmers attitudes	No. of farmers	Relative frequency
Covered drainage:		
1. It is required for all area	19	55 %
2. Its life span is short.	6	16.6%
3. It is needed only for isolated or remote plots (without drainage outlets).	35	100%
4. There is no problem with current network*	11	33%
Disconnected plots:		
1. Self-reliance solutions: holders buy a pass hrough neighbors fields to make their own drain	7	20%
2. The rest of the holders fail to make such agreements. They feel that covered drainage is the only was to find drainage.	18	80%
Drainage in irrigation canals: This current system is common which causes deteriroration in water quality and land productivity of the farms that reeive such water.	35	100%
Open drainage subsystem:		
1. Loss in significant proportion of land.	11	33%
2. Loss in large proportion of water.	11	33%
3. It dictates to move the inner drainage canal** from one plot to another overtime.	1	33%

* These formers have a significant proportion of land under fallow.

** In order to prevent salinaty of soil.

land topography is not suitable for lazer leveling technique. They added that the land leveled with lazer has shown an increase in water table level and has not been productive any more. (c) 100% of the farmers cited that the current irrigation time schedule is the main limiting factor for irrgation decision rather than the plant's growth curve in Fayoum.

SOCIO-ECONOMIC FACTORS

Areas of Cooperation Among Farmers and Water Management:

There are four areas of cooperation among farmers for water:

Irrgation date and timing: The National Policy for regulating water management has been recently, changed where the constant water charge in the canal is left continuously by the day as well as at night. It is assumed that the farmers are missusing the water by competing for irrigation by the day and neglecting the irrigation during night hours. Accordingly, the irrigation responsible postulate that the water deficit is only during the day hours and the canals are full of unused water at night, which is wasted to the drainage destinations.

The sample survey showed that there is an INHERITED TRADITIONAL SYSTEM THAT HAS THE POWER OF A LOW. THIS SYSTEM DETERMINES THE TURN OF EACH FARMER (FOR IRRIGATING HIS FARM) AMONG HIS NEIGHBORS SHARING THE SAME "MESQA". The system determines not only the quota of water (time-wise, e.g., 30 minutes per feddan) but it also, determines the date of the onset of irrigation within the week. This date is fixed and can not be changed even, over successive generations. However, the farmer at such specific date is free in either using the water for irrigating his farm or to leave it (voluntary) to his neighbor or relative whose farm is using the same "Mesqa". Therefore, the postulated assumption that all farmers prefer to irrigate their farms, only by the day hours and not at night is bare form truth.

Maintenance of the mesqa: 100% of the farmers cited that there are a traditional commitment among them to share in the maintenance of the

Mesqa. The farmer with the largest holding that is irrigated from such "Mesqa" leads the maintenance operation and takes the role of coordinator among farmers. Usually each farmer is responsible for the maintenance of the proportion of the canal that is passing by his field.

They have full awareness towards the benefits of maintenance. All interviewees of the survey cited that maintenance and cleaning up of the esqa would help much in fair distribution of water among farms and makes (with support of other management factors) the water share of the holdings at the end of the mesqa compatible to the others at the beginning of the mesqa.

All farmers of the sample cited that maintenance is usually manual. They all participate, however, if some one has not share in maintenance, other neighbors take his part voluntary.

On the other hand the visual observations of the research team detected poor conditions of most of the side canals, particularly". The Ganabia(s)" e.g., "The side canal" at the front of "Southern Seila Canal (Bahr)" which is also called "Bahr Latta" that is located within the agronomic zone No. 12. The weeds are intensive in large proportion of the canal. It seems that the implementation of what farmers believe-cleaning mesqas - is conducted. But the side canals (Ganabias) are ignored which suppose to be the responsibility of FID and may cause the following negative externalities: (a) Intensive weed growth in the canal stream causes much loss in water due to consumption of the plant and evaporation through the green surface of these plants (weeds). (b) There will be a partial obstruction of water stream along the canal. Truely, such factor causes a side diffusion of water from the canal, particularly that most of these canals are adjacent to drains. It also causes. Less water will reach the farms at the end part of the canal within the quota of the time schedule allocated for them.

Exchange of trading the surplus water-quota among farms: The types of cooperation among the farmers, in using the excess of water during a certain time, are presented in Table (7). They are attitudes to minimize losses and maximize benefits of the water allocation. It seems that there

-re, generally, four different options of cooperation in this concern. Water transfers to neighbors, which means that the beneficiaries have not to return that they got from their neighbors. The Brotherhood attitudes, where the transfers are limited only within relatives of the farmers. Lending (Exchanging) excess water to be refunded when the donor is in need of water for his own farm. Selling (purchasing) excess water, particularly, during critical times of shortage, e.g. during tomatoes season.

