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Understanding Mesqa and Marwa Water Management Practices in IIP areas of the Nile Delta

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Understanding Mesqa and Marwa Water Management Practices in IIP areas of the Nile Delta

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Abstract

Based on primary research in the Nile Delta, this report evaluates the impact of the irrigation improvement projects, and also analyses the factors that shape the water management practices of farmers. It demonstrates that irrigation management practices are shaped by informal organisational and institutional arrangements of farmers which primarily evolve from socio-political structural relations. The boundaries of water management arrangements are not rigid and often overlap, and are influenced by the socio-culturally embedded institutions. It further demonstrates that coping mechanisms of farmers like direct pumping from the canal or reusing drainage water are major factors that shape the equity of water distribution and the efficiency of water use at the lowest levels of the irrigation system. Based on the observations, the report offers a set of recommendations that might improve the adaptability and impact of the improvement projects.

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List of Abbreviations and Illustrations

Glossary and List of Abbreviations

ICARDA	International Center for Agricultural Research in the Dry Areas
ARC	Agricultural Research Center
NWRC	National Water Research Center
IIP	Irrigation Improvement Project
IIIMP	Integrated Irrigation Improvement and Management Project
PIM	Participatory Irrigation Management
IMT	Irrigation Management Transfer
WUA	Water User Association
CPR	Common Property Resource
BC	Branch Canal
IP	Individual Pump
Feddan	Unit of land (0.42 hectares)
Sakia	Persian Water Wheel
Mesqa	Tertiary Canal
Marwa	Quaternary Canal
Tatweer	Development – Used to refer to irrigation development projects
Islah	Land reform
Milk	Owners

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1 Introduction

1.1 Context

The economy of Egypt is primarily agrarian with 58% of the population engaged directly in agriculture. Irrigated agriculture utilises 86% of Egypt's annual share of 55.5 milliard cubic metres from the river Nile (El-Nahrawy, 2011). The Nile Delta covers an agricultural area of 2.5 million ha (app), which contains a dense network of canals that transfer water from the Nile to nearly two million farmers. Large-scale development and land reclamation projects and the demand of water in various economic sectors have increased the pressure on the available water resources for agriculture (Hamza and Mason, 2005). A significant amount of water is diverted to industrial and municipal use and for the development of the reclaimed lands. It is expected that the pressure will further increase in the future. Rising operations and management costs coupled with the need to improve efficiency of irrigation system led to the introduction of irrigation reforms in the form of infrastructure improvement and more user participation in management (Aziz, 1994). In the last two decades, various irrigation reforms projects have been initiated by the government as part of the Integrated Water Resource Management (IWRM) action plan made by the Ministry of Water Resources and Irrigation (MWRI) with the objective of improving water use efficiency, equity of water distribution and for saving water (MWRI, 2005). The Egyptian case is a typical example of the dominant global paradigm of irrigation reform process. The reforms have been shaped by the neoliberal paradigm and driven mainly by the lack of adequate government funds for irrigation operations and maintenance, increasing rate of degradation of infrastructure and need for better accountability (Turral, 1995; Svendsen *et al.*, 2000; Ghazouani *et al.*, 2012).

The irrigation reform process of the Egyptian government has been supported by many major donors like the World Bank, USAID etc and they have funded projects like the Irrigation Improvement Project (IIP) and Integrated Irrigation Improvement and Management Project (IIIMP) for technical and institutional reform at various levels of the irrigation system. IIP/IIIMP's central objective was to introduce collective pumps at the tertiary level (*mesqa*), in place of individual pumping by farmers, and distribution by a pressurised piped network, sometime extended to the plot level. IIIMP is, in theory, planned to be gradually implemented across Egypt.

This report evaluates the impact of the projects on the water management arrangements of farmers at the lowest level, and also explores how farmers have adapted the technical changes. It must be added that the organisational and institutional arrangements of farmers that shape water management practices, and the impact of the irrigation improvements on these arrangements are still largely unexplored. Based on primary research in W10[1] area in the Nile Delta, this report aims to unpack the organisational and institutional arrangements of farmers which shape water management practices.

The field work and the report are part of the research project 'Management of water and salinity in the Nile Delta: A cross-scale integrated analysis of efficiency and equity issues' led by the research organisation International Water Management Institute (IWMI), Egypt. The project is financed by

[1] W10 is a pilot area in Kafr El-Sheikh Governorate, which comprises 6,000 *feddans* in the downstream tail-end area of the Meet Yazid command canal, as shown in Appendix 2. The second phase IIP package and on-farm improvements have been implemented in this area.

the Australian Center for International Agricultural Research (ACIAR) and is a cooperation between international (IWMI, ICARDA) and national research institutions (ARC, NWRC).

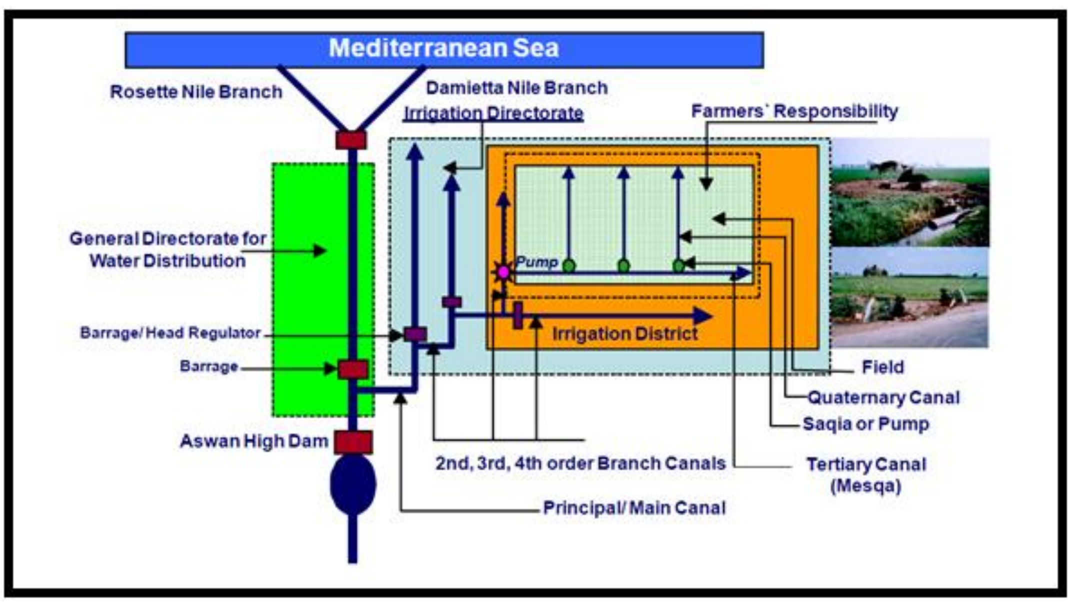
One of the major limitations of the study is the insufficient analysis of the impact of gender relations on organisational arrangements. As both the researchers were men, it was not possible to interact with women due to the cultural boundaries of the rural Egyptian society. Hence, the study is constrained by its male bias in respondents' selection.

The report is divided in five chapters. Chapter I contains the description of the irrigation system and the improvement projects, along with the research details. The basic observations in the Masharqa branch canal (BC) are explained in Chapter II, whereas the next chapter explains the characteristics of two pump stations. Chapter IV contains a detailed discussion of the water management arrangements. The discussion drawing on the evidence is presented in the next chapter, which also concludes the report along with a set of recommendations.

1.2 Traditional irrigation system

History of large-scale artificial irrigation in Egypt goes back to the Ptolemaic period (300-1 BC) when the *sakia* was introduced, and history of modern-day irrigation can be traced back to the construction of the High Aswan Dam in the 1960s which was followed by the foundation of the current delivery system (Manning, 2012). The delivery system is four-tiered with main canal, branch canals (BC), tertiary canals (*mesqa*) and the quaternary canals (*marwa*) as shown in the figure 1.1. Main canals run on a continuous basis, while the distribution at the branch level is done on a rotational basis. The *mesqas* and *marwas* are considered as private channels, owned and managed by the farmers.

