504 cont.

have leveled off, at best; and, in many cases, slipped into a pervasive and gradually accelerating decline. Countries that only a few short years ago fed themselves from their irrigated fields have become major importers of basic foodstuffs, eroding their national economy, food security, and independence. The decline of these systems results largely from the lack of maintenance. Dams, dikes, canals, and regulators were put in place, and left in place. Today, the price tag for catching up on a quarter century's deferred maintenance is enormous. Donors, governments, and private investors are loathe to make the investment unless future maintenance and hence efficient operation can be expected.

Maintenance is an organizational problem as much as a technical problem. Experience shows that the large irrigation bureaucracies cannot perform adequate maintenance without the active cooperation of farmers and local farmers' groups. The irrigation chain is only as strong as its weakest dike, and farmers and the irrigation bureacracy are dependent upon each other.

There is little question that the technology exists for refurbishing the great irrigation systems of Asia and Africa (and for building new ones), and that the necessary funding exists to do this (considering the projected returns). It is not at all certain, however, that we possess the knowledge and skills to create viable

bureaucratic structures and political arrangements to respond to the problems of operating and maintaining the irrigation networks upon which the feeding of the world will depend during the coming era. The success of this crucial organizational aspect of irrigation rests, we believe, on the creation of effective links between the farmers and the water bureaucracy. The following study in Egypt pays little attention to important issues of on-farm water management or upper level management of the Ministry of Irrigation. We focus on the pivotal relationships (technical, organizational, and political) between the ministry's distributory canal and the farmers' ditches, between farmers (individually and collectively) and their government's irrigation bureaucracy.

2. DELTA LIFT SYSTEM 505

Key Features

History - The Delta water delivery system has seen a number of important changes over the last century and a half since Mohamed Ali had the Delta Barrages built and turned the area into one of perennial irrigation. In 1955, the Ministry of Irrigation moved to convert the entire area to the present below grade system by re-digging canals and lowering the water level throughout. This

policy was, and is, presented as a means of preventing farmers from wasting water. At that time, many large landowners were able to invest in pumps, but small farmers were forced to switch from simple gravity and tambour (Archimedes' screw) irrigation to an investment in group owned water wheels.

Technology - The below grade lift system dominates the irrigation system of the Delta. The essence of the system is that water is provided through canals at less than one meter below field level and each farmer is responsible for lifting the water he or she needs for irrigation. The primary technology for water lifting is the cow or buffalo-powered water wheel, saqia.

Organizational Units - The primary cooperating unit among the farmers is the group that shares in a single saqia, or a "saqia ring". These "saqia rings" are ubiquitous throughout the Delta and almost every land-owning farm family belongs to one or more such groups. In the Delta lift system, then, the primary irrigation-based social grouping is this "saqia ring" This means that the size of the primary cooperating group is about a dozen families. What ties them together is (a) shared ownership in the water wheel, (b) shared maintenance responsibility, and (c) the need to allocate among themselves their times and turns for irrigation.

The second cooperating unit consists of all the farmers sharing the same ditch, or mesqa. The main form of this cooperation is arranging for maintenance of the ditch and sharing the expenses according to the size of each farmer's holdings at that location.

Conflict - Within this system, the most obvious and onerous source of conflict is among members of the same ring in disputes over the allocation of time at the saqia during times of shortage. Overt conflict and dispute over water or saqia rights is rare in the Delta, primarily because farmers try very hard to avoid it. There is an inherent competition for water among the separate saqias along the same irrigation ditch. However this rarely is manifest because the lack of water in the ditch is not blamed on the other irrigators so much as on the Ministry of Irrigation. This last is a point of conflict and farmers often complain individually and in groups to the district irrigation office.

Current Changes - The system is switching from a system based exclusively on the communally-owned saqia to one that combines the use of the saqia with the renting of diesel pumps. The advantages of the mixed system are that it breaks the bottleneck of time constraints at the lifting site. The major source of conflict among fellow saqia owners is removed by the fact that some of them

can use the diesel pump. The combined system provides more flexibility in that farmers can use one or the other depending on the crop, their personal circumstances, or the degree of crisis over getting water on their fields. The disadvantage of the mixed system is that water in the irrigation ditch becomes unreliable because of the increased pumping capacity of several pumps working simultaneously on the same ditch. Another disadvantage is that the pump seems to lead to some over-irrigation, at least on the part of well-off farmers who are not supervising their fields.

A policy issue - We had hypothesized that farmers were turning to diesel pumps as a way of escaping from the constraints and disputes of the saqia ring, especially as many farmers were involved in the difficult social task of juggling membership in several saqia rings. In this regard, it seemed to us that the mobility of the diesel pump was an important feature freeing the user from the saqia ring. However, the diesel pump works most effectively from the same structure that houses the saqia, which is the place that connects the water source with the delivery canals to the fields. Most farmers who use diesel pumps must maintain their membership in the saqia rings. The pump, rather than providing a means for the deterioration of the saqia ring organization, reinforces the saqia ring and makes it less troublesome than before.

Agriculture in Qalyubiya and Minufiya Governorates

The two research sites in the Delta area are in Qalyubiya and Minufiya Governorates. The two Governorates have similar features in that, located in the southern part of the Delta, they are old, early settled, very densely populated areas with relatively high elevation and sandy soils. The areas have both been included in the tile drainage network.

Agriculture is intensive in the two governorates, which are known primarily for food production. Due to the density of population, the percentage of crop area is far above the national average. Traditional agriculture is typical in these governorates with the order of crops as follows: maize, berseem, wheat and cotton. Also, because of their location of proximity to the capital there is an emphasis on vegetables and fruits. In summary, these two governorates have traditional agricultural emphases, modified by urban markets.

The governorates differ in their specializations. Qalyubiya has a long standing reputation for fruits. The percentage of orchards in the governorate is six times the national norm. This is explained by the relatively high elevation and sandy soil which afford good drainage. Minufiya, on the other hand, is a tradi-

tional supplier of milk products and has a high density of animal population which goes with the exceptionally high percentage of clover (berseem) and maize cultivation found in the governorate.

Water Delivery System

Both of the distributory canals studied are under rotation and are fed directly from major canals. These canals distribute water to the feeder ditches which carry the water to the fields. They operate on a rotation system of five days on and ten days off during the winter and seven days on and seven days off during the summer.

These canals operate on a water budget which is determined annually on the basis of the theoretical crop mixes according to the Ministry of Agriculture plan. However, the Ministry of Agriculture plan does not necessarily correspond to what the farmers grow and therefore, actual water needs vary from those projected in the water budgets. (This will be discussed later under water shortages). Also the means by which these water budgets are measured make it difficult to give exact quantification of how much water is distributed to the different canals or how much the conveyance losses in the delivery system are. It is largely by experienced guessing that district irrigation engineers determine conveyance losses. In describing the system, the engineers agree

that each district is allocated a water budget for which he is responsible.

The most important measure is the level of the canals. There should always be a constant flow of a head amounting to 25 cm. in the distributory canals. Therefore, the quantity of water to a district does not change but the district engineer can change its distribution by allocating more time to a given distributory canal. For instance if the canal is on a 15 day rotation (5 on and 10 off), he could keep the water on for 7 days instead of 5. He must subtract these two days from another distributory canal which affects the rotation dates on that canal and causes shortages for farmers on its mesqas. Guards are responsible for the water levels and they are to report on these levels at the head and tail end daily, in the morning and evening. The fear is of flooding, not water shortage, which is serious but not alarming. Guards are also responsible for day to day control of the the major canal regulators and the headgates of the distributory canals.

Water flows from the distributory canals to the field mesqa and is lifted by the farmers to the field. Most mesqas are below the field level but there are places where the mesqa is at the same or a higher level (at the Minufiya site, for instance). However, there is a concentrated effort on the part of the govern-

ment, as pointed out by district engineers, to place all mesqas below the level of the land, the theory being that the farmer would be less inclined to waste water if he had to pay to lift it.

Each field mesqa is built with the expected water needs of the farms served by that mesqa in mind. Accordingly, the appropriate dimensions of the field mesqa itself and the inlet pipe size are determined by the district irrigation engineer. All expenses incurred for the pipe and the pipe's installations are paid by the farmers served by the mesqa according to the size of their holdings (heyazas). Since these pipes do not have gates, whenever the distributory canal is in the "on rotation", the field mesqa should also have water in them. Therefore, the water flow into the mesqa is a function of three factors: (1) the head of water in the distributory canal (2) the size of the inlet pipe (3) the canal water rotation cycle.

