EXCHANGE OF IRRIGATION WATER BETWEEN FARMERS IN EGYPT

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ABSTRACT

Some forms of water trading are practiced between farmers in Egypt to get an efficient and flexible mechanism to allocate water than administrative means. A Study of such practice was conducted in order to find its impact on water management, water conservation and crop production.

This study has included two areas, where informal water trading is practiced. The study included also two different water resources, surface water in Fayom and groundwater in Farafra Oasis. A questionnaire was prepared, and two focus groups were held, one in Fayoum and the other in Farafra. The questionnaire has covered all aspects relating to water resources water rights, land holding, gender issues, institutions and regulations, and social customs … etc. The farmer s sample was 114 persons, of which 56 from Fayoum and 58 from Farafra.

The paper presents data and information obtained from the questionnaire and the actual water trading practiced in the study area. Conclusions showed that water trading has positive impact on water conservation, increased crop productivity and help to minimize water distribution disputes and conflicts among farmers. It proved that trading was not based on money in the study area

INTRODUCTION

Developing new approaches to water management in the country is important due to the high rate of population growth and the role of economy that are causing increased agricultural, municipal, industrial and tourism water demands from limited supply. Special attention is being given to enhance the benefits returned from each cubic meter of water used, measures deal with deteriorating water quality, and promote further increases in efficiencies of water allocation and utilization.

Informal water trading usually begins when maximum efficiency from limited water resources is required . Typically such informal trades consist of farmers making some economic arrangement for trade or transfer an amount of ground or surface water for a period of time to neighboring farm or town. An exchange of water can provide permission to use a specified amount of water, and this might be more flexible and efficient mechanism to allocate water than administrative means.

Fayoum and Farafra Oasis were selected as two examples to provide information on water trading and water use exchange practices that could be worth for study and evaluation. Evaluation of these practices can provide information for developing more efficient water allocation methods and for designing potential economic instruments that may help to address Egypt's current water management challenges. Figure 1 shows the location map for Fayoum and Farafra.

The main objective of the study is to conduct an assessment of the existing water trading practices in Egypt, based on examples from Fayoum and Farafra Oasis. This will include and cover the following topics:

- Description of the catchments in order to expand the understanding of the available water resources, existing infrastructure, irrigated area, cropping pattern, delivery system and scheduling, and regulations of the irrigation system.
- Investigation and presentation of the existing water rights or quasi-water rights.
- How and when water is traded?
- Identification of the institutional and regulatory framework as well as social aspects.
- Impacts of these practices on water use efficiency, fairness, and social disputes.
- Design and prepare a questionnaire and conduct two focus group meetings one in Fayoum and the other in Farafra Oasis.
- Analysis of the results, and presents conclusions and recommendations.

CONTEXT OF WATER MANAGEMENT IN FAYOUM

1. Overview

Fayoum is a depression in the Western Desert, some of 100 km to the South West of Cairo. The climate in Fayoum is arid and characterized by hot dry summer and mild winter. The area of Fayoum is about 2000 km^2. Population of Fayoum is 2 million. Rainfall is limited and ranges from 10 to 20 mm per year. Evapo-transpiration is about 1952 mm per year.

2. Irrigated Area

Although Fayoum is considered as an oasis, but it is supplied with water from River Nile through Bahr Yousef Canal that branches from Ibrahimia canal. The total irrigated area is about 0.4 million feddans. New lands have been reclaimed along the fringes of the basin. This has resulted in the increase of the drainage reuse in order to meet the increased water requirements.