Figure 1.1: Irrigation System in Egypt



Source: Kotb and Boissevain (2012)

The government is responsible for water management and operations and maintenance till the branch canal level, while the water distribution and operations and management at the tertiary and quaternary level are the responsibilities of the farmers (Allam, 2004). The *marwas* cover 1-5 hectares comprising 5-20 farmers, while *mesqas* cover 5-40 hectares and 25-100 farmers. Studies like Radwan (1998) etc have pointed out that even though water allocation in the main canal is supposed to be done on the basis of cropping pattern under the canals, it is actually done on the basis of need of the branch canals as assessed by the department, due to the scope of error in the earlier system. The objective is to maintain the canal level to a predetermined height. Similarly the flow in the branch canals is controlled by maintaining a certain level of water rather than a precise amount based on the demand of farmers or the crop pattern.

The *mesqas* are earthen ditches lower than the branch canal and get water based on the rotation system in the branch canal. A BC supplies a number of *mesqas*, based on a rotation schedule which is loosely based on the rotation system which divides the water of the main canal in various BCs. The *mesqas* are made lower than the *marwas*, and farmers have to lift water from the *mesqa* to their *marwa* using individual pumps. Before the use of pumps became widespread, water distribution at the *mesqa* was based on the *sakias* which lifted water from the branch canal to the *mesqas*, to be shared on a rotational basis. The *sakias* also defined the lifting points on the branch canal, for the farmers of each *mesqa* (Hopkins, 1999).

An important part of the irrigation system is the drainage network that covers the entire Nile Delta and releases about 12 BCM/year of drainage water to the sea (Allam *et al.*, 2005). The network consists of a web of laterals and collector drains, which collect the local run-off and surplus water after irrigation and convey it to the open drainage canals. It is primarily used to control the water table and salinity of the soil. The reuse of drainage water is a common practice in the delta region and the tail-enders use both drainage water and fresh canal water for irrigating their crops (Moustafa, 2004). It is also mixed with fresh water at secondary and main canal levels, through pumping stations established by the ministry.

1.3 Irrigation reform

The major projects for irrigation reform have been IIP and IIIMP. The primary objective of IIP is to improve irrigation water use efficiency and agricultural productivity. The improvements planned under the package are:

- Infrastructure improvement at the branch and secondary canal levels.
- Conversion of rotation system of water distribution at branch canal level to continuous flow.
- Mesqa technical improvements:
    - Replacing *mesqa* ditches with pipes or brick-lined channels
    - Single lifting point at the head of a *mesqa*, in the form of a collective pumping station.
- Organisation of farmers in water user associations (WUA) for irrigation management at mesqa level.

The plans were to make the water supply continuous and demand-driven through collective pumping and therefore reducing the over-irrigation believed to be generated by the uncertainty in supply. The individual lifting points were replaced by a single collective pumping point for the same reason. WUAs have been formed at the *mesqa* level for operations and maintenance of the improved *mesqas* and collective pump stations, improving water delivery and water use efficiency, and conflict resolution (MWRI, 1998).

IIIMP was launched to build on the experience of IIP and to extend the improvements to the *marwa* and farm-levels. One of the major components of the IIIMP package is the on-farm improvements which include the following:

- Replacing *marwa* ditches with a pressurised pipe and valve system, based on the length of the *marwa* ditches and the consent of the farmers.
- Land levelling of the plots.
- Promoting water management techniques like irrigation scheduling etc.
- Organising farmers of a quaternary canals in Marwa Committees (MCs).

The aim of replacing the earthen ditches was to increase the distribution efficiency. The project is expected to improve the conveyance efficiency and farm-level efficiency. A major focus of the project is on the management of the drainage system. The project is driven by the need to reduce the reuse of drainage water at the local level, which would be followed by an increase in the official reuse of drainage water at the secondary and main canal levels (World Bank, 2010). The technical component also includes improvements in the drainage system at the farm level and branch canal level. The institutional component of the project includes organising farmers in WUAs and branch canal water user associations (BCWUAs).

In tune with the principles of irrigation management transfer (IMT), the farmers are expected to repay a part of the capital costs of *mesqa* improvements over a 20-year period. They are also expected to repay the total costs of *marwa* improvements over a similar period.

Review of Evaluation Studies

The projects aimed to improve both the efficiency (water saving of 10% to 30%) and the equity of water distribution. Increasing the participation of water users in the operations and management at various levels of the irrigation system is expected to help in improving the equity and efficiency. Most of the studies (El-Agha *et al.*, 2011; Kotb and Boissevein, 2012; MWRI, 1998) have evaluated the projects in terms of the narrow objectives of equity, efficiency and productivity. Some studies have also evaluated the impact of organising farmers in WUAs. This section attempts to review the existing literature and studies on the impact of the socio-technical package.

As mentioned earlier, a major objective of the package was the conversion to continuous supply at the branch canal level. But most of the studies have pointed out the failure to introduce continuous flow operations. Simas et al. (2009) have evaluated the *marwa* improvements based on preliminary observations in the W10 area, and they have argued that the package has resulted in the improvement of conveyance efficiency, irrigation time and on-farm irrigation efficiency. They have also documented an increase in crop yield, water productivity etc. Most of the studies like Kheira (2009) point towards reduction in operating costs and time required for irrigating each feddan. The shift from diesel pumps to collective electric pumps (either through the IIIMP project or by the farmer themselves) has reduced the operating costs. At the same time, irrigation time available per feddan has increased, due to the continuous operation of the pumps for 20 hours/day. Similarly, increase in supply adequacy, irrigation efficiency and subsequent water saving have also been documented. A qualitative study (Gouda, 2009) was conducted by GTZ in the W10 area in 2010 to understand the socio-technical impacts of the experimental *marwa* improvements. The study suggests that there has been improvement in the efficiency and equity of water distribution, and there have also been social benefits like reduction in conflict and more participation of women in irrigation etc.

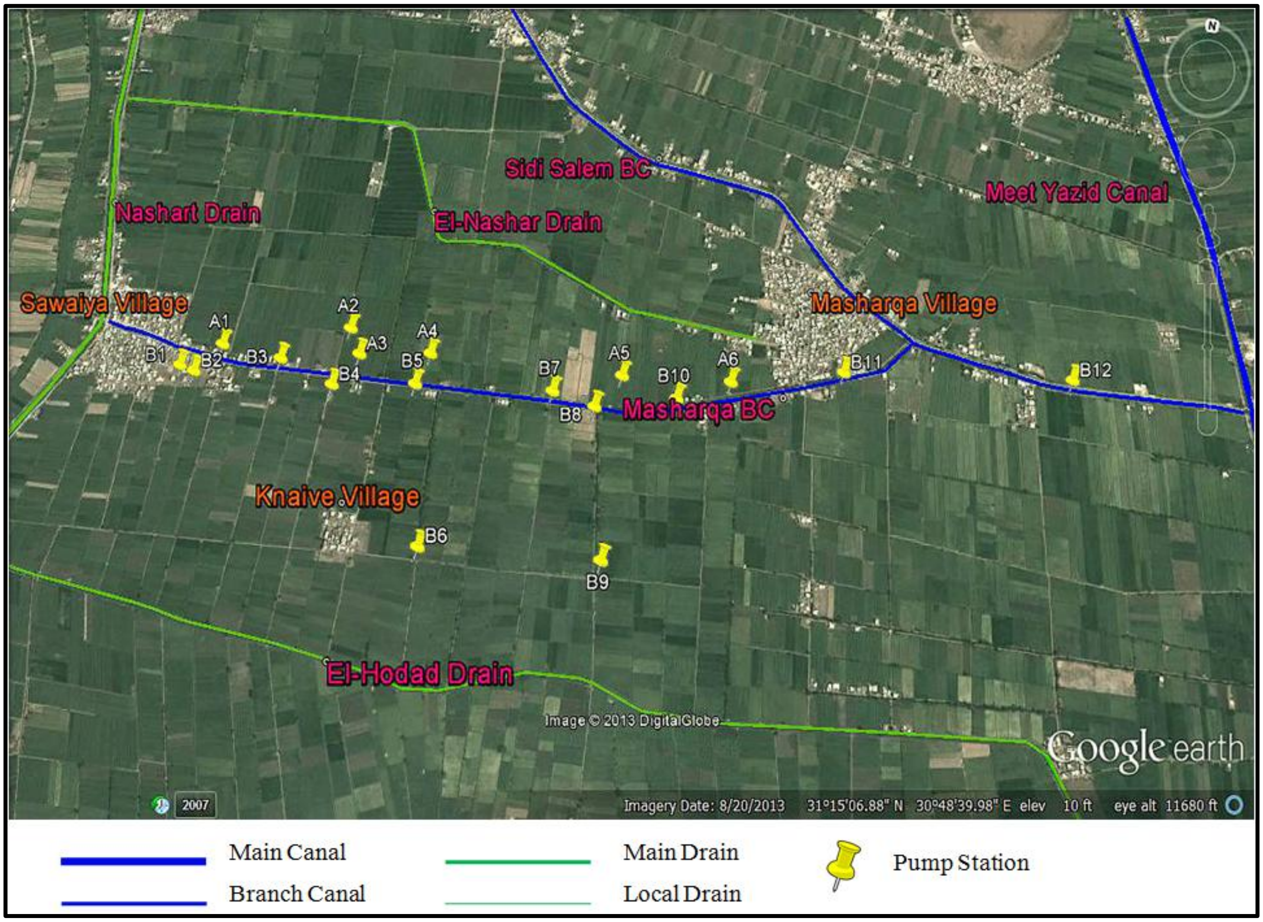
Even though most of the studies point towards the benefits of the projects in terms of equitable water distribution, water use efficiency etc, none of them have evaluated how the water management practices are shaped at the lowest levels and how the socio-technical improvements affect social arrangements and the water distribution. This study aims to fill that gap.