In other words, the system assumes that only a certain percentage of the total area on each field mesqa would be irrigated on a particular day. i.e., if the water rotation is 5 days then one fifth of the farming area on each mesqa should be irrigated on each day. This calculation is made on the assumption that farmers irrigate twenty-four hours a day. What really happens is that the farmers rarely irrigate at night unless they have a real water

shortage. The demand for water in the mesqa is highest in the daylight and during the beginning and end of the rotation period. Night irrigation is practiced by some farmers during the summer season for their maize crops.

Two Delta Sites

The final part of the Delta water delivery system which is still under ministry control is the distributory canal (ter'a) that feeds directly through open gates or pipes into the long ditches (mesqa) from which the farmers must lift their water. It is the water level of this canal, the duration of its 'on' period, and the condition of its openings to the ditches that are the basis of relations between the farmers and the district irrigation office. What takes place beyond those gates, along the irrigation ditch is the responsibility of the farmers. At this level, there are both similarities and differences between the two Delta sites .

A. At our research site in Qalyubiya the water flows into the Kom Beteen Canal at a major gate off the large canal called El Basussia. The Kom Beteen then conveys its water for a distance of eleven kilometers, distributing it to eight major branches (under ministry purview) and into numerous ditches. At the fifth opening of the Kom Beteen, the water flows through a pipe into

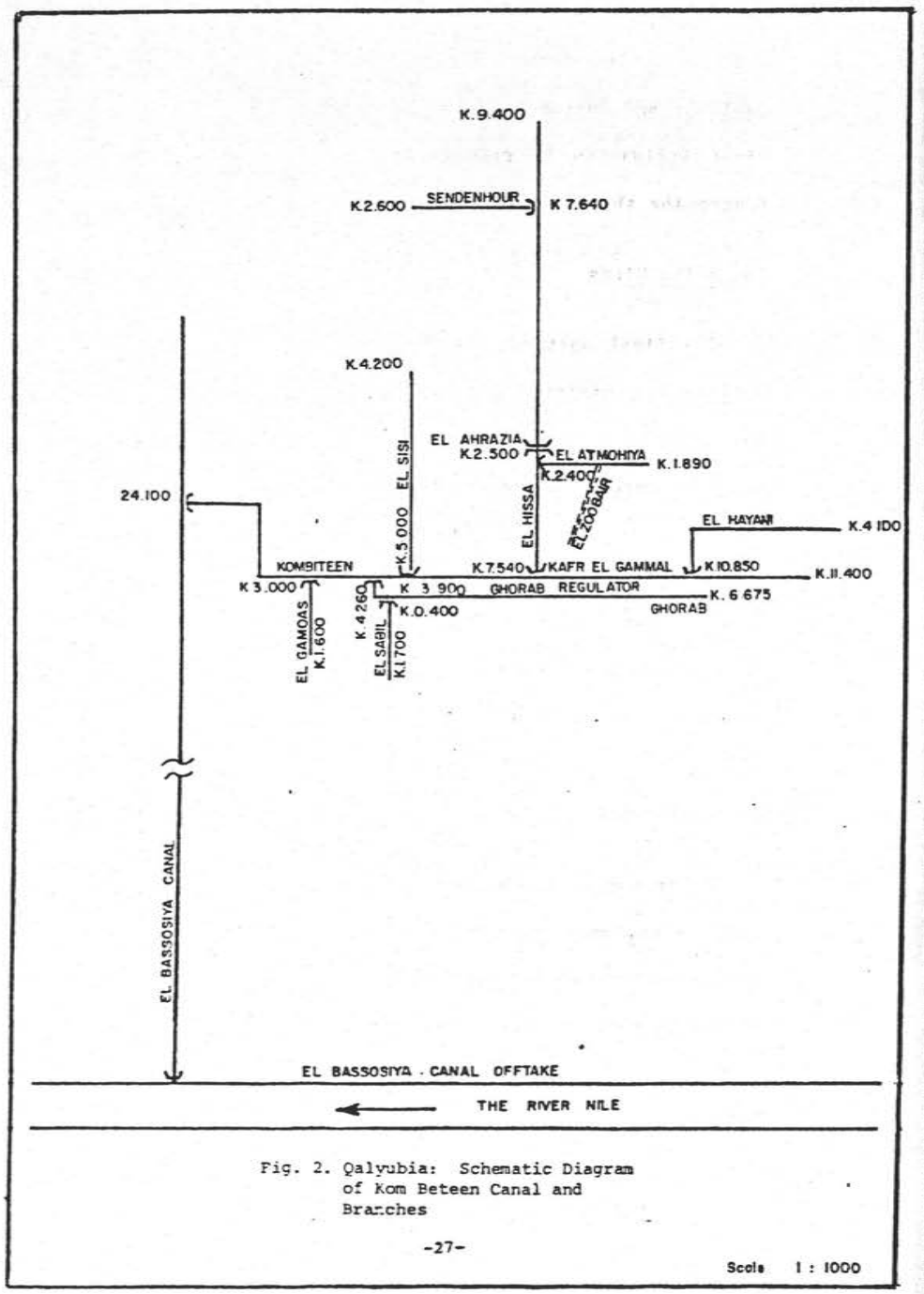


Fig. 2. Qalyubia: Schematic Diagram of Kom Beteen Canal and Branches

Qalyubia Governorate - Kom Beteen Canal and Branches

- Area Served 36,000 Fed.
- Length 11.040 Km
- Taking its water from El Bassosiys Canal at Km. 24.100
- Ending by a Tail-escaping in El Qalyubia main drain at Km. 55.500
- Canal Discription

Km From	To	Bed-Width m	Elevation	Hydraulic Gradient cm/km	Side Slope
Intake	3.24	8.00	12.25	5	1.1
3.24	4.20	7.00	12.09	5	1.1
4.20	7.40	6.50	12.05	5	1.1
7.04	10.80	3.50	11.89	5	1.1
10.80	11.36	1.00	11.72	5	1.1

- Canal Branches

Name	Area Served in Fed.
Kom Beteen	3000
El Gamoas	1500
Ghorab	7000
El-Sabil	1500
El-Sisi	5000
El Hissa	9000
El Atmohiya	2000
Sendenhour	2000
El Hayani	5000