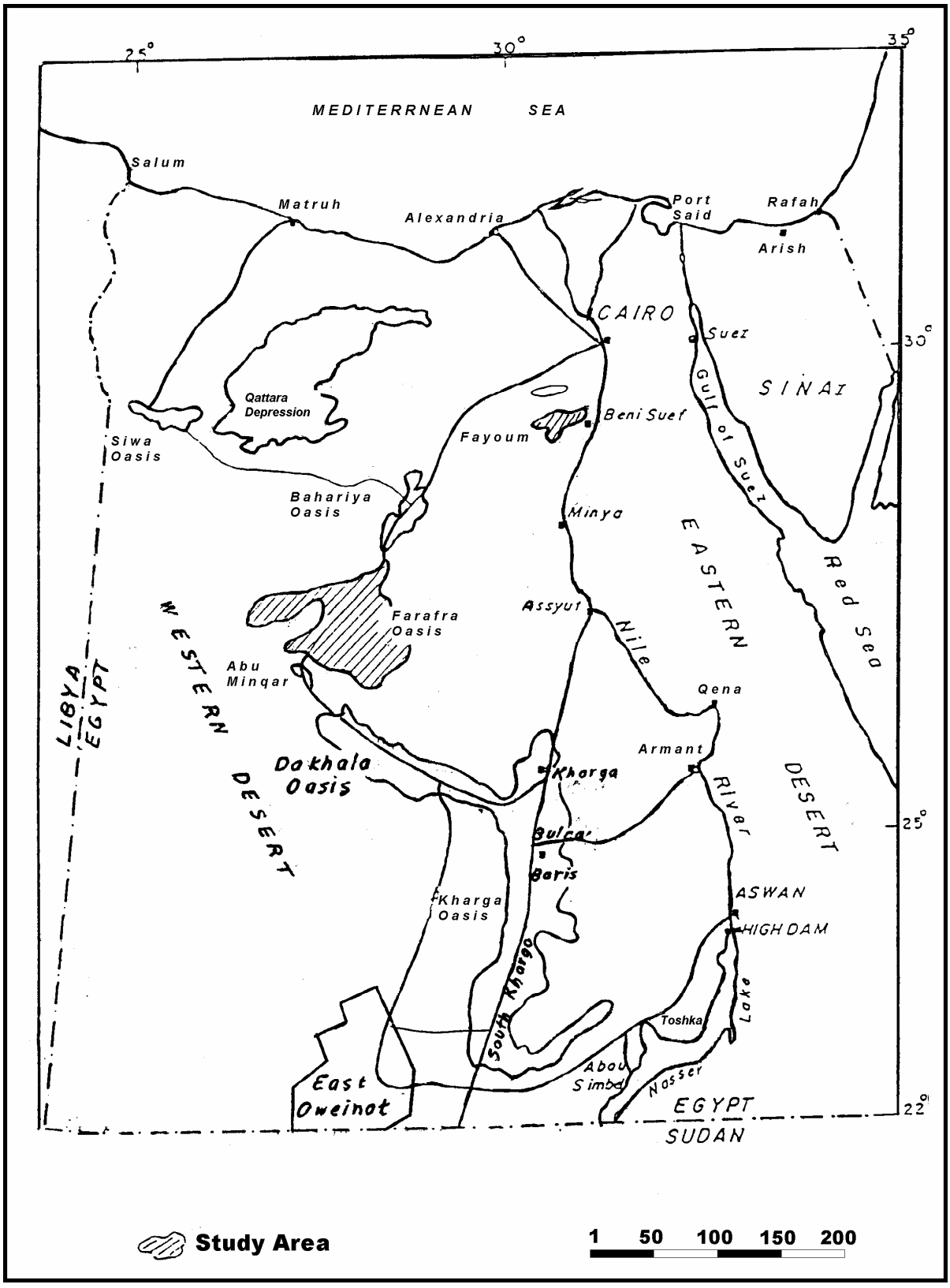

Figure (1) Fayoum Map

Drainage reuse implies increase in the overall irrigation efficiency. According to the data of the period 1988-1995, the overall efficiency in Fayoum increased from 66% to 73%. The conveyance efficiency was estimated at 85% [1]

3. Land Tenure

The size of farms in Fayoum ranges from 0.1 to more than 10 feddans with an average of about 2.5 feddans. About 56% of farmers who are working in this area own their land, while the remainders are renting the land. The family members provide most of labor required for farming works. Table 1 presents areas owned by land holds and their percent.

Table 1. Distribution of Land Holds by Farm Size

Area (Feddan)	Percent of Land Holds
Less than one	46%
1-5	44%
5-10	7%
More than 10	3%

4. Cropping Pattern

Ten major crops are cultivated in Fayoum. These crops include berseem, vegetable, maize, wheat, cotton, sorghum, broad beans, green fodder, fruits and rice.