1.4 Study area and methodology

The study is based on the *mesqas* in the Masharqa canal, which covers three villages, Masharqa, Knaive and Sawaiya from the head to tail respectively. The Masharqa canal is one of the branch canals of the Meet Yazid canal in the W10 area. The Meet Yazid canal is 63km long, and serves 60 branch canals, covering a command area located in two Governorates, El-Gharbeya and Kafr El-Sheikh. It gets water from the Bahr-Shebin carrier canal which is primarily fed by the Delta barrage. As the pilot area is at the tail-end of the main canal, it faces periods of water shortage during peak summer season.

Masharqa canal has 18 electric pump stations (A1-A6 and B1-B12) along a length of 4.2kms, as shown in figure 1.2. The pump stations were constructed at the head of each major *mesqa*. It branches off Meet Yazid at km59.50, and meets the Nashart drain at the end, as shown in figure 2.1. A sub-branch of the Masharqa branch canal, Sidi Salem BC branches off after the pump station B12. The Nashart drain which was originally a canal, is made artificially higher through the operation of the gates constructed in the drain downstream in Sidi Salem, and hence a major part of the water in the canal is drain water, that is allowed to flow by gravity from the Nashart drain.

Figure 1.2: Research Site



It also must be mentioned that even though, with two exceptions of the sub-BCs, the original *mesqas* have been filled in, the main pipe system of each pump station is still referred to as *mesqa*, and the words *mesqa* and pump station have been used interchangeably in the paper.

Farmers in the *mesqas* B4, B6, B9 on the left bank, together with farmers of A1, A4, A5 and A6 on the right bank have access to the local secondary drains El-Hodad and El-Nashar respectively that border the command area on both sides, as shown in figure 1.2.

The basic aim of the research was to evaluate the socio-technical package with regard to water management practices and the arrangements of farmers around the *marwa* and *mesqa* improvements. A case study approach, involving various research tools including direct observation, semi-structured interviews, and unstructured interviews, has been taken to understand the micro-arrangements. Case studies are useful in doing an in-depth analysis of a social phenomenon or practice within its real life context (Yin, 2009). A major component of the field work was to observe the daily irrigation practices of farmers along the canal and the *mesqas* and *marwas*. The field work was done in three phases as explained below. The survey period (May-July) corresponded to the highest water demand in the year offering opportunities to study social interactions and coping mechanisms of farmers.

The first part of the field work involved a survey of all the 18 pump station (PS) command areas in this canal to understand the historical trajectories of their use and operations, and it was primarily based on semi-structured interviews with 40 farmers. The participants were selected on the basis of their positions along the *mesqa*. The information was used to create a profile of each pump station.

The second phase involved an in-depth analysis of the water management practices and organisational arrangements of farmers in two *mesqas* B4 and B7, selected on the basis of a matrix scoring of the pump stations profiles done by the researchers. Factors like, WUA management, practice of direct pumping from drainage and branch canal, conflict among farmers etc were considered for the matrix ranking. The matrix score card is attached in Appendix 3. The second phase involved observing the flow of water along the *mesqas* and *marwas*, and the various micro-interactions around it, and then unstructured interviews with the farmers based on the observations. In a third phase, it was attempted to zoom out and look at similarities and dissimilarities in other *mesqas* based on the observations in B4 and B7.

It must be added that the names of the respondents who have been quoted in this paper have been changed. The list of interviews is provided in Appendix 1.

2 Basic observations

This chapter describes the basic characteristics of the pump stations, and also explains the local socio-economic context.

The IIP package (*tatweer*) was implemented 5-6 years ago, whereas the *marwa* improvements were implemented three years back. *Tatweer* was initially refused by many farmers of the Masharqa area, but the construction company went ahead with the implementation. Many respondents claimed that they were forced to accept the package. It also emerged from the survey that there was confusion among the farmers regarding the financial aspect of the project. As mentioned earlier, the land owners have to repay a part of the loan in annual instalments which is added to their regular taxes. The land owners have to pay it irrespective of whether the pump station is working or not, and of whether they use it or not. But many respondents stated that they were told that the project was a grant from the government and external agencies, and they were not aware that they would have to pay for the improvements.

Table 2.1: Basic Details of Collective Pump Stations

Position along BC	S No.	Command Area (Feddan)	Farmers	No. of motors	Valves	Working status	Farmers opted out	Use of IP on BC	Use of IP on main local drains	Use of IP on local agricultural drain	Access to main local drains
Tail	A1	80	35	3	11	Working	No	No	Yes	No	Yes
	A2	27	12	2	3	Working	No	No	No	No	No
	A3	60	2	2	8	Working	No	Yes	No	No	No
	B1	28	20	2	2	Working	No	No	No	No	No
	B2	60	50	3	6	Working	No	No	No	Yes	No
	B3	45	60	3	4	Working	No	No	No	Yes	No
Middle	B4	72	90	3	13	Working	No	Yes	Yes	No	Yes
	A4	52	50	3	5	Working	Yes	Yes	Yes	Yes	Yes
	B5	20	40	2	3	Working	No	Yes	No	No	No
	B6	40	35	3	7/8	Not working since fire	NA	Yes	Yes	No	Yes
	B7	40	30	3	4	Working	Yes	Yes	No	Yes	No
	B8	50	NA	2	NA	Not working since beginning	NA	Yes	No	No	No
	B9	70	NA	NA	NA	Not working since beginning	NA	Yes	Yes	No	Yes
	A5	90	60	3	NA	Not working since last 3 years	NA	Yes	No	Yes	Yes
Head	B10	24	25	2	3	Working	No	Yes	No	No	No
	A6	20	10	2	3	Working	No.	Yes	No	No	Yes
	B11	20	1	2	3	Working	No	Yes	Yes	No	Yes
	B12	16	35	2	3	Working	No	Yes	Yes	No	Yes

A major objective of the package was institutional improvements in the form of WUAs and MCs. WUAs comprising five members were formed at each pump stations during the project implementation. The members were primarily selected by the engineer or by some influential farmers of the pump station. The five members comprise the president, secretary, treasurer and two other water users. Each pump station was received by some of the WUA members of that area. Some reports like Gouda (2009) have also mentioned that *marwa* farmers were organised in MCs, in this area. But the survey could not find any evidence of formal MCs; rather it was observed that the farmers had informal water distribution arrangements at the *marwa* level which will be discussed in Chapter IV. In this report, institutions and organisations promoted by the projects are considered as formal, while socially and culturally embedded institutional and organisational arrangements are considered as informal.

One of the primary objectives of the package was the conversion of the rotation system of water distribution to a continuous flow system. But it was observed that the flow in the BC was not continuous and was based on a rotation schedule controlled by the irrigation engineer, as it used to be in the past. Since the canal was also supplied from the Nashart drain at its tail end, the resulting regime of double water supply was quite irregular. Predictably, the middle stretch of the BC (between B4 and A5) faced varying degrees of water deficit.