Fig. 3. Technical Summary

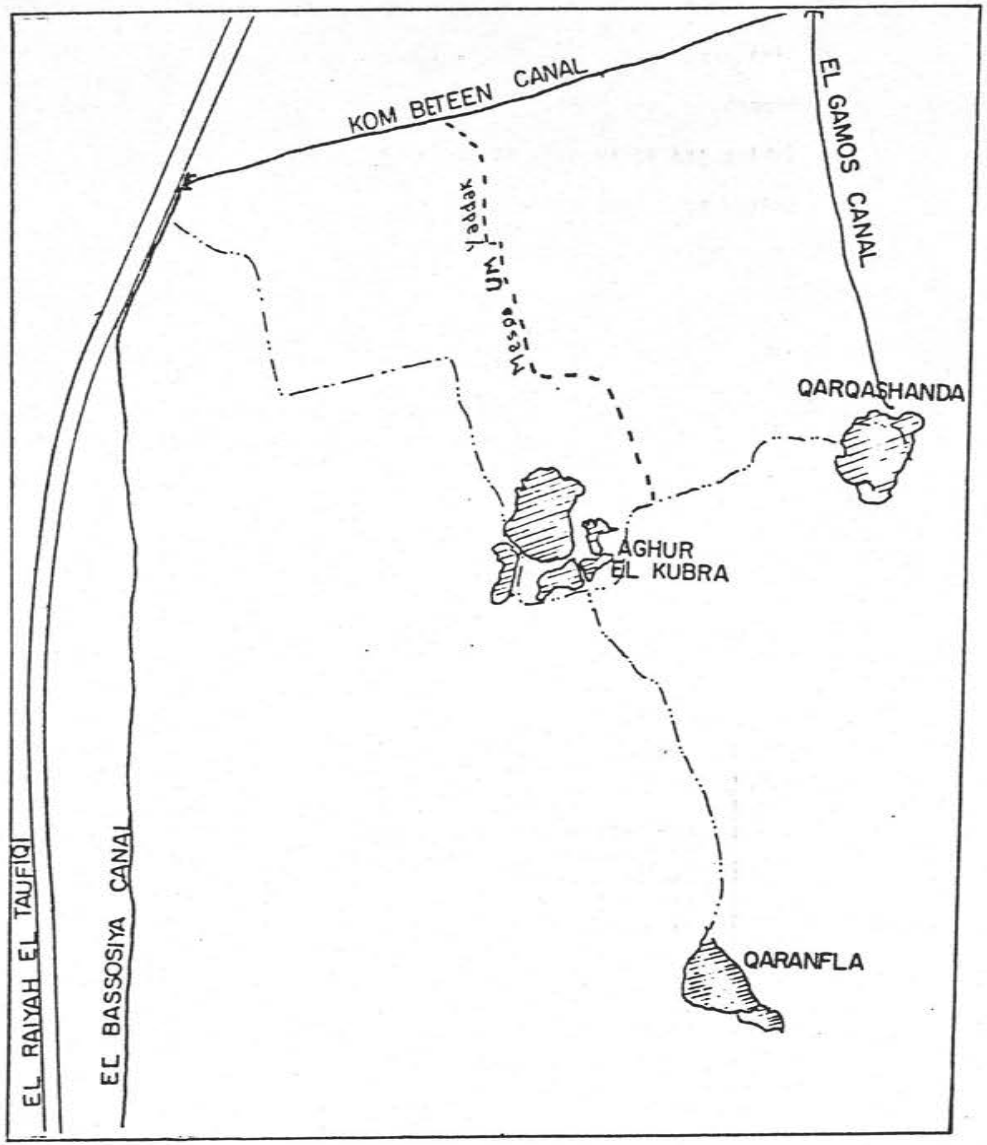


Fig. 4. Qalyubia Site: Kom Beteen Canal, Mesqa
Um Yaddak, Aghour El Kubra Village

the Um Yaddak ditch which wanders for three kilometers. On this journey, the water flows past twenty water wheels and eight diesel pump placements. At one point, the ditch is carried over a drain by a raised pipe 25 cm. in diameter and 20 meters long. All together, the Um Yaddak irrigates an area of 2000 feddans.

There are several problems with this ditch's ability to deliver water. First, the opening is improperly constructed. The original opening had been a brick archway which after deterioration was replaced by the pipe. The pipe, however, was placed too high so that only when the Kom Biteen Canal is extremely high does it function properly. At other times, it gets only a partial share of its intended volume and also gets easily clogged by surface debris. The drain crossover also has maintenance problems. It leaks, and much of the water intended for farmers further along, pours directly into the drain during the 'on' period.

The Um Yaddak illustrates a common situation in the Delta in that those at the tail end of the system have certain advantages. The end of the ditch comes into the proximity with the ends of other ditches. This provides the farmers with alternate sources of water which they can divert to their fields by constructing little mud dams. Also the lower elevation of the tail end of the

ditch presents certain advantages as the water level is closer to field level. The farmers at the end of Um Yaddak have avoided the expense and complications of constructing water wheels. Usually they need only the tambour (Archimedes' screw) to irrigate their fields and rely on rented diesel pumps during times of emergency. On the Um Yaddak, it is the farmers in the middle, especially shortly after the ditch crosses through the leaky pipe, who suffer from inadequate and uncertain water supply.

Most of the farmers along the Um Yaddak live in Aghour El Kubra village. This is a large village of 12,000 inhabitants with an agricultural cooperative, a number of schools, and a health unit. The area on the irrigation ditch is characterized by a heavy concentration of fruits and vegetables. Most of the farmers we interviewed have orchards. Some had switched their land to orchards long ago (twenty years) to avoid the cotton rotation enforced by the government. More recently, farmers have shifted to orchards because of the shortage of labor and the low government prices for traditional crops. Water requirements differ according to the maturity of the orchard. When the trees are young, field crops can be planted between the rows of trees.

B. In Minufiya, we studied the Telwana Canal which takes its water from the major canal called El Rayah El Minufiya. The

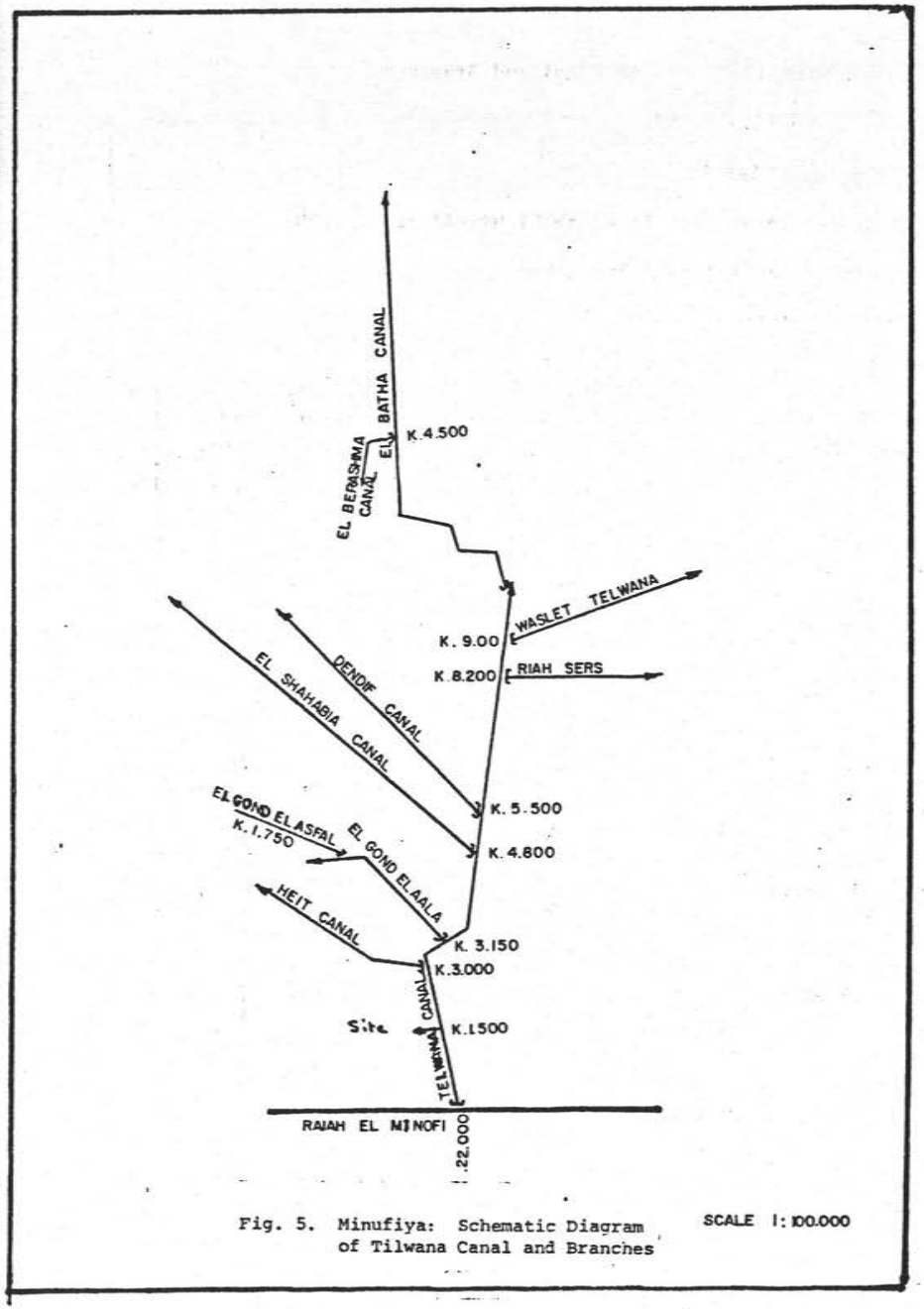


Fig. 5. Minufiya: Schematic Diagram of Tilwana Canal and Branches

Minufiya Governorate - Telwana Canal and Branches

- Area Served 14,500 Fed.
- Length 9.093
- Taking its water from El Raiah El Minufi at Km. 220.
- Ends by El Batha Intake Regulator
- Canal Discription