5. Water Delivery and Supply System

Bahr Yousef canal constitutes the sole source of water to meet the whole water requirements in Fayoum area. The total amount of water delivered to Fayoum is about 2.42 bcm/y representing about 25% of total flow of Ibrahimia canal intake. This amount is delivered through Lahoun regulator and Bahr Hassan Wasef intake. Further down, water is delivered to branch canals and mesqas through well-established weir system. The breadth of the weir was designed to deliver water quantity that is proportional to the served area. One of the main features of this system is the existing of continuous flow that runs by gravity. Consequently, water diversion to fields is made over 24 hours period in order to minimize canal water spills to drains. On this basis, a well-established rotational table among farmers determining the water quota for each user is essential for improving water efficiency. This table is currently existing for each mesqa and implemented by the mesqa leader. Water quota or water right is defined on time-basis where measurements are not practiced. This means that each user has a certain time and period to irrigate his land.

CONTEXT OF WATER MANAGEMENT IN FARAFRA OASIS

1. Overview

The non-renewable groundwater of the Nubia Sandstone Aquifer is the only source of water in the Western Desert of Egypt. The Nubia Sandstone Aquifer System is one of the major aquifer systems in Northeast Africa having a huge storage capacity of about 200,000 billion m^3 of freshwater. However, only a small fraction (about 2% or 4000 bcm) of this can be extracted in the Western Desert. The previous studies [2], showed that the amount of groundwater that can be extracted from the Nubia Sandstone Aquifer is about 2.4 bcm per year over a period of 100 years. The development and utilization of groundwater resources in the Western Desert Oases started some centuries ago, but large-scale development was initiated in the early sixties. The current annual groundwater abstraction in Western Desert is about 0.70 bcm. Most of which is being utilized in agriculture and domestic use. However, much of this aquifer is under artesian pressure resulting in free flowing groundwater with 5 to 8 atmosphere at the well heads. Control of the flow from these wells is difficult due to problems associated with sudden back- pressure in the water bearing formation if the well is subjected to rapid and frequent shut down. The back pressure can result in a collapse of the formation around the well and abandonment of the well. While these wells can be controlled on a longer-term cycle (seasonally for example), the continuous flow in the shorter-term produces water in excess of demand during irrigation period. The unused flow during the night cause water logging and drainage problems. These environmental effects may seriously reduce agricultural productivity. Therefore, better management of deep groundwater in Western Desert is essentially needed. This may require introducing the concept of water trading in these areas.

2. Location and Climate

Farafra Oasis is located in the Western of Egypt, about 550 km South West Cairo (Figure 1). During the period April-September, the air temperature is ranging from 25-37 reaching maximum degree to about 45 in June-September. Precipitation is less than 5 mm/year and the humidity is ranging from 24-25% with maximum value of 60%.

3. Hydrogeology and Deep Aquifer System

The hydrogeological framework of the Western Desert encompasses three principal deep aquifer systems. The lower Miocene Moghra Sandy Aquifer, the Tertiary/Upper Cretaceous Fissured Carbonate Aquifer, and the Mesozoic/Paleozoic Nubia Sandstone Aquifer. The deep groundwater in these aquifer systems are considered a non-renewable resource, except the part of the Moghra aquifer at the Desert fringes of the Nile Delta region, which receives recharge from the adjacent Nile Delta aquifer [2]. The Nubia Sandstone Aquifer System in the Western Desert is considered the greatest development potential. It contains large volume of fresh groundwater (less than

1000ppm) in storage of 200,000bcm covering the new valley area including the study area of Farafra Oasis.

4. Cultivated Area

The total reclaimed area in Farafra Oasis is about 31 000 feddans. However, only 12 000 feddans in the command area are currently under cultivation. A field inventory of the irrigated areas in Farafra – Abu-Minqar area indicated that about 7 790 feddans are unofficially irrigated outside the command areas making the total irrigated area around 20,000 feddans. Most of the unofficial areas are irrigated from drainage water, where water salinity is quite low and suitable for cultivation. It is expected that drainage water will not meet the water requirement for the non-official areas when the well discharges are controlled.

5. Cropping Patterns in Farafra

Wheat and berseem are the major and more favorite crops in winter. Other crops are also recorded in Farafra such as beans, barley, alfalfa, vegetables and onions. The dominant summer crops are rice, sesame, maize, sorghum and other.