A two-week period of water deficit in the BC was observed during the field work. It coincided with the peak irrigation season of rice transplantation. It was also observed that the pump stations stopped working, if the water in the BC reduced below a certain level because of the high level of the intakes of the pump stations. Only some pump stations at end namely A1, A2, A3, B1, B2 were operational throughout the period with the exception of two days, thanks to the availability of drain water. It can be seen from the table 2.1 that the characteristics of the pump stations are not homogenous. A major observation during the survey was that two pump stations (B8 and B9) were lying unused since their installation. It was also observed that water users of two of the pump stations (B6 and A5) which had stopped working due to some technical issue, had refused to get them fixed. Three major reasons were observed:

Pumps or electric wires stolen: Pump station B9 is not working since the beginning, as the pumps were stolen immediately after installation. It must be added that there was initial disagreement amongst the farmers about receiving the pump station from the implementing agency.

Conflict among farmers: Pump stations B4, B5, B6, B7 and A5 had stopped working after a fire in the electric supply. The transformer and the wires had burnt in the fire. All the farmers of that area collected money to get a new transformer. But water users of B6 and A5 refused to get the electric wires installed for their stations. B6 is lying unused since then. While at A5, farmers eventually installed electric wires, but the pump station has not been working since the last three years as farmers refused to get the PS repaired after some technical snag developed in the PS.

Initial disagreement: At B8, there was a disagreement among the farmers of that area about accepting the pump station from the implementing agency, and it lies unused since then. It was also mentioned by some farmers that the motors were eventually stolen.

These issues will be discussed at length later in the report.

A primary objective of the package was to replace the practice of individual pumping with collective pumping.

Before the implementation of the project, the farmers used to lift water directly from the BC or the *mesqas* using individual diesel pumps. The lifting points of the farmers were fixed, based on their *mesqas* and *marwas*. These individual lifting points were replaced with a single lifting point at the head of the *mesqa* with the aim to control over irrigation. An irrigation schedule has been designed each pump station for collective pumping. The collective water division is based on the irrigation schedule, and every unit area of land (feddan) gets a fixed duration of water supply. It can be drawn from the table that the practice of direct pumping from the BC and the drainage is still very common, and the practice is more common in the middle stretch of the BC. Also, the practice of drainage water reuse is a major coping strategy of the farmers against irregular supply in the BC. It also emerged from the survey that some farmers have opted out of the collective pumping system at some of the pump stations in the middle part of the BC like A4, B7 etc. Many reasons like conflict among water users, lack of adequate water from the CPS etc emerged from the field work that are analysed in detail later on. It was found during the survey that the water management practices and pump operations were influenced by the land ownership pattern which was then explored in the next stages of the research. It is discussed at length in the next section.

The *marwa* improvements included filling in the *marwas* and replacing them with a pipe-and-valve system, and land levelling. It was observed, however, that in most of the *mesqas*, the *marwas* have been kept open by the farmers even after shifting to the pipe and valve system. Multiple studies (Gouda, 2009; Simas et al, 2009) have documented that replacing *marwa* ditches with pipes has led to land savings and a subsequent increase in cultivable land. Our observations raise serious questions on the claims about land saving. Two reasons were pointed out by the respondents:

- Farmers prefer to keep the *marwa* ditches open so that they can be used if the pipe and valve system stops working for some reason.
- Traditionally *marwas* also represented the demarcation between plots and roads or between adjacent plots. Farmers have an apprehension that filling up the *marwas* adjacent to the roads by owners of land adjacent to those *marwas* might slowly lead to an encroachment of the road by those owners. And that would lead to conflicts. So, farmers prefer to leave the *marwa* open to avoid any conflict over land encroachment. But it is not the same for *marwas* between plots. Many farmers prefer to keep those *marwas* open to keep a clear demarcation between plots.

It was also pointed out by most of the respondents that replacing the *marwa* ditches with pipes had helped in saving water during irrigation. Other positive impacts of the package like reduction in irrigation time and cost were also pointed out. All the respondents further stated that the distribution of water had become equitable after the implementation of the project as all the plots along the *mesqa* got the same amount of water in a given duration. The impacts of the package are discussed in details in Chapter IV.

2.1 Ownership pattern

The agricultural arrangements and the land ownership pattern influence the water management practices and the operations. The agricultural arrangements are built around the land-people relationship. Even though there are not many landless farmers in the villages, there are large numbers of marginal farmers and sharecropping is a common practice in the villages. It is important to discuss the history of land tenancy in Egypt to understand the current arrangements.

The Agrarian Reform Laws of 1952 gave land rights equivalent to ownership rights to the tenants over the land they used to cultivate. As part of the *islah* (land reform) initiated by the government under the leadership of Abdul Nasser, many areas were nationalised and distributed to the landless and the existing tenants were granted perpetual tenancy contract renewal (Saad, 1999). Around 350 *feddans* of land owned by a Greek businessman in the study area (comprising the three villages) were also distributed amongst its tenants and labourers. This land comprises major parts of the area between the pump stations B4 and B7. Initially, the *islah* area was served by a large-scale central pump managed by the government, while the *milk* (owner) areas were served by *sakias*. But with the advent of small diesel pumps, the *sakias* and the *islah* pump were replaced by individual pumps and all farmers started using individual pumps.

In the 80s-90s, the government changed the land tenure laws as part of the liberalisation policies. The land rent ceiling was eventually abolished and the owners got back the right to evict the tenants while the tenants were given an option to buy the land they were tilling or to get a minor compensation from the owner (Springborg, 1991). The *islah* farmers of this area also got the option to buy the land through instalment over a period of 15-20 years. Many *islah* farmers have become the owners of their lands by now while the others are still paying their annual instalment. The economic differences between the *islah* and *milk* farmers have reduced over the years. A rich and known figure in the society, Rahman, stated, 'Initially, the *islah* farmers were poor. But now there is not much difference between the *islah* and *milk* farmers' (Interview 9, 12th June 2013). But the structural and social differences still exist and can be understood from the fact that they used different *mesqas* for irrigation or lifted water from different points along the branch canal, before the implementation of the projects.

People who own large areas of land often rent it out to small farmers for sharecropping. Two types of sharecropping arrangements were observed, 1) one-fourth rule – the tenant rents the land for a year, and has to give three-fourth of the yield to the owner at the end of the season, while every input is provided by the owner, and 2) money rule – the tenant rents the land for a year for a fixed amount of money and the owner is not responsible for any input and does not get any part of yield from the tenant. The tenants are dependent on the owners for the irrigation arrangements, in the first system. The owners pay the operations and maintenance charges for the pump station, and also arrange for individual pumps for direct pumping. The second system of sharecropping based on money, is more popular among the land owners. Musa, who rented land in the B8 *mesqa* for cultivating rice, said, 'The rent system in this area is based on money rather than one-fourth rule, as the owners feel that tenants don't work hard enough in the latter system' (Interview 50, 27th June 2013).

The areas under B8 and B9 are owned by a few large land owning families who have rented the land to other farmers. It emerged from the study that the land owners do not have any interest in the operations and maintenance of the pump stations, and the pump stations have been lying unused. The issue was clearly stated by a couple of farmers, who had rented land in the B8 area, 'this pump station (B8) has not been working since the beginning, and the pumps have also been stolen. None of the farmers agreed to receive the PS at the beginning. This area (both B8 and B9) is owned by rich farmers and has been rented out to other famers like us. So the owners don't care about *tatweer*. And they have not tried to get things fixed.' (Interview 51, 27th June 2013). It was further observed at other pump stations like B7, A4 etc that the tenants had little say in the operations and management of the collective pump stations, and were not part of any kind of decision-making regarding the operations. The tenants just follow the set of rules of the pump station. The impact of land ownership on collective pumping operations is discussed in the next chapter.

A3 and B11 present interesting cases of participatory water management. The command area of 60 feddans and 20 feddans under A3 and B11 respectively are owned by one family each. Even though a major objective of the project was to increase the participation of farmers in the operations through WUAs, these pump stations are serving only a couple of rich families. Hence, the rationale of collective pumping does not apply here, and the only difference for these families has been the conversion from diesel pumps to electric pumps.