Km. From	To	Bed Width m	Elevation	Hydraulic Gradient cm/km	Side Slope
Intake	3.00	6	12.15	5	1.1
3.00	4.80	5	12.00	5	1.1
4.80	6.20	4	11.83	5	1.1
6.20	9.09	3	11.69	5	1.1

- Canal Branches

Name	Area Served Fed.	Length km
Heiat	2050	8.26
El Gond El Ala	280	1.94
El Shahabia	2470	6.25
Dendif	820	3.60
Riah Serse	1650	6.20
Waslet El Telwana	300	2.20
El Batha	2800	8.84

Fig. 6. Technical Summary

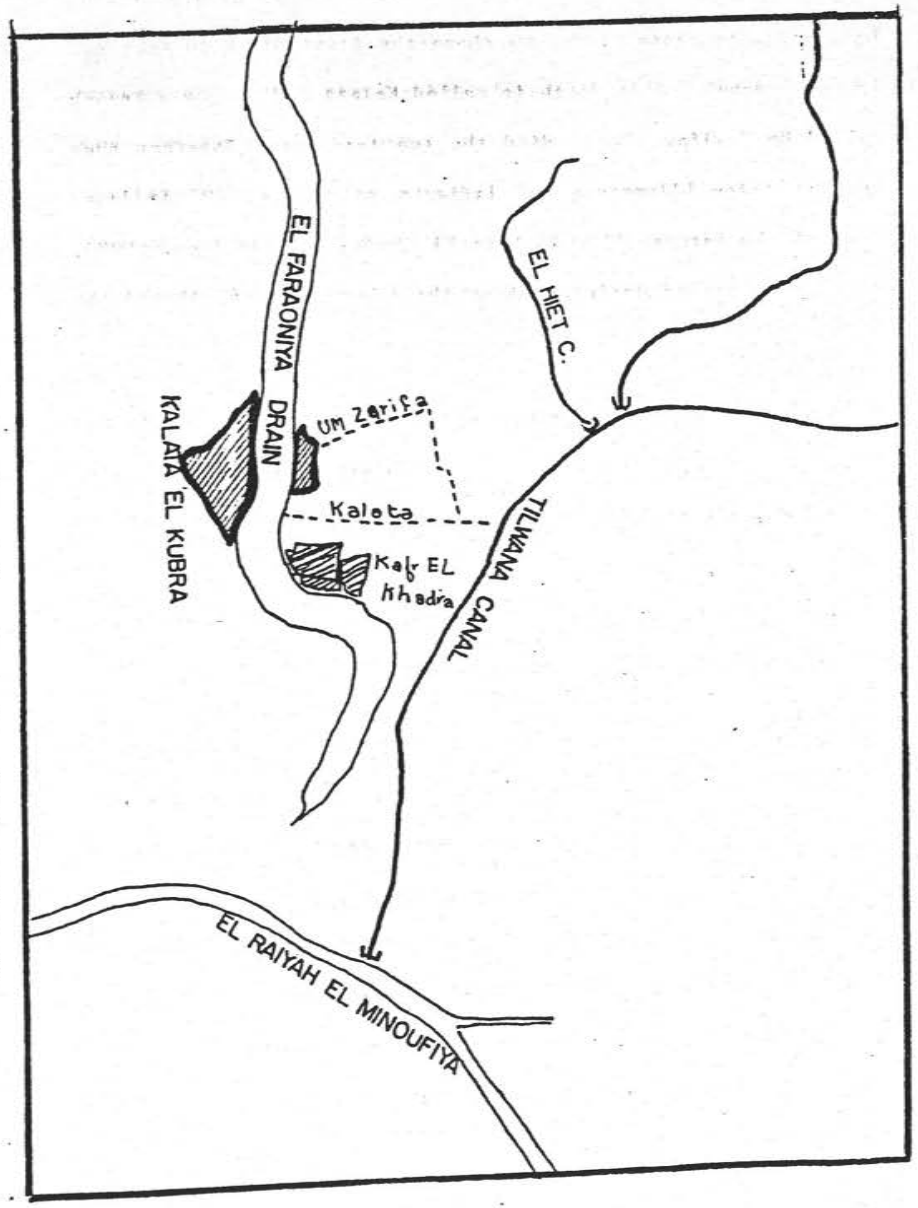


Fig. 7. Minufiya Site: Telwana Canal, Mesqa Kalata and Um Zarifa, Kafr El Khadra Village

Telwana is nine kilometers long and feeds seven branches as well as the many ditches. All together it commands an area of 14,500 feddans. For close study, we chose the first ditch to take off from the canal. This ditch is called Kalata and it has a branch called Um Zarifa. We studied the two together. Together they run for three kilometers and irrigate an area of 500 feddans. Most of the farmers live in Kafr El Khadra village (pop. 5000), and these ditches irrigate about three quarters of all village lands.

Along these ditches, there are twenty one water wheels and nine pump emplacements. Kalata has nine of the water wheels, six on the right side and three on the left, with the last 200 meters using gravity flow. On the branch Um Zarifa, there are twelve water wheels, eight on the right and four on the left. Here the last fifty meters use gravity flow.

The fields irrigated by Kalata/Um Zarifa ditches are planted largely in traditional field crops. The village cultivates 400 feddans of clover (berseem) and 300 feddans of wheat in the winter, and a mixture of soya beans, maize and vegetables in the summer. In contrast to the Qalyubiya site, only a small proportion of village land is in orchards. The size of individual land holdings is small, and for this reason the village is exempt from the cotton rotation regulation.

In comparing the Qalyubiya and Minufiya sites, note that they have roughly the same numbers of water wheels and diesel pump emplacements along the ditches, but that one serves an area four times as large as the other. One important factor here is that the Qalyubiya site has a number of alternate sources of water whereas the Minufiya site is not so blessed. Another factor is the cropping pattern with Minufiya dominated by water-hungry clover and Qalyubiya largely planted in orchards.

The Water Wheel (Saqia)

The water wheel remains the most common form of lifting in the Delta system in spite of the important introduction of diesel pumps. We were surprised by the extent to which the Delta farmers still rely on the water wheel, especially as our research sites are in the southern Delta, relatively near large towns (Bagur and Tukh) and Cairo. Some estimates place the number of saqias currently operating in Egypt at over 400,000, the majority in the Delta.

The water wheel was originally a device for raising water from deep wells but was converted to lift water the short distance from canals to fields. During the 1950's, the perennial system of the Delta was systematically transformed to the current below grade

lift system. The Ministry of Irrigation uniformly lowered the water level so that reliance on gravity and the hand operated Archimides' screw ceased to be feasible. This led to a great increase in the numbers of saqias which went from roughly 150,000 in 1950 to 300,000 by the end of the 1960's.

The design of the water wheel has evolved over the last century from the old bucket wheels to the "ring of chambers" model to the current "spiral" type, called qadosa. The bucket type was really adapted rather directly from the old use of the saqia to lift water from deep wells. The "ring of chambers" type was the first to have the wheel itself dip directly into the water. This model had one hole in the side of the wheel near the outside of the radius for the water to enter, and another hole near the inside of the radius for the water to exit when that part of the wheel revolved to the top position.

The spiral type wheel is in a sense a combination of the advantages of the other two along with some of the principles of the Archimedian curve. The spiral type scoops the water like the bucket and holds it in the revolving chamber to be exited from a hole near the inner radius when the chamber is raised. Additionally, the spiral curve of the chambers keeps the weight of the water being lifted very close to the wheel's center of gravity thereby minimizing the energy needed to lift the heavy water.