6. Well Locations in Farafra Oasis

A total of 97 production wells are located in Farafra – Abu Minqar area, of which 86 wells are free-flowing, while 10 wells in the eastern part of El-Sheikh Marzouk ceased flowing. The 80 active wells are used in irrigation, while 3 wells are allocated for domestic purposes at an annual rate of 160 mcm.

7. Water Distribution and Land Tenure

There is a unique water distribution system in Farafra. It involves determining the water quota and right for each user. This quota is mainly defined in terms of time. This is usually fixed by the district engineer. Then, a leader for each mesqa is nominated to be responsible for implementation of this water quota table.

In Farafra, the land holding is about 5 feddans per person, but it increases for graduates to range from 5-10 feddans. Most of lands are owned by user, however, there is a certain system of land renting practiced among Farafra people.

WATER RIGHTS

1. Overview

Water rights are very difficult to define in any place of the world. Usually, people who own the land to be irrigated own water. Change of water rights should depend on a realistic and careful assessment of existing rights to water and other natural resources

in all their complexity. Because rights to water are linked to a wider set of social relationships, successful change requires a full analysis of existing practices within a society. Water is also seen as a common property of the nation. This means that every one should have access to water to at least meet the human basic needs. Then water rights can be defined based on the goals of water use [3].

2. Existing Water Rights in Fayoum

In Fayoum, water rights were found to be well defined through a system made by beneficiaries and the government. Water quota is allocated by the government to each mesqa head through a specific weir (called Nasba). This weir (Nasba), has a width that is proportionate to the irrigated area on the Mesqa. Along the Mesqa, water is allocated to farmers by the Mesqa Leader who is nominated by water users or delegated by the village's Mayor. Every farmer is informed with time of his turn and period of irrigation as well. If farmer (water right holder) missed his turn, he couldn't then substitute it and should wait for the next turn, usually after one week. Therefore, farmers are very keen so as not to miss his turn. In most cases he may exchange his turn with his neighbor through informing him with enough time ahead.

In this water right system, water quantity is not defined. Instead, each farmer has a defined irrigation time and period during the week, this means that all 168 hours of the week are distributed among the Mesqa users. However, changes could be made to the water rights along the Mesqa if a new land (user) is added to the Mesqa. In this case, irrigation period (timeshare) of each user will be eventually reduced. To keep the water right unchanged, particularly in terms of quantity, the government intervenes to increase the water quota of the Mesqa through increasing the width of the weir "Nasba" allowing for more water to enter the Mesqa.

3. Existing Water Rights in Farafra

Farafra has two main systems of water rights. The first is water rights allocated by the government, and the second is inherited rights. In the first system, the government has dug deep wells where groundwater is available and accessible (artesian wells). Irrigated areas were allocated to investors and graduates with minimum 5 feddans for each. Rate of water allocation (water share) was determined as 22 cubic meter per day per feddan, during the period of high water requirement (summer season), while in winter is less, where flow of well is reduced.

For individual wells and springs, the water quota system is different. Water quota is inherited from grandfathers who participated in digging the well or the spring. The well or spring is then divided based on individuals' contribution. Water allocation and distribution are made by farmers themselves.

EXISTING WATER TRADING PRACTICES

Water trading practices in Fayoum and Farafra were found to have the following forms:

1. Exchange of Water Quotas

This type of trading involves exchange of water quotas among farmers along the same Mesqa. But since water quota is not defined on volumetric basis but on time basis, hence farmers used to trade time of irrigation among themselves without any interference from the government. Users who grow sensitive crops that need less irrigation intervals can take the weekly water quota of users who grow less sensitive crops. For example, vegetables are sensitive and sometimes need to be irrigated once a week, but berseem was to be less sensitive crop and can be irrigated once every three weeks. Therefore, vegetables' growers may take water quota of berseem growers in case of non- using it.

2. Exchange of Irrigation Turn

Exchange of irrigation turn is very common in Fayoum and Farafra. Such type of practice involves a flexible water rotational table of the Mesqa that allows farmers to change time of irrigation through exchange of water turns This sort of training is also made by farmers at their own initiative. Exchange of irrigation turns can achieve two main benefits; increased crop yield and considering gender issues. Some crops need to be irrigated at day time and others at night. Therefore, farmers may change the irrigation time and rotation in order to maintain the high yield of crops. Also, farmers who are not able to irrigate at night can exchange time of irrigation with colleagues. In this case, the gender issue is considered. When woman can't irrigate at right time, she can exchange her turn with one of men farmers to irrigate during daytime only .