2.2 Project planning and implementation

The layout and command area of the PS were decided by the engineers of the project without consulting the farmers, and the implementation was done by a contractor. The farmers did not have the choice to accept or reject the project. The evidence as discussed below also points towards the lack of adequate consultation with farmers regarding the layout and design of the project.

The engineers obtained the land ownership data from the local village cooperative and designed the layout and the command areas of the pump stations based on their plans. After completion of the project, the respective PS and the associated water distribution systems were handed over to a group of farmers which was selected by the engineer in consultation with some large landowning farmers, or in some cases by the engineer only. Those farmers comprised the WUA. It also emerged that many farmers did not want the improvements, and were not comfortable with paying for the improvements.

Two major issues were raised by the respondents regarding the pump station layout:

- **Large command area:** Some pump stations like B4, A3, A4, A5 etc have large command areas in the range of 60-90 feddans. It was pointed out by the farmers of these pump stations that large areas make operations difficult and lead to more conflicts.
- **Lack of consultation:** Farmers were not adequately consulted during the design of the layout. The layout and command area under the pump stations were decided by the project engineers. Before the project implementation, all the *mesqas* had specific lifting points on the BC. Many such *mesqas* were clubbed together and brought under one pump station, without consulting the farmers. A farmer of B8 stated the significance clearly, ‘Farmers of this area used to irrigate from the sub-BC (the one connecting the BC and the PS B9) earlier. So the farmers of B10 did not want them to become a part of the B10 area, as we did not take water from that part of the BC in front of B10 area earlier.’ (Interview 52, 27th June 2013). It was observed that at some pump stations like B4, B2 etc, the clubbing of various *marwas* and lifting points under one collective pump station had been accepted by the farmers, whereas it was one of the major issues at some pump stations like A4, B7 etc. The trajectories of B4 and B7, discussed in the next chapter, explain the issue in details.

It emerged from the survey that some of the pump stations were officially received by signing an official paper, by a group of farmers with the consent of other farmers of that area, while a few were received by individual farmers or a limited group of farmers without the participation of other water users of that area. Pump stations like B8, B9 etc were received by individuals, whereas B4, A1 etc were received by a group of farmers. It was observed that there were distinct differences in the management of these pump stations. Pump stations which were received by a limited group of farmers or individuals were managed poorly compared to other pump stations. A farmer of A4 explained the reason of poor management in his own words, ‘Here many farmers were not ready to accept the PS at the beginning. So it was used by only a few farmers who received it. Eventually other farmers who were initially not ready to accept *tatweer* also wanted to become a part of the PS, and this led to conflict. Farmers have not collectively decided anything here. This leads to conflict and misunderstanding.’ (Interview 34, 17th June 2013). In most of the pump stations, the process was dominated by the rich and large landowning farmers. Sarfaraz, a farmer of A4 and also a WUA member, explained it clearly, ‘During the implementation, some land-owning farmers used to hobnob with the engineers. After completion, the engineer got the PS received by one of those farmers’ (Interview 43, 22nd June 2013). A similar situation was observed at B7 where a rich farmer had received the pump station from the implementation agency.

On the other hand, pump stations like B4 were received by a group of farmers. As the operator of B4 aptly commented on the non-working status of B9 while comparing it with B4, ‘That pump station was received by only one person who was asked by the engineer to do so. And that led to a lot of conflicts’ (Interview 40, 20th June 2013). A similar thought was echoed by a farmer of A4 who compared his CPS with B4, ‘At B4, farmers collectively received the PS and collectively decided the rotation system. But here, many farmers were not ready to accept the PS at the beginning. So it was used by only a few farmers who received it. Farmers have not collectively decided anything here. This leads to conflict and misunderstanding.’ (Interview 34, 17th June 2013).

It can be drawn from the evidence that the farmers were not adequately consulted during the layout design and implementation. Also, the present-day operations are affected by the process of getting the pump station received by the farmers.

2.3 Technical constraints

The IIP package was implemented with some changes in the W10 area. The pump capacities have been reduced to increase the working hours of the pumps. Two types of pumps with the following technical specification have been used in this area:

Type	HP	Capacity (L/S)	Main Head (M)	RPM
Big	7.5	40	6-7.1	1450
Small	5.5	20	6-7.1	1450

As shown in table 2.1, smaller *mesqas* have two motors comprising one big and one small in terms of pump capacity, while the larger ones have three motors comprising one big and two small ones. The motors pump water from the BC to water towers constructed adjacent to the pump stations. And water is released to the *mesqa* from the water tower. In large *mesqas*, the pump stations are used for 20-22 hours every day during summer, whereas they are used on a demand basis in winter. And in smaller *mesqas*, the pump stations are used for 15-16 hours every day. The pumps were expected to run for 16 hours, as per the design of the project. At the same time, the limited pump capacity results in a lack of adequate pressure at the tail end of long *mesqas*. The impact of limited pump capacity is discussed in Chapter IV. There are some more technical constraints related to infrastructure and design like electricity cut, large command area etc which affect the water management practices and operations, as explained below:

- **Electricity cut or pumps not working** – One of the major technical constraints is the regular electricity cut. Farmers miss their irrigation turn and prefer to use their individual pumps rather than waiting for their next turn. When Mehmoud, a farmer of B4, was asked why he was using the individual pump (IP), he said, 'It was my turn to irrigate last night at around 9 pm, but there was a power cut and I missed my turn. So, I am using my IP to irrigate from the drainage now' (Interview 25, 12th June 2013).
- **Water availability in the BC** – It was observed that the pumps stopped working if the water in the BC dropped below a certain level. It is a major factor in the middle stretch of the BC, which has been discussed in details later in the report.

Some specific instances of technical errors were also observed. The position of the first valve and outlet at the pump station A4 is an example of technical error and the lack of adequate consultation with the farmers during the implementation. The outlet has not been used since it was installed. It has been designed to supply water to a small vat which further connects to the *marwa* of the first part of the command area. Figure 3.4 shows examples of a vat. It was pointed out by the farmers of that *marwa* that the vat was constructed at a lower level than the *marwa* and water through the vat cannot flow along the *marwa*. Also, the small size of the vat results in overflow and irregular flow to the *marwa*. The farmers were not consulted before deciding the position of the valve. They wanted the outlet to be constructed at the head of the *marwa*, as they knew that the area was higher. The outlet has not been used even once, and all the farmers in part one use their individual pumps to irrigate their plots.

Figure 2.2: Vats constructed by farmers

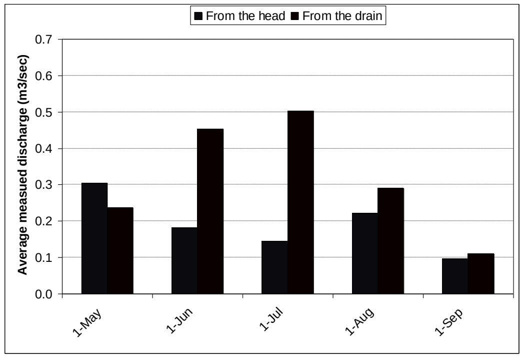
The impact of the technical constraints on the water management practices and operations of the pump station is discussed in Chapter IV.

2.4 Water allocation in BC

During the field work, it was observed that the water distribution in the Masharqa canal was still based on a rotational system controlled by the water control gate at the head of the canal, as opposed to the planned continuous flow. The gate is operated by the *bahaar* (gate-keeper) on instructions of the *muhandis* (engineer). The theoretical schedule in the Masharqa canal is four days on and four days off in summer and four days on and eight days off in winter. All the branch canals have a theoretical fixed schedule during which they get water from the main Meet Yazid Canal. It was further observed that the water control gate was not operated as per the schedule and the allocation is done on the basis of the need or water level in BC assessed by the engineer, and/or on the basis of the complaints received from the farmers. As per one of the engineers of the local irrigation department, the control gate is kept open for as long as the water does not reach the end of the BC. In Masharqa, the gate is kept open until the water from Meet Yazid reaches the 1.5km mark, while the water from Nashart drain reaches up to the 2km mark. The downstream control gate in Nashart is also closed at times to increase the water level and the drain water eventually crosses the 2km mark. The level of water is therefore better at the head and the end of the branch canal, because of their proximities to the Meet Yazid canal and the Nashart drain respectively. Eight pump stations (A4, A5, and B4-B9) in the middle stretch of the canal face varying degrees of periodic water deficit, due to irregular supply from the Meet Yazid canal. Overall, it can be seen from the following chart that during summer, Masharqa canal receives more water from the drain than from the main canal itself.