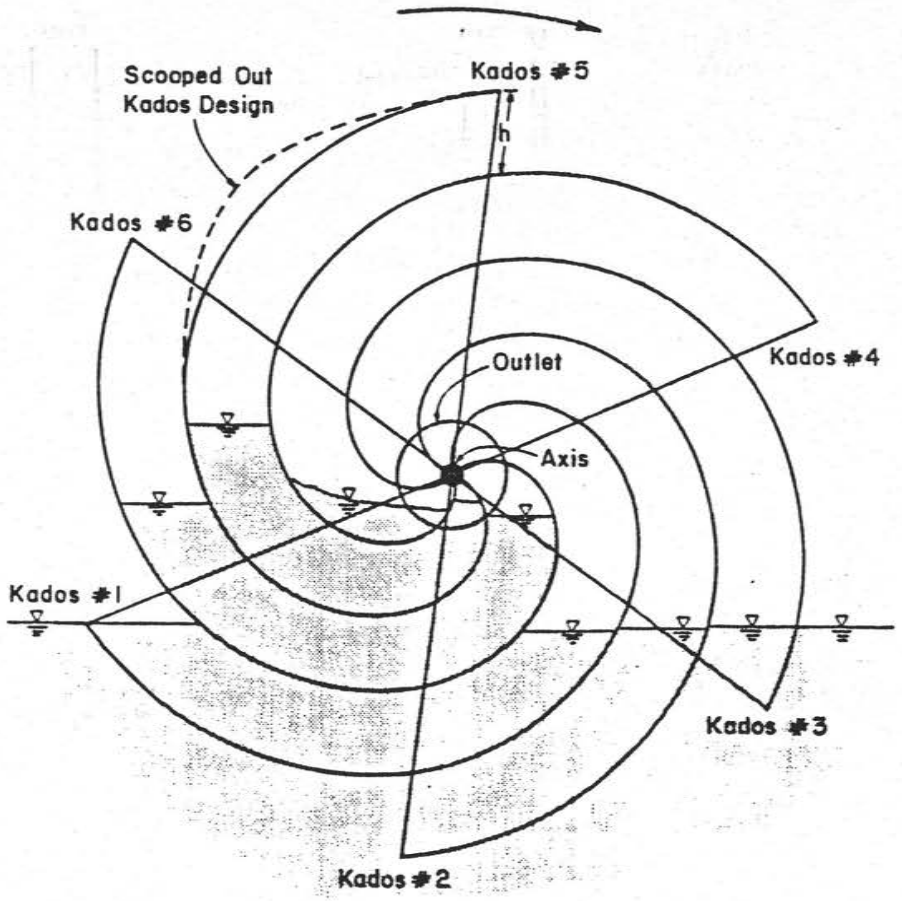
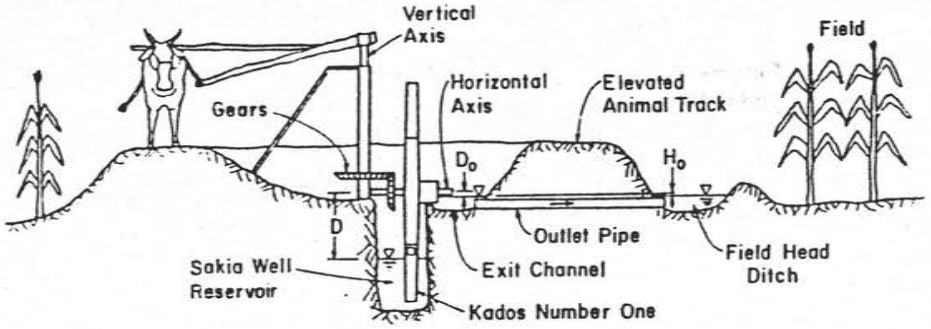


Fig. 8. The water distribution in an idealized six kawadeis sakia. Kados #5 shows the scooped out kados design common in field sawaki.

(from Slack 1981)



Sakia, Front View (Slack 1981)

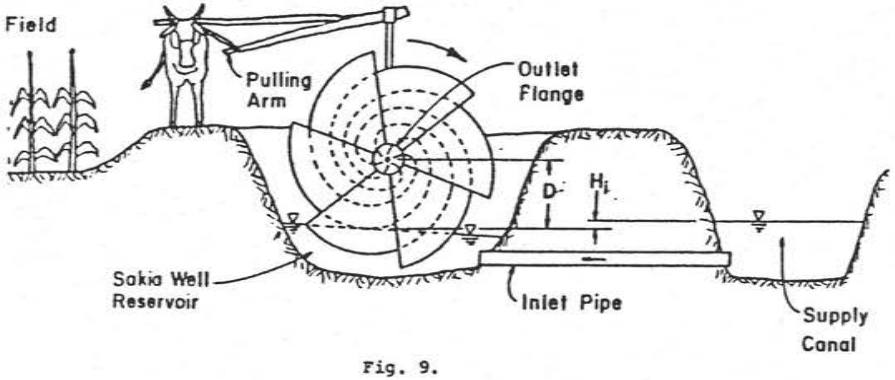


Fig. 9.

Sakia, Right Side View (Slack 1981)

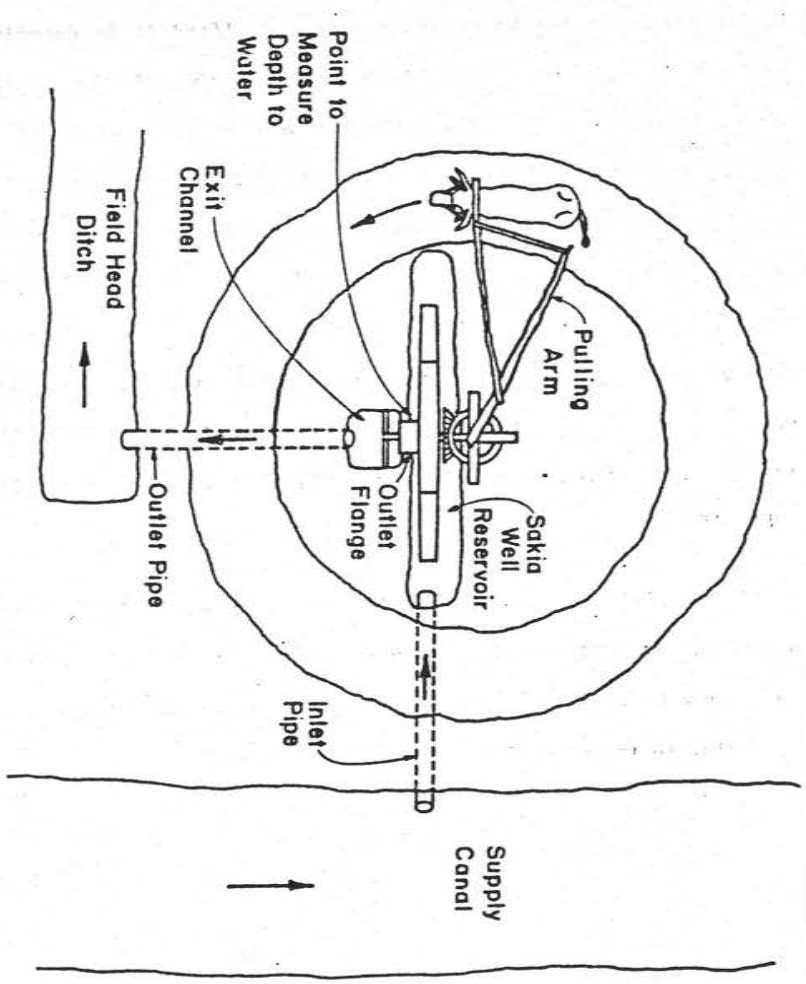


Fig. 10. Sakia, Top View (Slack 1981)

The saqia emplacement is a raised circular area next to the feeder ditch, mesqa. The saqia wheel is established in a "well" into which the water from the feeder ditch flows through a pipe. The water level in the saqia well, then, is the same as in the feeder ditch. As the water is scooped and lifted it is deposited in a small exit pipe from which it flows through the surface ditch, merwa, to the fields. Both the deep entrance pipe and the higher exit pipe must go under the raised circular path travelled by the working animal. The animal powers the saqia by walking blindfolded in a circle around the emplacement, connected by two long poles to the saqia. The torque is transmitted from the horizontal circle of the animal to the vertical circle of the saqia wheel using gears. The gear ratio is usually about 2:3 which results in a rotation of the saqia wheel of about 3 rpm (Slack 1981: 15).

A new saqia cost about L.E. 500 to construct in 1983, and it has an expected life of over twenty years. The annual maintenance cost runs L.E. 80 to L.E. 100 and is shared by the ring members according to the size of their share in the saqia.