3. Trading Water Against Benefit

Some users may trade water to his neighbor against benefit. This benefit is not money but usually use of neighbors' agricultural tools or animals. Trading through selling the quota was said not to be existing and for religious reasons it is prohibited.

IMPLICATIONS OF FOCUS GROUP MEETINGS

In order to evaluate the actual practice of water trading, two focus group meetings were held, one in Fayoum and one in Farafra [4]. For Fayoum, the sample was 56, of it 51 males and 5 females, while in Farafra the sample was 58, of it 56 males and two females. These two meetings have been attended by key local stakeholders including water boards and Ministry of Water Resources and Irrigation (MWRI) officials. The issue of water trading has been explained to participants. Then, the discussion has

been opened to get a general feedback from participants. Then, participants have been asked to fill the questionnaire through consultation with other farmers.

The questionnaires were aimed at collecting data about the water rights, trading practices and factors affecting them as well. In brief, the questionnaires included the following:

- Source of water and water rights.
- Land holdings.
- Crops and seasons – method of irrigation.
- WUAs and individuals.
- Legal and illegal land holding.
- Gender issues.
- Institutions and regulations.
- Social norms and customs.
- Social disputes.

Data collected by questionnaires were tabulated and discussed where some statistical parameters were obtained. Conclusions obtained are presented in the following:

- About 61% of farmers in Farafra are University graduated, while in Fayoum only 23% having University Certificates. Illiterate farmers are more in Fayoum reached 28.6% of interviewed farmers, but in Farafra was 5.2% (Table 2).

Table (2): Level of Education of Interviewed Farmers

Description	Fayoum		Farafra	
	No	%	No	%
Illiterate	16	28.6	3	5.2
Reading and Writing	15	26.8	13	22.4
Primary School	9	16.1	3	5.2
Preparatory	3	5.4	4	6.9
High School and Equivalent	13	23.2	35	60.9
Total	**56**	**100**	**58**	**100**

- Gender issues were tried to be investigated in these questionnaires. The female farmers interviewed were 9% of Fayoum sample, while 3.4% were interviewed in Farafra.
- The unemployed farmers in Farafra were 94% of the sample, while in Fayoum they were 73.5%. The unemployed farmers rely totally on agriculture as the source of their income. Employed farmers usually have a job in the government but also have compensation from agriculture.
- The following table (Table 3) shows the distribution of the interviewed farmers on the head, middle, and end of Mesqa and canals.

Table 3: Farmers Location on Mesqa and Canal

Region	Canal			Mesqa		
	Head	Middle	Tail	Head	Middle	Tail
Farafra	25%	39.3%	35.7%	31.7%	36.6%	31.7%
Fayoum	26.8%	39.30%	33.9%	36.4%	38.6%	25%

- It can be concluded from the table that distribution of interviewed farmers among different canal and Mesqa reaches is representing all cases.
- The farmers have been asked to tell about who provides them with information on water rights. Their answer was that the district engineer and Mesqa Leader in Fayoum, and the district engineer in Farafra who provides information on water rights.
- The question "Is Your Water Right Fixed?", was answered as follows:

Description	Fayoum (%)	Farafra (%)
Fixed Time.	37.4	88.9
Fixed Irrigation Period	32.7	5.6
Fixed Irrigation Quota	12.2	3.7
Fixed Water Level	17.7	1.9

- This proves that water rights are mostly expressed in time basis particularly in Farafra. But in Fayoum in some cases, irrigation periods are the mechanism of rights.
- Water rights may change with the season. In Farafra 73.7% of farmers assured that their water rights change with season due to control free flow well. But in Fayoum, about 34% of farmers stated that their water rights change with season.
- Are people who grow rice usually have the same water quota? About 93% of farmers in Farafra and 83.3% in Fayoum assured that they have the same water quota even if they grow rice.
- Therefore, the question was how to compensate the irrigation of rice crop under the same quotas. There are two main mechanisms that farmers used to follow to compensate rice irrigation.

1. Farmers collect water from those who grow less water consumptive crops.
2. Farmers rely on drain to complete irrigation requirements for rice .