Average measured discharges downstream El-Masharqa head regulator and at its tail end (from Nashart drain) during summer 2012

Chart 2.3: Measured discharge in Branch Canal



It must be mentioned here that the situation is different in winter. All the respondents stated that the availability of fresh water in the BC was more regular in winter, and the farmers did not face fresh water deficit. During the field work, a period of water deficit was observed when the water from Meet Yazid was not released in the BC for around ten days. The situation can be understood from the figures (2.3 – 2.8) which show the level of water in the canal and the impact on crops. Farmers were seen trying to collect some water in the canal by manual desilting. Also, many farmers were spending their whole time near the pump waiting for some water to collect. The water was eventually released after complaints and mass protests like blocking roads etc from the farmers of this area. When one of the department engineers was asked about this period of water scarcity, he blamed it on the lack of adequate water in Meet Yazid and its consequences at the end of the canal system. He further added that 15 branch canals had to be supplied with water in that region, and the allocation was done on the basis of need assessed by the engineer rather than a strict rotation schedule. It must be added here that most of the respondents claimed that the water situation in the canal was better before the implementation of the IIP project.

Figure 2.4: Farmer trying to collect water in BC

Figure 2.5: Absolute scarcity in BC

Figure 2.6: Completely dry rice field

Figure 2.7: Affected crop

Figure 2.8: BC Water not adequate for IP intake

Figure 2.9: BC Water not adequate for PS intake

In most of the large-scale public irrigation systems in the world, farmers have to depend on whatever amount of water is supplied to them (Molle, 2009). Similarly, farmers do not have effective control over the supply of water in the branch canals in the Egyptian irrigation system. It has been pointed out by appraisal reports and studies (World Bank, 2005; Kotb and Boissevain, 2012) that there is scope for saving water by using water more efficiently at the farm level. But direct observation along the *marwas* during the field work threw some interesting insights into the claim. The optimum range of water depth required for rice cultivation is 5-10cm (WMRI, 1996). It was observed that farmers preferred to keep 8-10cm of water standing in the rice fields which is in the range of the recommended water depth. Some farmers along the local drain claimed that they had to irrigate their land more frequently as the water in the field drained out faster than other plots further away from the drain.

It was also observed that there were dry periods as well, when the farmers kept the water level in the rice fields intentionally low. The alternate wet-and-dry cycle is followed by many farmers for optimum growth of the crop. The standing water level can be seen from the figure 2.3 of four different plots. As discussed in the earlier sections, the practice of reusing drainage water is quite common which increases the efficiency of water usage. The observations raise serious questions about the claim that farmers over-irrigate and waste water. It also must be mentioned that there were some instances of over-irrigation as well. One of the instances is explained in box 2.1.

Box 2.1: **Over-irrigation - A4**

A couple of women are sitting beside their IP which is working. One of the women is irrigating her rice field (head-middle region, part of valve 2) with the IP since 7:30 in the morning. She tells us that her turn from the PS will come tomorrow, and her rice field needs irrigation today. So she is using her IP.

We check her field and the adjacent field. There is around 5cms water standing in her field (1.5 hours irrigation since morning), while the adjacent field is sufficiently moist to survive for a couple of days without irrigation. We ask her if her field was in a similar state in the morning.

She says that the field was in the similar state. And then adds that rice will die if she doesn't irrigate today. When pointed out that the adjacent field can survive easily for couple of more days, she says "Since the PS was not working for a long time, I am not sure if it will work continuously. It might stop working again. So I am using my IP to irrigate."

Source – Field Notes (28th June 2013).

It can be drawn from the example that over irrigation is chiefly driven by the unpredictable nature of supply. The farmers are still dependent on the irrigation department for assessing their need and allocating water in the BC. The transfer of the irrigation management at the branch canal and higher levels to the water users has been nominal as there has not been any major change in the ownership and management pattern. As mentioned earlier, the *marwas* and *mesqas* are privately owned by farmers, whereas higher level canals are owned and managed by the government. Even after the implementation of the reform projects, this ownership pattern has not changed. The branch canals and higher levels of the system are still managed by the government. BCWUAs have been formed at the branch canal level for devolution of O&M of the canals to the farmers, but the domain of BCWUAs is still very limited as discussed in the next section. Ghazouani *et al.* (2012) evaluate the reform projects in the NEN region, and suggest that the major focus of the government and the irrigation department has been on transferring the O&M costs to the farmers, rather than transferring the management of the system.

Figure 2.10: Water level at different times during rice cultivation.

BCWUA

The Branch Canal WUA (BCWUA) was formed after the implementation of the project, in 2011, and its primary responsibilities include keeping the BC clean, liaising with government officials, resolve issues of farmers related to BC etc. The association is formed of members from most of the pump stations. It has a small office which is housed in a room in the house of the president. Some of the respected men hold a grudge against the BCWUA as they feel that their authority was not recognised during the formation of the association. The president of B4 mentioned that the engineer got the pump station received by a common man (president of BCWUA) and did not consult respected men like him. He also added that the BCWUA president was trying to become a big man now. (Interview 41, 20th June 2013). It must be mentioned here that the BCWUA president is a teacher in the local school, and is a known face amongst the farmers now. An interesting observation was the relationship between the Irrigation Advisory Service (IAS) officials and the BCWUA president. IAS has been formed as part of the reform process primarily for the capacity building of the new institutions. The officials interact with the president the most, compared to other members of the BCWUA. He is considered the most important person among the community members, by the IAS officials. The officials also portrayed the Masharqa BCWUA as the model association, in front of the research team. But any role of the BCWUA in the operations and maintenance of the BC was not observed during the period of the field work. The BCWUA does not have any role in the water allocation in the BC. Even though the allocation is based on need assessment or demand of the farmers, the BCWUA does not have any role in need assessment or advocating the demand to the department.

It also must be added that the operations and maintenance responsibilities have not been adequately devolved from the irrigation department to the BCWUA. The President of the BCWU4A stated quite explicitly, 'The government wants the farmers to take up all the financial and maintenance responsibilities. It is not good. Government formed the BCWUA to solve the problems of the farmers. But the government does not want the burden of farmers and has passed it on to the BCWUA.' (Interview 28, 12th June 2013). He also added that the BCWUA should be given decision-making powers, while the financial management should rest with the government. The situation was well summarised by an engineer of the district irrigation department when he said, 'The associations were formed three years back. But only three out of the 15 in this district are operational. There isn't any role clarity. Also, the government has not given them any money to start maintaining the BC' (Interview 57, 4th July 2013). The financial, maintenance and water rotation responsibilities still lie with the government. It was observed that the role of BCWUA was limited, with minimal visibility among the farmers. The awareness about the BCWUA among the farmers is also low.

An interesting example of the role and effectiveness of the BCWUA is the maintenance of the branch canal. It was observed that the practice of throwing local rubbish and sewage waste in the BC was common in both Masharqa and Sawaiya villages. Figure 2.10 shows the sewage floating in the BC. The quality of water in the BC can be understood from figure 2.11 which shows the lather produced in the water. Farmers, who were pumping from the BC, expressed their unhappiness and helplessness over the quality of water in the BC. Most of the respondents complained that the poor quality of the water had an impact on their health and liver diseases were quite common among the villagers. A farmer of B2 clearly pointed it out when he said, 'Water is available all through the year, as the pump station is near the end of the canal (and near the drain). The only problem is the quality of the water. It leads to health issues like liver problems.' (Interview 4, 22nd May 2013). It was further observed that the local waste of the village was regularly thrown in the BC. One of the main reasons that emerged was the lack of a sewage and local waste management in the village. The village sewage and waste management is the responsibility of another department of the government, and needs to be analysed as a separate issue. Even though the maintenance of the branch canal is supposed to be the responsibility of the BCWUA, the president expressed his helplessness in ensuring that villagers did not throw the rubbish into the BC, due to lack of any other sewage management system.