To irrigate by saqia, each farmer supplies his or her own animal or rents or borrows one from a relative or neighbor. A cow can generally work a saqia for two hours at a time, a buffalo for

three. Buffaloes can be used for this labor when they reach one year old, cows when they reach two. One advantage of the saqia is that it requires minimal supervision. A young child can supervise while the adults tend to the work on the field itself which may be some distance away.

Much has been written about the expense of using cow or buffalo power in terms of the opportunity costs of lost milk production and potential cropland given over to fodder production. An important aspect to these equations is that any one animal is not likely to be working the saqia more than six hours a month. The outside observer sees those cows going round and round for what looks like eternity, and forgets that it is not always the same animal. Regarding the opportunity costs of feeding the draft animal, it is important to recognize that animals are being kept for their milk and dairy products as much or more than for irrigation labor. If all the saqia were replaced by pumps, the bovine population (and the land area devoted to clover) is not likely to be reduced (See Hopkins et.al. 1980).

The Saqia Ring

The saqia is conceived of as being divided into twenty-four shares, or qirats. This is analogous to the division of the feddan

into twenty-four qirats, except that a qirat of a saqia is not related to any fixed amount of land. The owner of four qirats of a saqia is entitled to 4/24ths or one sixth of the irrigating time and is responsible for one sixth of the maintenance costs. In theory this person also owns one sixth of the land served by that saqia, and these saqia rights are sold with the land.

The saqia rings in our sample ranged from those shared by only two persons to one with an incredible thirty-seven members. The mean is a saqia with fourteen members. Saqia ring members can be all from one family or from different families in the same village or even from different villages and families altogether. The variation in the amount of land served is also great, ranging from four feddans up to twenty-six. But most saqias irrigate an area of about twelve feddans.

Each saqia has a leader who is responsible for (1) keeping the kambusha (a hinge which is placed on the top vertical axis of the saqia to make it work) at his house, so that a person using the saqia would have to come to his house to get it and in that way he would keep track of who uses the saqia; (2) maintaining the saqia by providing the money for the repairs and then collecting it from the different members, each according to the amount of land served by the saqia whether owned or rented; (3) being in charge of

irrigation turns; (4) deciding turns in case of quarrels or disputes.

The criteria for saqia leader are that he be well off, honest, senior, and have his house located near the saqia. Several of the saqia leaders we interviewed are in that position because they own the land on which the saqia is built or else they own the largest area of land irrigated by the saqia.

Because of the fragmentation of land most people belong to more than one saqia ring. The following are examples of people who belong to several saqia rings:

Abdel Hamid, 56 years old, farmer, has children who are all in school and help during vacations. His wife also helps with agricultural work of weeding, irrigating, cutting berseem, wheat, and maize. He has a cow. He rents out some of his land on a share cropping basis. His heyaza (1 feddan and 3 qirats) is divided into four parts served by four different saqias and therefore he belongs to four different saqia rings.

Heyaza division:

6q	Saqia No. 1	Um Zarifa
15q	Saqia No. 1	
Kalata		
3q	Saqia in Telwana	Telwana Village
3q	Sersawia main canal	

Raafat, 28 years old, B.A. in agriculture, works as the agriculture extension engineer at the village agriculture cooperative. He is not married, looks after his mother, sisters and brothers since his father's death. The whole family has a heyaza (1 fedden and 4 qirats) located on three saqias and belongs to three saqia rings.

Heyaza division:

20q	Saqia No. 7	Um Zarifa
4q	Saqia No. 8	Um Zarifa
4q	Saqia No. 9	Um Zarifa

Abdel Latif, 45 years old, agricultural laborer, has six children, owns a cow and a donkey. His heyaza (12 qirats) is divided in three parts. He belongs to two saqia rings.

Heyaza division:

3q	Gravity flow	Um Zarifa
3q	Saqia No. 8	Um Zarifa
6q	Saqia No. 4	Um Zarifa

Each family must regulate and plan its irrigation of each of its fragments of land, according to the turns of fellow ring members in two or three rings. These timing arrangements must also be coordinated with the "on" periods of the canals and the water requirements of the various crops on the different parcels of land. Usually none of this is terribly difficult as much of this

arranging takes place within fixed patterns of relationships. Obviously, when water is short or unreliable, all of these fixed patterns need to be readjusted constantly and then the system becomes quickly very complex indeed.

Mesqa Maintenance Group

Mesqa cleaning is the collective responsibility of the farmers along the same ditch. This cleaning is done during the winter closure. The way it is done is by announcement during the Friday prayer. Farmers gather and each farmer either cleans his part himself or provides the labor needed for cleaning his part. Mesqa cleaning is usually done manually. Last year the farmers on Um Zarifa (Minufiya) decided to have their mesqa cleaned mechanically. They went to the district engineer and requested a crane to come and clean the mesqa. The engineer then informed the agriculture cooperative to provide him with all the names and field sizes of the farmers on the mesqa. As soon as this list was provided a crane was sent to clean the mesqa. The expenses were then calculated, each according to his holdings, and a list of charges was sent to the agricultural cooperative of the village to be deducted from the farmers' incomes.

Farmers were not happy with the job done by the crane. In addition to having to give the driver money (tips) so as not to

cut their trees along the banks or dump the mud on their crops, they were dissatisfied with the cleaning job itself. They complained that the crane did not dig the areas at the end of the mesqa deep enough and destroyed parts of the banks which affected the flow of water. They felt that manual cleaning was better, therefore they planned to contract labor the next year and have the mesqa cleaned by hand.

As for the mesqa of Um Yaddak (Qalyubiya) the banks are too narrow to facilitate the movement of the crane and therefore the mesqa is cleaned manually. This year the farmers organized themselves and gave the responsibility of cleaning to one chosen from among them, who in turn contracted labor to do the cleaning. Expenses for the job were calculated and divided among the different farmers according to their holdings. Some of these farmers did the actual work of cleaning as part of the contracted labor and were paid for their work.

In previous years farmers on Um Yaddak asked the agricultural cooperatives and the Local Popular Council to clean and dig out the mesqa. These officials provided contract labor to do the job but the farmers were dissatisfied with the job and they complained about the price they had to pay. They accused the officials of being dishonest. They complained about the job itself, which was

not done properly. The dirt was thrown on their fields which destroyed part of their crop, and the trees on the banks were cut down. This latter was an important loss because they sell these trees themselves to the nearby charcoal factory. Therefore, they decided this year to get someone from among themselves to be in charge of the cleaning.

The design, construction, and repair of the mesqa is the responsibility of the Ministry of Irrigation. This is an important limitation on local farmers' control over even this lowest level of the water delivery system. For instance, the farmers on Um Yadduk mesqa cannot themselves arrange to replace the leaky pipe across the drain, even though it is a relatively simple problem. Nor can they legally take steps to improve the faulty intake at the head of the mesqa. There is a certain ambiguity regarding the mesqa in that although it is a "private" rather than a ministry waterway, the ministry still retains important prerogatives that greatly effect the efficiency of mesqa water delivery.

Saqia and Pump: The "Virtues" of a Mixed System

In recent years the increased availability of the diesel pump has revolutionized local irrigation in the Delta Lift System. In the Delta system, water is made available "everywhere", but for a limited time (five out of fifteen days in winter, seven out of

fourteen days in summer). The availability of the pump has broken through the time barrier. In irrigation, "time is water".

Pumps were first introduced into the Qalyubiya site in 1967 by a large landowner who bought a fourteen horsepower Shoubra brand (manufactured in Egypt). The first pump in our Minufiya site was introduced in 1976. Today the pumps range from four to fourteen horsepower and cost between L.E. 500 and L.E. 1200. Rental of the pumps ranges from between 60 PT. and L.E. 1 per hour. There are many pumps available in the Qalyubiya site, but the Minufiya site has only six in the local village, and two of these were purchased during the period of our research. A pump takes between two and six hours of operation to irrigate one feddan, depending upon the level of the water and the power of the pump.