- The two mechanisms are usually implemented in Fayoum, where 52.6% of farmers use the first mechanism, while 42.1% of the farmers used the second. In Farafra 87.8% use the second mechanism, while 12.2% use the first one, and this attributes the good quality of drainage water in Farafra (Figure 2).
- One of the dominant aspects of water trading is exchange of water turn with neighbor 78.2% of farmers in Fayoum and 87.5% farmers in Farafra usually use this type of water trading.

- The questionnaire aimed also at investigating the practices of water trading that are dominant in Fayoum and Farafra (Figure 3). The following results have been found;

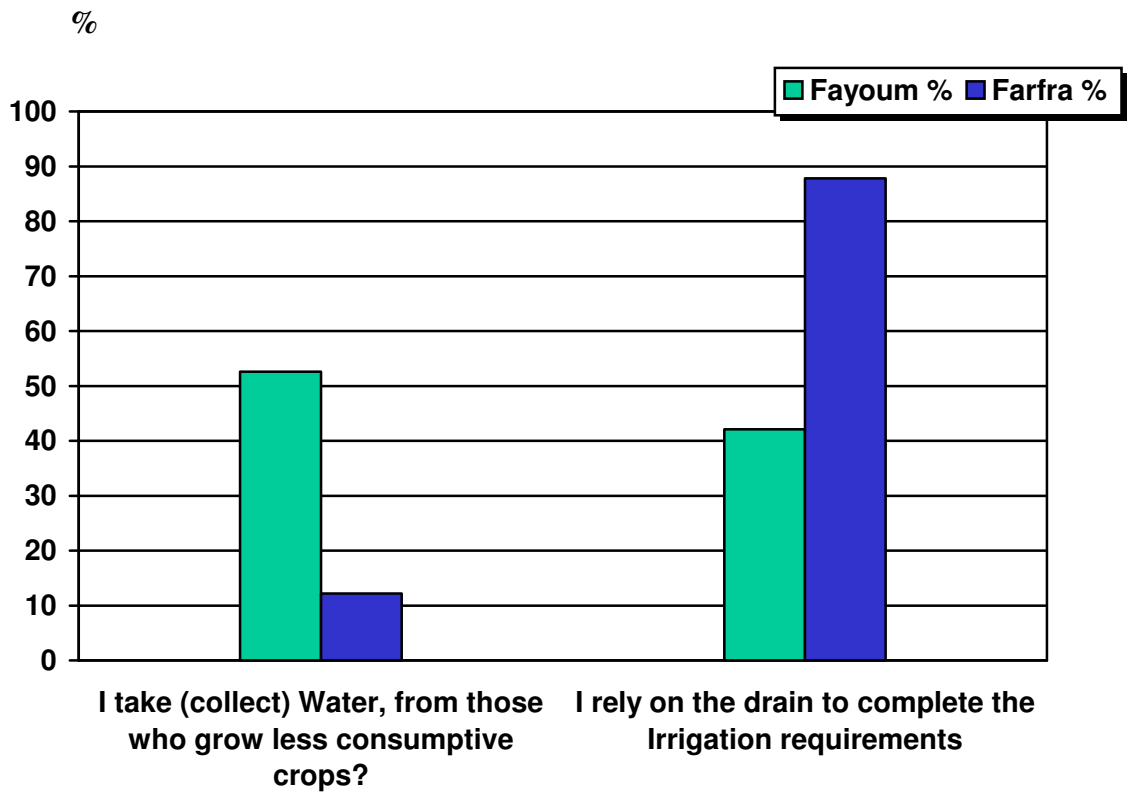

Fig (2) Compensation of Water Shortage for Rice Irrigation

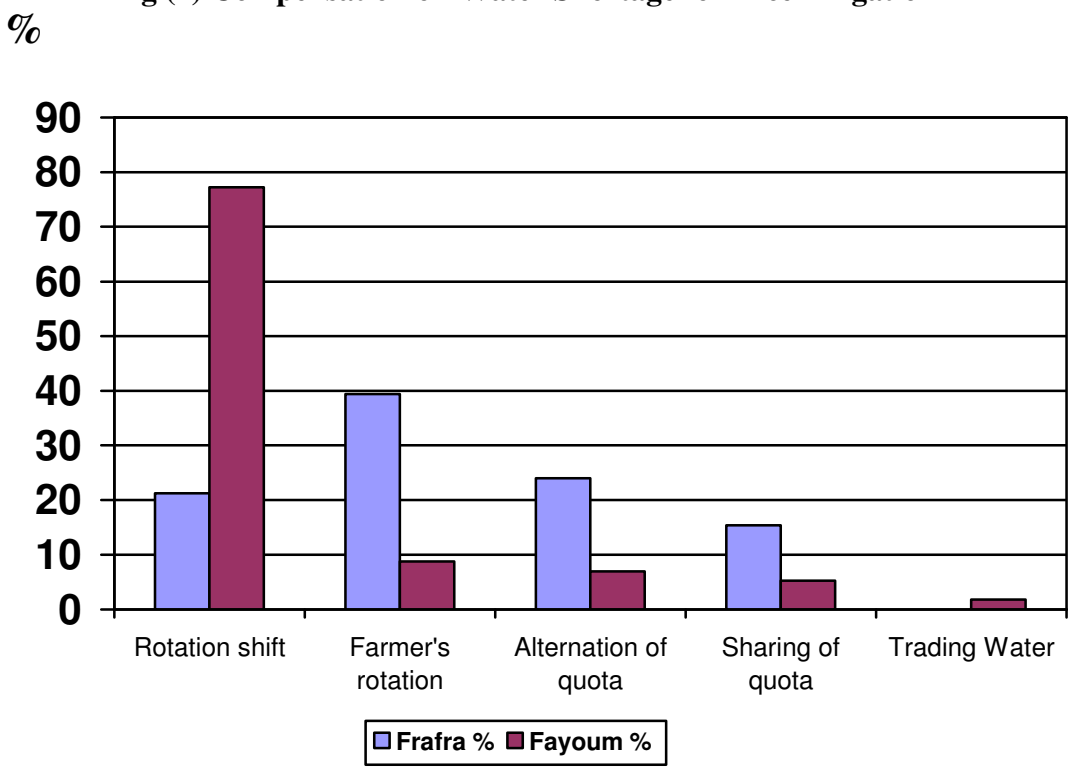

Fig (3) The Dominant Water Trading In Fayoum and Frafra

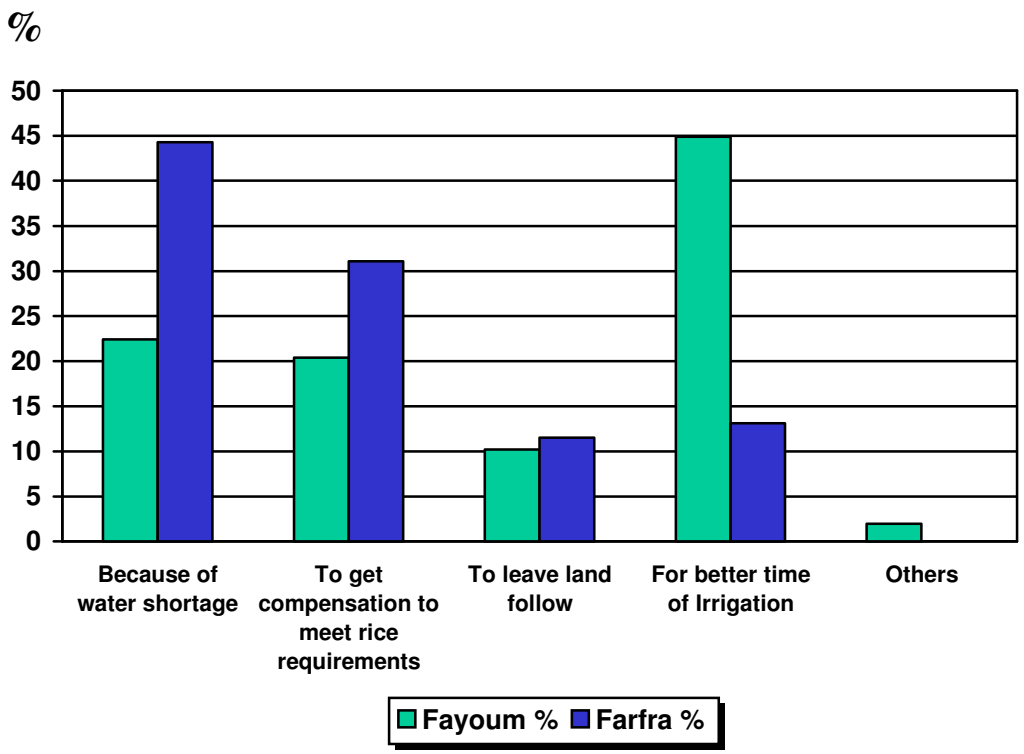

Fig (4) The Need For Water Trading

- 21.2 of farmers in Fayoum practice the rotation shift that allows them to delay or advance their irrigation turn, while in Farafra 77.2% of farmers practice such kind of water trading system.
- 39.4% of farmers in Fayoum practice the farmers rotation that allows farmers to change time of irrigation with neighbors, while only 8.8% of farmers practice this system in Farafra.
- The type of alternating water quota that allows farmers to change water quotas among them, i.e. one can take the larger quota and the other can take the smaller one. This system is practiced by 24% of farmers in Fayoum and 7% of farmers in Farafra.
- Other system of water trading is shared quota that means two or more farmers can collect their quota and shared among themselves depending on the irrigation requirements. There are 15.4% of farmers, who practice this system in Fayoum, while 5.3% of farmers in Farafra practice it.

- Figure 4 presents why some people need or prefer trading water.