Table (7): Areas of cooperation with respect to using water excess.

Attitudes of cooperation	Frequency	
	Absolute	Percent
1. Water transfers.	18	50%
2. Attitudes of Brotherhood	23%	66%
3. Lending water for a certain time.	18	50%
4. Selling (purchasing) of water.	7	20%

Areas of Conflicts Among Earmers and Water Use:

Three sources of conflicts are detected from the survey.

The weirs are broken (stealing water): This action is taken, sometimes, y an individual farmers (50% of the sample answers), or is taken by a group of farmers. (cooperation in wrong direction), as cited by 33% of the sample. If the farmers know the individual farmer who made such action they notify, either the police station or the mayor (Sheikh Al-Balad). The one who had broken the weir would be punished by paying a monetary value as a penalty. If he made it for a group of farmers they bare voluntary the penalty for him. Sometimes, the group of farmers who get benefits from this action hide the name of the farmer who made it and they accept to pay the penalties as a group, without mentioning his name (18% of the sample answers). It seems there are a common role among the farmers. They say "Brake the weir for your group and we pay the penalty for you". The penalty value goes to the Ministry of Irrigation without any compensation for the farmers whose farms are hurted due to the broken weir..!!".

Illegal agreements with "Al-Bahhar": "Al-Bahar" is the man who is responsible for supervising the proper implementation of the water management in the village among the farmers. He has to notify the government offices about any violation of the regulations or any conflicts concerning irrigation schedule and/or any damage to the irrigation network or infrastructure. However, 80% of the farmers of the sample cited that illegal agreements are made between some farmers and El-Bahhar or even higher rank employees 3% of the farmers mentioned that tips are paid in different forms to those people. Why do they pay tips?. The employees can not raise the water in the canals. However, they can close their eyes when they detect he action of breaking the weirs by someone. Such employee has a rule in this concern" you brake the weir and pay me, then I do not see..". The tips are usually provided in kind rather than in monetary terms and under he name of gifts.

Pressure groups: The farmers of social power are able to violate the irrigation rules and/or receive illegal remissions. 60% of the answers of the sample cited that there are strong farmers that have powers to violate the rules of water quota and schedule without being punished or stopped. hen they raise there requests to get more water for irrigation they get positive reply from the irrigation authority. This unfair treatment made the other farmers to be more aggressive and brake the weirs and open the banks as the only way to get enough water.

Role of Water Availability and Quality in Farmer's Decision for Identification of Cultivated Crops:

This part is devoted to identify the factors affecting the decision making in identification of cultivated crop by season. The analysis, according to farmers answers, includes the major crops, either in winter or in summer. Under each crop the analysis shows the major factors that affect the farmer's decision to cultivate a given crop, according to the frequency of their answers. Water availability is one of these investigated factors:

Winter season: The presentation of the analysis was provided in Table (8) for major winter season crops and Table (10) for major summer season crops.

Table (8): *Factors affecting farmer's decision in cultivating winter season crops.*

	Determinant	Relative frequency %		
		Wheat	Berseem	eans
1.	Irrigation water availability.	0.0	0.0	0.0
2.	Profitability.	18.0	6.6	80.0
3.	Consistency with neighbors acreage.	14.8	13.0	0.0
4.	For home consumption.	81.5	*	20.0
5.	As a main feed for liverstock	7.0	73.0	0.0

* Not applicable.

It should be mentioned that Table (8) shows that water availability is not a limiting factor for winter crops or at least is not taken into the decision making for the selection of cultivated crops. This result reflects the excess available irrigation water in winter that is more than the existing cropping pattern. On the other hand, although the weight of profitability in decision to cultivate berseem is apparently low it is implicitly, high if we consider the fact of liverstock-feed response. Actually, berseem is profitable as feed converted into meat and milk. The 6.6% answers cited explicity that its profitability is a factor behind cultivating berseem is, in fact, reflect the percentage of farmers that have excess of berseem production for sale (Ibrahim Soliman & S. Imam, 1989). Actually, berseem as a main feed livestock on farm has a weight 73%. In spite of the current policy aiming at to raise, significantly, the wheat price and its market has being left free, the Home-Consumption is still the major factor that determines the wheat, i.e., 81.5%. Also straw production has a significant effect on the decision to cultivate wheat because straw is an important source of roughage-feeds (7%). It should be mentioned that barley is also a winter crop in Fayoum but its acreage share has a fourth relative importance after the three crops presented in Table (8).