The pump has not replaced the saqia ring system as an organization of fundamental importance. Ironically, the diesel pump has strengthened the social solidarity of the saqia ring. In discussing the diesel pump, observers often make much of its mobility in contrast to the fixed nature of the saqia. We need to be precise about the advantages and limitations of this mobility. Most fields are not next to the mesqa or a canal. Water must reach them through a series of small surface ditches called merwa. These ditches lead from the saqia structure at the side of the

mesqa to the fields. Diesel pumps, then, most often use the saqia structure as the place of operation: the hose draws water from the saqia well and the water is pumped into the usual system of surface ditches for conveyance to the field. The importance of the pump's mobility is that it can be easily moved from one saqia to another according to need and demand. Another important use of the pump in conjunction with the saqia involves using the pump to fill a mesqa. Farmers along a dry part of a mesqa will combine and rent a pump to fill up their mesqa from a large canal or drain, and then they separately use their saqias to lift the water up to the surface ditches leading to their fields.

Farmers emphasize the importance and uses of both the pump and the saqia, each device being preferred under certain situations and for certain tasks. Pumps are useful or necessary under the following conditions:

(1) Farmers expressed their preference for pump use when the soil is very dry, i.e. between two crops (after the harvesting of a crop and before the planting of another) because the soil will need a lot of water and saqias would take too long and exhaust the animal in the process.

(2) When the farm is located far away from the saqia and there is a pump emplacement and a pump close by, the pump is preferred.

(3) Another reason is the level of water. As the water level falls the pump is used to save time and effort on the part of the animals used.

(4) Rich farmers also expressed their preference for pump use since in doing so they are hiring labor (the pump operator) and if he is irrigating clover or orchards where water quantity is not crucial, the farmer's presence might not be needed at all.

(5) Also related to this is the fact that farming has become a secondary job for some farmers and to complete irrigation in a short time they prefer using the pump. (The rough estimate is that the pump takes one third the time used by the saqia).

(6) During bottleneck periods the pump is preferred so as not to miss the rotation cycle.

On the other hand, farmers unanimously agreed that the saqia is preferred:

(1) In the case of irrigation of maize, soya beans and vegetables. For these crops a gentle flow of water is required, and, for those crops that are cultivated in basins, farmers need the time to be able to open and close each basin as the water comes to it.

(2) By farmers who keep animals and plant traditional crops. The labor is provided by their animals which they keep anyway, therefore they can avoid the expense of the pump.

(3) Fragmentation of land is another reason for using the saqia since pump owners do not rent their pumps for small land holdings.

(4) For some farmers, using the saqia is better in order to preserve mesqa banks as well as the banks of their surface ditches, merwas.

Our data suggests a certain pattern. It is clear that farmers with small holdings, numerous children, planting traditional crops and keeping an animal or two, prefer using the saqia while rich farmers with large land holdings, planted in orchards or clover prefer using the pump. The current government plans to replace all the saqias with mobile pumps do not represent the desires or the best interests of the poorest of the land-holding farmers in our two Delta research sites.

Regarding saqias and pumps, the farmers view it thus:

"I would never give up my share in the saqia. Pumps might not always be available when I need to irrigate."

"Saqias and land go hand in hand. You can't sell land without a water passage."

"Saqia repairs are not too great since we do not use the saqia much, but its existence gives us security, in case we need it."

"We can't use the pump because our surface ditch, merwa, is too narrow to allow the flow of pumped water without destroying it. We do not have a sump to facilitate a gentle flow."

"I prefer using the pump in irrigation because it is faster, but our field is small and no pump owner would come just for us. If the pump is working for our neighbors we reserve a turn after them. We can't leave it to chance, if the pump is not available in the area the saqia is always there."

The opportunity to use pumps in some situations and the saqia in others is especially important for those farmers who are the most economically vulnerable: widows, the elderly, those with small and fragmented landholdings. The following are a few examples from among those we interviewed.

Fardus Mitwally, married woman, owns 18 qirats, 12 q. located on saqia No. 1 and 6 q. on saqia No. 2. She plants her land in wheat one year and in berseem the nextt, with a small area of vegetables for her home consumption. Her main and only job is farming. She thinks that farming is not a tedious job nowadays because of the machines introduced. She hires a pump for 60 Pt. per hour for irrigation but she would not give up her share in her two saqias for fear the pump would not always be available or would be out of order.

Mohamed El Sayed, farmer, 56 years old, owns one feddan which he inherited from his father. He is part of one saqia ring. He plants berseem and wheat and sometimes potatoes. In summer he plants maize. He irrigates by saqia when water is low and by gravity when water is high. As soon as his children get jobs, he will shift to orchards because this would not require a lot of labor and its net profit is high.

El Shahat, 30 years old, farm laborer, works for daily wages, owns 20 qirats divided in two parcels, each 10 q. He uses the saqia to irrigate. He has a cow and a donkey. If he is away on a job his wife irrigates instead of him. He uses the pump only between two crops when the soil is very dry.

Om Ezz Attia, 65 years old, widow, has four children, including two daughters married in the village and two sons

working in Cairo. She uses the saqia to irrigate 6 qirats which she plants in wheat. She does not own any animals but rents a cow for L.E.1 to irrigate. If the pump is around she rents the pump. In summer she experienced water shortage and had to irrigate at night.

Coping with Water Shortages

Water shortage has different meanings to different farmers. To the farmers who irrigate by gravity flow in Minufiya, water shortage means they can not irrigate by gravity but must lift the water. To other farmers, water shortage means that the water rotation does not correspond to their own crop requirements of irrigation. Again to some, water shortage means that they can not irrigate during daytime. At the extreme, water shortage means farmers can not find water in the mesqa during the "on" period of their canal.

Most of the farmers who complain about water shortages in Qalyubiya (Um Yadak mesqa) are located in the middle part of the mesqa after it crosses the Aghour drain. Shortages were experienced three times during the year: in October (before the winter closure), in March, and during the summer months.

The way farmers overcome these shortages depends on the location of the field vis a vis the source of water. On Um Yaddak,

for instance, if the field is located between the beginning of the mesqa and the drain, the farmers come together and rent a diesel pump to draw water from the main canal "Kom Beteen" to the mesqa. From the mesqa each farmer uses either his saqia or another pump to get the water to his field. The group renting the pump pays collectively for the pump's use.

As to those located by the drain, when shortages occur they rent a pump to draw drain water for irrigation. Again the method used is the same. A group of farmers rents a pump, calculates the time needed to fill their part of the mesqa, divides the cost among themselves, then each draws water to his farm using his own method.

Those at the tail end of the mesqa have other options. Some who are near another mesqa with an alternative schedule, route that water to their land. Rarely, if a farmer along Um Yaddak is near a groundwater well, he will pump that water for irrigation.

Some responses from farmers on Um Yaddak are:

"Because we are located near the tail end of the mesqa when there is no water in Um Yaddak we divert water from Megaz El Hefny which gets its water from Ragabia canal and El Bagamoum".

"I have used water three times last winter from El Bassusiya (main canal) by renting a pump and pumping water into the mesqa."

The case of Kalata and Um Zarifa in Minufiya is different. The supply of water of this mesqa is sufficient since it is the first mesqa on the main canal. But in some locations on the mesqa, farmers complain of shortages.

For example, some farmers on Kalata located on the last 200 meters experience water shortage in that they have to lift water rather than irrigate by gravity. This kind of shortage is also experienced by farmers located on the last 150 meters on the branch mesqa Um Zarifa. Also farmers on Um Zarifa have a tail end problem. The branch mesqa passes through a small village where houses have been built and consequently a crane cannot be provided for the cleaning. Also, the mesqa cannot be cleaned manually because it is used as a dump for sewage and trash. Filth, broken glass, rusty tins and such debris make cleaning by hand dangerous and difficult.

To overcome these "shortages", those who normally irrigate by gravity use pumps. But others use drainage water from the drain pipe collectors. They block the cement pipe of the collector until the water level rises then use a pump to apply the water to their crops. They know that the water quality is not good but as they use it only in emergencies they think it will not harm their crops. Of course, this method can not be used except on farms

having drainage collectors. A few farmers at the tail end do not have these alternatives. When they experience water shortage, they must just wait for the water to come. As one farmer from Um Zarifa said: "Last year the yield of my potatoes decreased because I missed one irrigation. We could not do anything to get the water except complain to the district engineer who could not help us."

Farmers and Irrigation District Engineers: Different Perspectives on Water Shortages

From the farmers' point of view, these various types of water shortage are largely the fault of the Ministry of Irrigation, cooperatives, and other government activities and inefficiency. When asked about the reasons for the shortages, farmers typically cited the following causes:

1. Compensatory time which is allowed by the district engineer. The district engineer receives complaints and requests for additional water on a certain canal which he has to grant, and in so doing causes farmers on other canals to experience shortages.