- The following remarks were noticed:
  - 22.4% of farmers in Fayoum and 44.3% in Farafra practice water trading because of water shortage.
  - 20.4% of farmers in Fayoum and 31.1% in Farafra practice the water trading to get compensation in order to meet rice requirements.
  - For better irrigation, 44.9% of farmers in Fayoum and 13.1% of farmers in Farafra practice water trading.

- Trading water based on money was not found in Farafra, while 81.3% and 92.9% of the sample in Fayoum and Farafra respectively, practice water trading by exchange services.

CONCLUDING REMARKS

Discussions with farmers, water managers, and localities have revealed many issues and facts concerning water trading practices and water management issues in general. Findings can be listed as follows:

- Water trading aspects are mainly exchange turns.
- Water buying or selling is prohibited for religious reasons.
- Water quantities are not defined but only the time and period of irrigation are defined to constitute water rights.
- Exchange of water turns is made among farmers without governmental intervention.
- Mesqa leaders play a vital role in allocating water rights along the Mesqa, and the government should build upon this system for improving water management in future.
- Illegal crops (such as rice) result in the problems of management and mis-allocation of water rights, therefore strong regulatory framework should be existing to stop such illegal cultivation.
- The government should increase the awareness about water conservation and crop selection, so as to optimize the use of water in an economic and social way.

Practices of water trading are being made individually and unofficially. It should be noted that these practices do not account for selling or buying water, but only exchange of water turns and quotas. This system provides flexibility to some extent for more efficient use and reallocation of water to a higher-valued