Summer season:

The four major crops in summer are cotton, summer maize (white broad corn sunflower) and rice. Table (9) shows the major factors that determine the decision making in cultivating those crops.

Table (9): Factors affecting decisions to cultivate summer crops.

	Determinant	Sunflower	Cotton	Maise	Rice
		..... Percentage			
1.	Irrigation-water availability	50	5	90	100
2.	Agricultural rotation quota	0.0	100	0.0	0.0
3.	Profitability	85	10	60	40
4.	Consistency with neighbors acreage	0.0	0.0	25	20
5.	For home-consumption	0.0	*	80	80
6.	As green fodder in summer	0.0	0.0	90	0.0
7.	Soil characteristics	85	0.0	50	0.0
8.	Type of land holding	15	.0	0.0	0.0

* Not applicable.

It seems that in summer, the water availability is a major determinant of the area of all summer crops, but at different magnitude. For rice it has absolute importance in determining the acreage of rice (100%), and it is the first factor affecting the decision of cultivating maise (90%), and it is the second factor (50%) after the soil characteristics that determines the sunflower area. For cotton, the induced abundant water supply in March by the government, is an incentive to cultivate cotton, but after that the farmers have to leave some land as fallow to provide the water requirements for cotton and rice.

Land allotment by Ministry of Agriculture is the first factor determines the cotton cultivation because it is, actually, not the farmer's decision, probably, he violates the planned area to keep part of it for berseem.

For other summer crops they are now according to the farmer's decision.

To cultivate maize is mainly determined, after water availability factor, by home-consumption, as corn is a household subsistence food. The farmer requires, also, to keep part of the area of Maize as green maize to cover, partially, the scarcity of green fodder in summer. But green maize is a rational decision to minimze the risk of not getting enough water, particularly, in June and July. The farmer chooses to cultivate green maize as the best alternative decision versus leaving such area fallow. If the water was not enough it would, only, determine the duration of green maize on land and its yield level but it would have not come up with none output, in comparison with fallow land.

Profitability, is the major factor behind cultivating sunflower. It is a salinity tolerant crop and bares less irrigation water. Cultivating rice is a decision (similar to the maize), highly determined by home-consumtion requirements. However, profitability of maize and rice (after current free market price policy), has a significant impact on the decision to cultivate them, in comparison with cotton where profitability has not high weight in the decision of cultivating it. Share crop tenant is a preferable pattern for cultivating sunflower, because it is profitable.

Cropping Pattern and Profitability by Season:

From the sample's data it was possible to estimate the relative frequency of the farmers who cultivate each crop in the year 90/91. The sample data, also, provided an estimate of the area under fallow as an indicator for the scarcity of water in summer.

Land under fallow: The impact of water constrain on cropping pattern is mainly in summer season. Such impact is expressed in terms of the area left fallow in summer, particularly, during the peak of water shortage, i.e. in June and July. The survey, date was in June, therefore it was ossible to detect, from the surveyed holdings, the actual average fallow proportion during summer. The profile of the area under fallow showed that the total area under fallow was 24%, of which the permanent fallow area was 6% and the temporarly fallow area was 18%.

The permanent fallow is due to the soil characteristics, i.e. it is under reclamation and washing (ACID LAND). The temporary fallow are lands uncultivated because of the lack of water. Therefore, the farmer uses the available limited quota of water to fulfill the requirements of the highest profitable crops. The fallow land proportion decreases in areas looking over "Batss Drain" and at the beginnings of the main cansls, where the fallow proportion reaches 5-6% while it reaches 30% in the areas at the end of the main canals.

Cropping pattern and profitability: The surveyed farms provided useful data about the frequency (percentage of farms) of each crop among the total holding numbers of both winter and summer season. The frequency of each crop, in fact reflects the aggregate result of the farmer's decision which is affected by a set of factors. The importance of these factors in formulating the cultivation decision was analyzed in the previous sections. Table (10) shows the relative frequency of each crop by season. The same table presents the revenue, costs and profits per feddan as averages estimated by surveyed farmers.

In winter, perseem is the most profitable crop and almost all farmers cultivate perseem, probably the little percentage that are not cultivating perseem are those holdings without liverstock.