Figure 2.11: Rubbish in various areas of BC

Figure 2.12: Lather produced by pumping directly from BC

An instance of the involvement of the BCWUA president in the maintenance of the BC was observed when the canal had to be desilted. As mentioned earlier, there was acute water shortage during a period of two weeks. It was decided by the farmers of the middle-end part of the BC to get that part desilted. The responsibility of maintenance of the BC lies with the irrigation department, and it has to be cleaned twice or thrice a year, according to needs. Even though the BC had been cleaned a month back, a part of it (1.5km from the end) was being cleaned again to improve the water level in the BC. The president of the BCWUA stated that he had requested the irrigation department for the out-of-turn cleaning (Interview 54, 28th June 2013). The department paid for the cleaning machine, while the farmers had to pay baksheesh to the machine operator. It was observed that most of the water users of the middle-end part were present near their pump stations to ensure proper desilting in front of their *mesqas*.

Capacity building of these organisations was also part of the reform process, and it is discussed in the next section.

Capacity Building of Institutions

Interviews with the WUA and BCWUA members suggested a serious lack of adequate capacity building of the institutions. None of the WUA members reported attending any training programmes. Also, only the BCWUA president is called for trainings and meetings a couple of times in a year, but other members have not attended any training. The BCWUA president stated the situation clearly, 'BCWUA gets two trainings per year at Kafr-el Sheikh. Sometimes all members go for the training, but most of the times, only I attend the trainings. The WUAs have not received any training till now. And no one has even talked about it till now.' (Interview 28, 12th June 2013). It must be added that this contradicts the claim made by some IAS officials who hold the view that the organisations have received adequate number of trainings. The president of B4 WUA also echoed the president's claim, 'The WUA has not received any training since the beginning, except a hands-on demonstration of the pump station.' (Interview 29, 13th June 2013). The operators of most of the pump stations mentioned that they had not received any training on how to use the pump station except a demonstration at the beginning.

The contradiction between the facts stated by the farmers and the IAS respectively raise questions on the functioning of the IAS, and needs to be explored more to understand the issues in details.

3 B4 and B7: Basic Characteristics

Both B4 and B7 pump stations are part of the middle stretch of the BC. Figure below shows the spatial location of the pump stations and their command areas. The local drain can be accessed by the farmers of B4, whereas it is not accessible for the B7 farmers. This chapter discusses the various characteristics of B4 and B7 in details. It also cites examples from other pump stations to draw a pattern in the Masharqa canal.

The basic characteristics of the pump stations are explained in the following table.

Basic factors/PS	B4	B7
Area (Feddan)	72	45
Farmers (No.)	90	30
Main valves (No.)	13	4
Farm outlets (No.)	109	47
High capacity pump (7.5 HP and 40 L/S)	1	1
Low capacity pumps (5.5 HP and 20 L/S)	2	1
Sub-parts of command area (No.)	13	4
O&M costs (EP/feddan)	60	35
Tatweer instalment (EP/year)	650-700	400

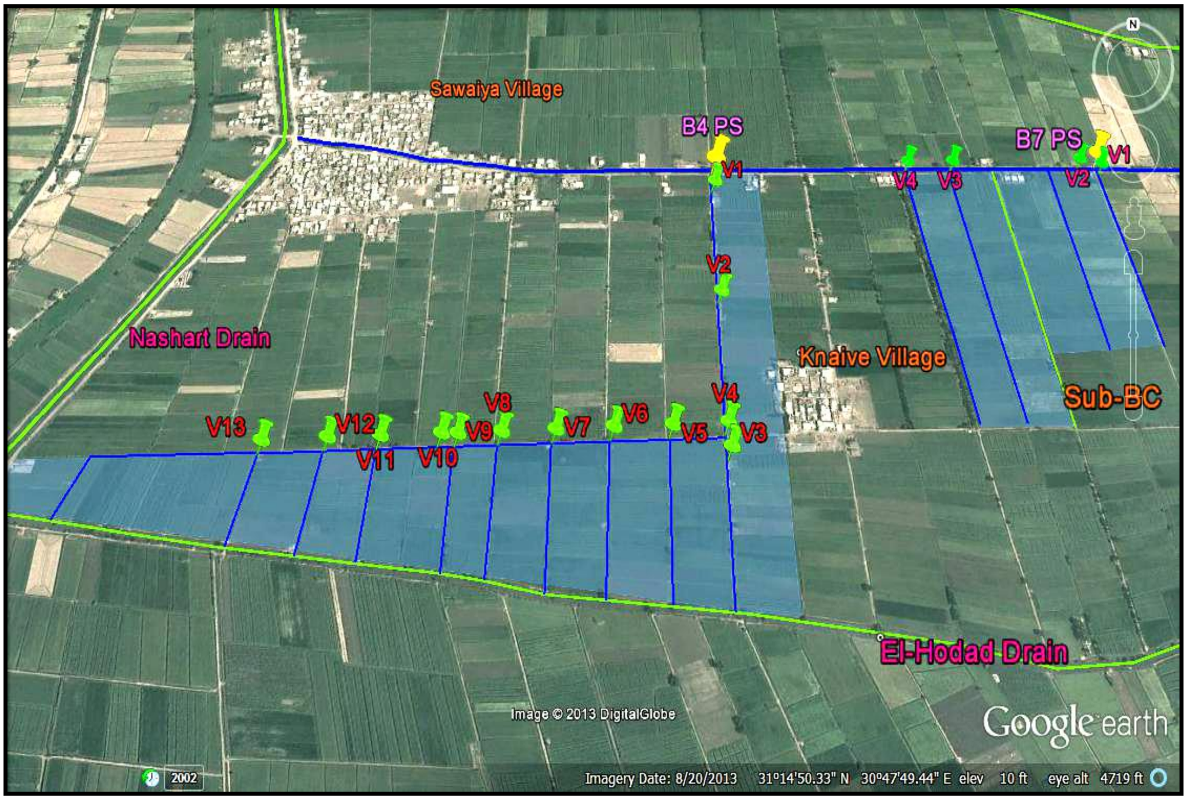
The pumps are operated as per the irrigation schedule. As mentioned earlier, the pump station is operational for 20-22 hours of the day. The farmers have set the following operating schedule for the pumps:

- At B4, the high capacity pump is operated for 12 hours, and then the combination of the two smaller ones is operated for the next 12 hours.
- At B7, the pumps are operated alternately or together, depending on the irrigation schedule. If the valves at the tail end have to be supplied, then the high capacity pump is

operated or both the pumps are operated. But it was observed that the smaller pump was out of order for most part of the study period.

The effect of the long operating hours on the wear-and-tear of the motors could not be quantified or explored.