use. Institutional ingredients may be needed to improve water resources management such as an administrative system that registers and enforces timely water deliveries, a transparent and accepted water measurement system, and a well-maintained delivery system are all required for a functioning system of water rights. Regulations are also needed to govern water allocation and rights and to stop violations such as growing high-water consumptive crops. Illegal lands should also be considered in developing regulations because this may result in increasing water disputes. Water Boards could be one of the effective tools to make this system functioning well.

Water trading can also have impacts on the following:

a. Water Conservation

Practices of water trading assume flexibility of distribution. Redistribution of scheduling will certainly achieve reducing water losses. When farmers are not able to irrigate on their time, then changing with his neighbor will prevent spilling water to drains.

b. Increased Crop Productivity

Since some crops need to be irrigated during night and other crops to be irrigated during day, water trading through changing irrigation turns will give great flexibility to meet crop needs. This will result in increased crop productivity.

c. Local Conflict Resolution

Water trading will minimize water distribution disputes and conflicts among farmers.

RECOMMENDATIONS

The study revealed many issues in water allocation, water rights, and water trading practices. The finding of the study should be considered as start for including water trading system in water allocation aspects. The MWRI policies for improvement of water management should be build upon what actually exist such as water trading systems. Water Boards Association should also consider this practice in their strategy of operating and maintaining the canal network.

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