Although broad bean is more profitable than wheat, only 20% of the farmers cultivate it. It is because the area of wheat for home consumption and also probably because of the market demand volume, where other governorate are of higher productivity of bean than Fayoum.

In summer the high frequency of cotton is mainly due to the land allotment by Government Policy, which is now restricted to only cotton and rice.

Maize cultivation is mainly determined by home-consumption requirements, because it is still of the lowest profitability among other summer crops. Although rice is of the second level of profitability among summer crops, after sesame, its frequency is very low. It is the water constraint that makes rice cultivation is risky and at the expenses of efficient land use, i.e., it needs to expand the land under fallow to save water for rice.

Table (10): Relative frequency of each cultivated crop.

Crop by season	Percentage of holdings with the crop	Revenue	Costs	Profit
		L.E. per feddans		
WINTER SEASON				
- Berseem	93.3	1000	100	900
- Wheat	90.0	1120	312	808
- Broad bean	20.0	960	100	
SUMMAR SEASON				
- Cotton	26.6	1300	700	600
- Maize	26.6	822.5	250	72.5
- Rice	16.6	1300	350	950
- Sunflower	50.0	950	220	730
- Sesame	10.0	1260	240	1020
- Denaba	10.0	900	100	800

Sunflower is a promising crop in the governorate. Its costs are less, easy to cultivate, resistant to diseases and infections, and finally occupies the land for a short duration.

As more important advantages, it is salinity resistant and its water requirements are not much. It is successful even in low fertile land. The Village Bank encourages its cultivation by providing loan at L.E. 150 per feddan. The time of financing sunflower by the Village Bank is that time where the farmer's budget is lacking of liquidity within May - August during growing maize. The farms of crops sharing tenant pattern is preferring to cultivate sunflower.

Sesame is also, a promising substitute crop for sunflower. It is of the highest profitability. However, it succeeds in the southern regions of the study area, because it requires a better soil than that required for sunflower.

"Denaba" is cultivated as a green fodder in summer, where there is a sever shortage in fodders. It is successful when there is a need of washing salient and acidic land, but water availability is a limiting factor (as rice) for the expansion in its area on farm. It should be mentioned that the area of the study is almost the worst area in the Governorate. Accordingly, cultivation of vegetables is very limited, because of poor land and water supply.

A COMPREHENSIVE MODEL FOR WATER MANAGEMENT RELATIONSHIPS

It is concluded from the study's analyses that water resource for in Egypt is considered as a public resource, where the state control its use among alternative uses through a central planning concept. The government provides such resource for irrigation without any charge paid by the farmers. The theme of the policy is to secure a sufficient water for all crops requirements on all fields. However, this policy ignores the economic concept. Such concept postulates that water demand for irrigation is derived from the primary demand for agricultural production in terms of area cultivated. Inputs applied and yields of crops. The farmer as the customer of such water is at the demand side. His decision stems from the comparative profitability of the crops. However his farm budget is free from any economic weight for using irrigation water. Therefore the price mechanism is not working in the direction of adjustment between water delivery and water requirements. Although this is an inherent problem facing agricultural policy in Egypt it will be more critical problem under the liberalization of agricultural sector from governmental intervention in production decisions. The result is a sort of "Market Failure", where the beneficiaries (the users of the water resource) get the whole benefit (agricultural income) without sharing in the costs of using such scarce input and the donor (the government) bares the total cost of such resource. The study simulate this interrelationships through the conceptual model in figure (1). The model shows that on the water delivery side (supply) the technical efficiency is the ultimate target affected by the water management on macro level, while the economic efficiency is the ultimate target of the water management on farm level.