2. Changing crop mix pattern which alters crop water requirements. The water comes when the crop does not need it. This is brought about by individual farmers

growing short period, water demanding crops such as vegetables. As one farmer put it, "During the summer the supply of water is limited. Summer crops such as vegetables and maize require excess water, they are irrigated every rotation in contrast to clover which is irrigated every other rotation. If the rotation does not come on time the crop is harmed."

3. Water rotation schedule does not match timing of supply of seeds, fertilizers and labor for the growing crops. "How could we irrigate before planting the seeds and preparing the fields. We have quarrelled with the cooperative officials to get our allotments of seeds and fertilizers but they are not to blame, they have not received these things from the district office."

"I tried to cultivate half a feddan of Soya beans in my field that is irrigated by gravity but it was exhausting because of all the weeds needing to be cleaned. It requires a lot of labor and I could not manage to get even school boys to work with me and of course the water does not wait until I manage my labor problem.

4. Public works projects such as digging of a new mesqa or changing an irrigation or drainage pipe. Completion of this work is not always on time and delays occur which in turn affect the water rotation schedule.

The district irrigation engineers, however, had a different view of the nature of these problems of shortages. Although they admitted being short staffed and consequently behind on a lot of basic maintenance, the engineers generally tended to blame the farmers for problems of water shortage. The engineers rely on their scientific calculations of water allocation. These numbers show that there is enough water. In answer to our questions about farmers' worries about water shortages, the engineers maintain that the farmers rarely experience real shortages.

They use more water than needed. "During the winter, because berseem is not harmed by over watering most of the farmers apply more water than the crop really needs. This in turn affects the level of water table. During the summer, on the other hand, water is not plentiful but is sufficient. Farmers are lazy, they want the level to be high so that they would irrigate by gravity. Also they go against the crop rotation and grow crops with water requirements which do not match the rotation and quantity

allowed. Also rarely do they irrigate at night in spite of the system which is designed for twenty-four irrigation."

On the other hand, the district engineer for the Qalyubiya site readily agreed that the Um Yaddak mesqa needed to have its entry pipe lowered in order to receive the correct amount of water. But he lacks adequate time, staff and maintenance funds.

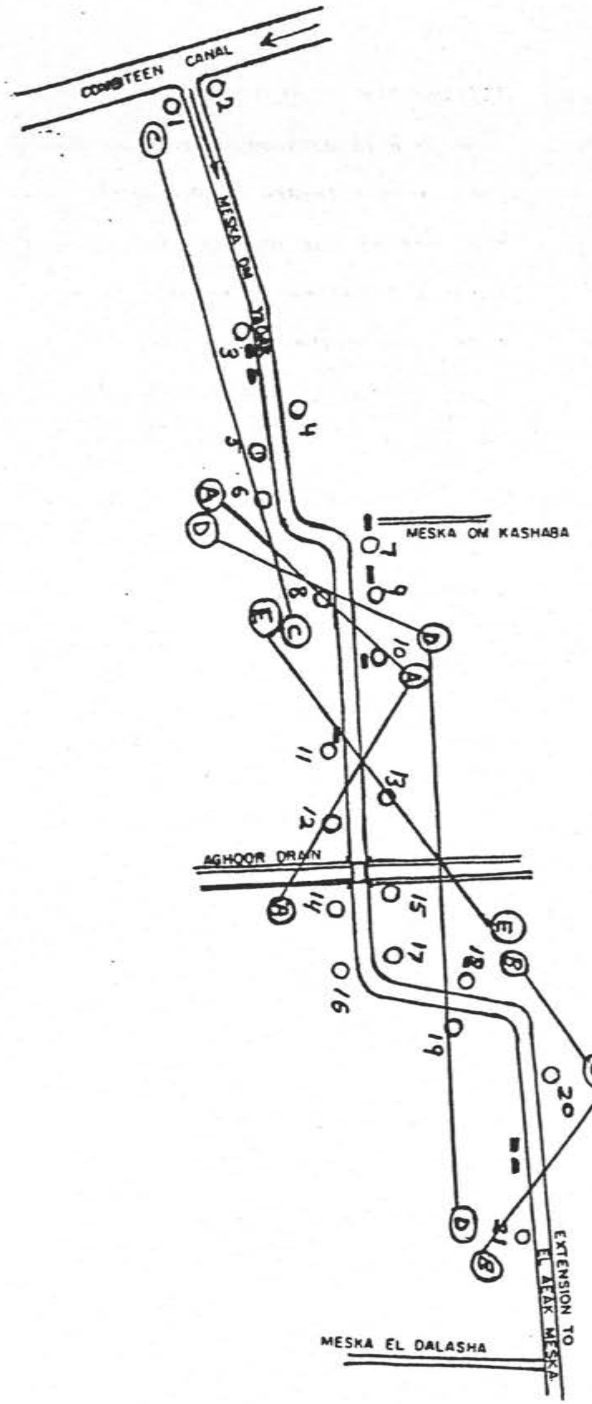
Factors Inhibiting Conflict over Water Allocation

The most striking aspect of the local social relations surrounding Delta water allocation is the low incidence of overt conflict and dispute, in spite of the fact that the institutional apparatus regulating local water allocation is minimal. Other irrigation systems in the world are known for their ancient communal water user associations (Spain, Philipines, Bali), complex legal and financial corporations and associations (American Southwest), or armed guards patrolling the gates of government irrigation systems (India). Delta farmers manage to avoid conflicts with a minimal internal or external institutional structure. Several factors served to inhibit conflict in the Delta irrigation system in 1983.

1) Availability of Water. Water shortage is, as we have said, a relative concept. Delta farmers face situations in which

lifting the water becomes more expensive or more time-consuming. They face situations where they must pump from a drain instead of their proper feeder ditch, or they must irrigate at night. During the year of our observations, never did any farmer fail to find water and the means to lift it to his field. This does not mean that water delivery was most efficient or most beneficial to the crops or that it cannot be improved upon. But regarding the issue of conflict, the fear of absolute water shortage and total resultant crop failure is not part of the psychology of the Delta farmer. The overall level of irrigation anxiety is less than that reported for other areas of the world.

2) Fragmentation of Field Holdings. A common source of conflict in local irrigation systems elsewhere in the world is the competition between head enders and tail enders. This conflict is mitigated in Egypt by the fragmentation of land holdings and consequent multiple membership in saqia rings. Any one farmer has lands at several locations along the feeder ditch, and maybe along another one as well. On one hand this spreads his risk and minimizes the level of anxiety. But it also means that the tail ender, or "middle ender", who is not getting water is in competition with himself as well as with any other party. The map of Un Zarifa saqias shows the distribution of some of the farmers' fields. Tail and "middle end" problems are real, but they are not transformed into tail-ender versus head-ender human conflicts.



Examples of Multiple Membership

Farmer A belongs to Saqias 6, 10, 14
" B " " " 18, 20, 21
" C " " " 1, 8
" D " " " 6, 10, 21

Fig.11. Distribution of Sakia and Farmers on Mesq Um Yaddak

3) Village Social Relations. Conflict is unacceptable to the interrelated and intermarried inhabitants of densely packed Delta villages. A dispute over water would permeate and poison every aspect of village and family life and make life intolerable. The price of dispute is a high one which people are not willing to pay for the sake of cheaper water or more convenient water. Conflict which was lessened by availability of water and diffused by land fragmentation, is mitigated by the social embeddedness of the irrigation system. For instance, at Um Zarifa there was a farmer who bought a piece of land that was located after saqia 4, but his water came from saqia 3, through a surface ditch passing by saqia 4. If someone were using saqia 4 while this farmer was trying to irrigate from saqia 3, the water would get diverted. There was considerable tension between this farmer and various members of saqia 4 until a marriage was arranged between his family and one of the members of the offending saqia ring. After that whenever he needed to irrigate this problem field, he was able to borrow time on the closer saqia from his in-laws.

4) Pump/Saqia Combination. The availability of diesel pumps has removed the most critical source of conflicts - the constraint of time at the saqia. Five years ago disputes were common and bitter among saqia ring members over the scheduling of saqia turns during the "on" days of the canal rotation. The constraining fac-