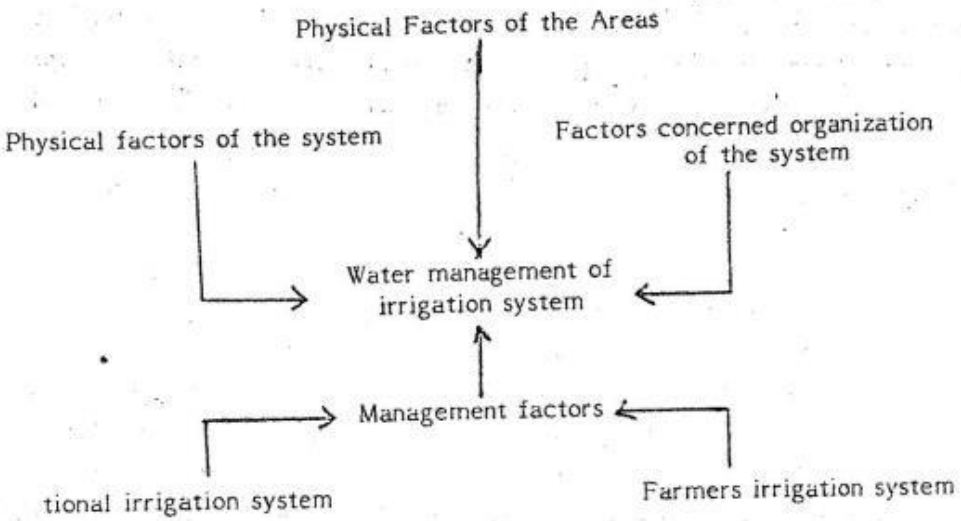

Fig. (1): Water management of irrigation systems

RECOMMENDATIONS AND POLICY IMPLICATIONS

The irrigation schedule of the farm level is traditionally inherited regème. Each farmer inherits the date of irrigation for his farm within the week. Therefore, the postulated assumption by the irrigation staff, that the farmers insist to irrigate by the day and heglect the night hours, is not true. The farmer receives water on his turn within the schedule, either by the day or at night. He has the rights to postpone his turn (His quota of water to a relative or neighbor farmer, voluntary). However, in winter the total supply of water exceeds the demand. Therefore, the farmers are rationale when they violate the given schedule and irrigate only by the day and ignoring the night hours, because the excess of water during the day hours would be lost in vain if they have not used it.

The farmers, sometimes, follow illegal practics because of the defecit between water delivery and requirements in summer, particularly, in May and June. The water delivery is not able to be increased, because the water discharge in the main canals is controlled by drainage capacity

of the "Kroon lake" over discharge of water results in flooding of the lake and damage of the adjacent agricultural area.

Therefore, in lights of the study analysis and output, a set of empirical recommendations are concluded. These are:

1. To complete the covered drainage network.
2. To establish an escape for KAROON LAKE and RAYAN-LOW-LAND to add external drainage capacity if it is feasible.
3. To approve additional funds to finance the maintenance program of irrigation canals, mesqa and associated infrastructure.
4. To encourage the current attitudes of the farmers towards changing the cropping pattern as self-solutions of the water deficit problem. 50% of the farmers cultivate sunflowers of low water requirements and salinity tolerant with high profitability. 10% cultivate sesame for the same reasons.
5. To use salt tolerant varieties of crops, particularly Green Fooder as alfaalfa and summer fodder, as well as other crops. Plant Breeding researches with Bio-Technology should work hard in this concern. Rice area should be vanished as a crop of high water requirements.
6. To avoid the current market failure in water market, the farmer should consider some costs of water in his budget when he takes the cropping pattern decision. This issue should be considered seriously with the current Era of librelaization of Egypt Economy. This issue has been frequently, investigated but it is not recommended for short-run to let the farmer pays the economic price of water. Even if it is decided to let him pay a reasonable cost for water, it will be not possible under the current surface irrigation system.
7. Re-formulation of the irrigation water balance on monthly requirements is needed. Such balance should be made in lights of a planning model that simulate the models shown in Figs. (1) in the text, which presents the frame-work of the irrigation aspects.

The model should not be a mathematical exercise. The diversification of the regions in terms of Topography, Soil Characteristics drainage and irrigation network conditions should be reflected in the model associated with the most technically feasible crops at the actual yield by region and by season. The model should be under the assumption of free market policy even with respect to cotton and rice, because this policy is currently, the theme of the Egyptian Economy. However, the water charge could be rationalized, under current conditions. The study showed that, even, the planned water charge is less than the actual charge. The ratio is between 76% to 87% between months. In addition to that there is an excess of water in winter, could such excess be transformed to summer?

8. Re-scheduling of water distribution among farmers:
To take the irrigation schedule among farmers on sequential base, i.e., to make the farmers irrigate their farms according to their successive location of the mesqa. Accordingly, the farms at the end of the mesqa will not to bare all losses along the mesqa.

9. In many locations it was noticed that efforts for land reclamation as well as construction works are progressing, thus the command areas of canals and mesqas are affected. Therefore, an accurate survey should be conducted to identify the newly reclaimed lands within the governorate which is a cause of the current deficit between supply and requirements on farm level.

10. It is recommended to work towards creating a new water management system, where the farmers would participate through associations at several levels within the governorate. These associations would consider not only the decision making, but also, allocate the total costs of water distribution between the government and farmers.

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