Figure 3.1: Spatial location of B4 and B7

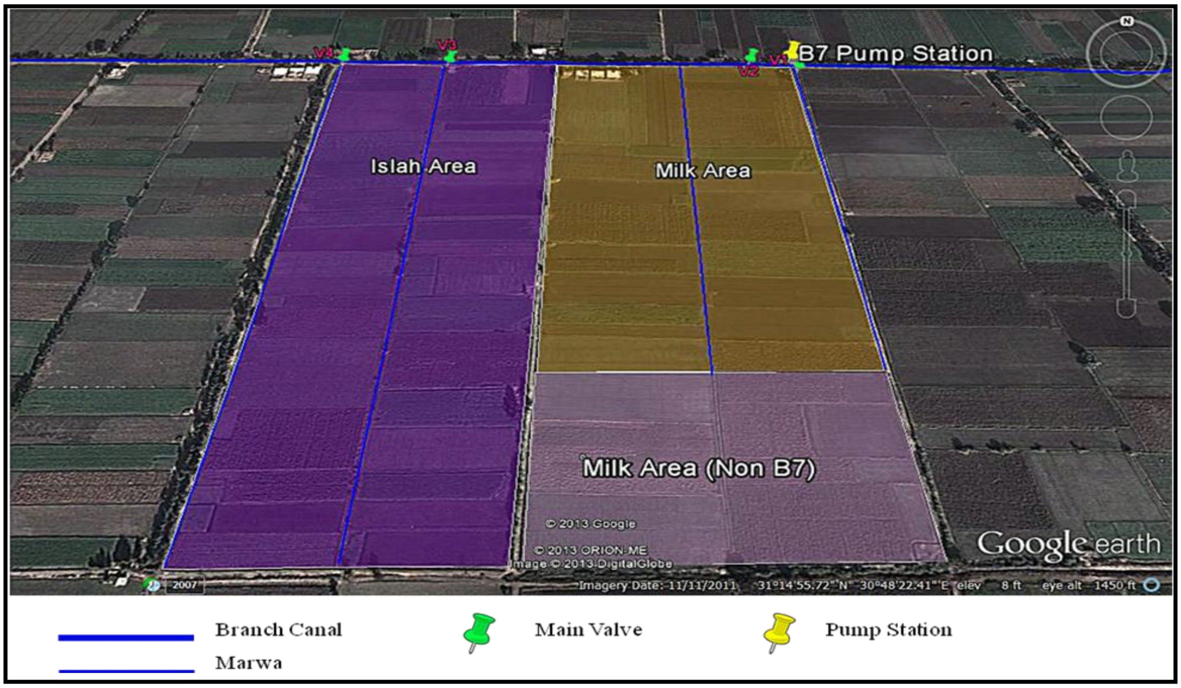


3.1 Pump station trajectory

As discussed in the earlier chapter, the area between B4 and B7 comprises both *islah* and *milk* land. But the pump station trajectory explains the structural differences between *islah* and *milk* farmers, and also the result of lack of adequate consultation with the farmers.

The command area of B7 is divided in four parts as shown in figure 3.2. Two parts belong to *milk* farmers while the last two belong to *islah* farmers. Before the implementation of the project, the *islah* farmers used to get water from the *islah* pump or from the *mesqa* on their side of the land. And the owners used to get water from the branch canal. Both the areas were clubbed together by the project and brought under the same pump station which was built at the same point of the branch canal from which the *milk* farmers used to draw water. This decision was not supported by the *milk* farmers, as they did not want the *islah* farmers to take water from their side of the branch canal. It is one of the major reasons of the conflict over water management in B7. Abdullah, a *milk* farmer of B7 explained the structural difference clearly when he said, 'the *islah* farmers are poor and depend on others for their basic needs like land, food etc. They take whatever you throw at them' (Interview 32, 15th June 2013). Even though the *islah* farmers gradually became the owners of the lands by buying it from the government, but they were still considered socially inferior to the *milk* farmers.

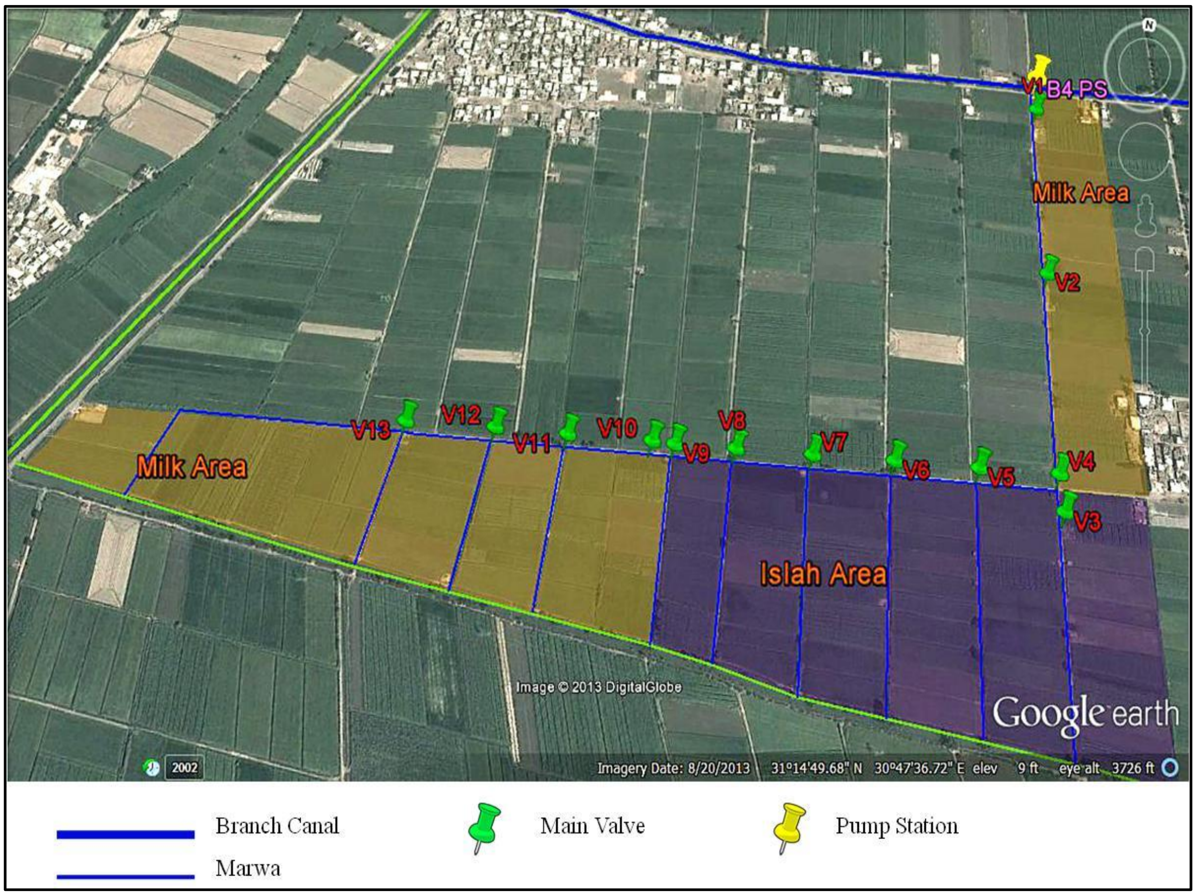
Figure 3.2: Layout of *Mesqa* B7



It can be seen from the figure that a small area (6 fed app.) at the end of the *milk* area of B7 has not been added to the pump station. The area belongs to one farmer and is part of the PS B9. Before the project, this area was irrigated from the sub-BC which was used by the farmers of the adjacent B9 area. From the discussion with the farmers of that PS, it emerged that the owner of that area wanted to become a part of B7, but the area was not included by the engineer.

Similarly, the command area of B4, as shown in figure 3.3, contains both *islah* and non-*islah* land. But the pump station followed a different trajectory than B4. V1-V2 is a *milk* area, while V3-V8 comprises *islah* farmers and V9-V13 is again a *milk* area. The area V1-V13 was originally served by a sub BC which extended all the way from B5 to V13. As part of the project, the sub-BC was only kept till B6 while the rest of it was filled in, and it was planned to include the V3-V8 area in B6, while B4 was supposed to cover the area V1-V2 and the area under B3. *Islah* farmers of V3-V8 did not want to become a part of B6. The reason was explained by a prominent *islah* farmer, 'The farmers of this area did not want to be clubbed together with the farmers of B6 as they were from a different village (Masharqa) and this would lead to conflicts' (Interview 20, 6th June 2013). Also, they wanted to take water from the BC rather than the sub-BC. The *islah* farmers talked to the *milk* farmers of V1-V2 who agreed to include the *islah* and *milk* area under one pump station. Some representatives of the farmers submitted an application along with a hand-drawn map of proposed area at the irrigation department and met the Director for stating their case. Eventually, the design was changed and the area was added to B4. At the same time, the *milk* farmers of V9-V13 also wanted to become a part of B4, and that area was also added to B4 after consent from the other farmers. The farmers of V3-V13 used to draw water from the sub-BC which supplies B6. But it was filled-in during the project implementation. A *milk* farmer of V9 explained, 'There wasn't any problem. The *islah* farmers did not mind the *milk* farmers joining the PS. And we did not have any option as the sub-BC was filled in, and the only way-out was to become a part of B4. We had to pay 600 EP more for the pipes and valves needed for extending the connection.' (Interview 24, 8th June 2013). It can be drawn from this case that the command area of B4 was the result of a negotiation among the *islah* and *milk* farmers, and also between the farmers and the engineer. A major difference between B4 and B7 is the role played by the president who is a respected man of the village, in the negotiations. Also, the *milk* and *islah* farmers of B4 wanted to come under the same pump station, whereas the *milk* and *islah* farmers of B7 wanted to opt out of the same pump station. It also must be pointed out that the *milk* and *islah* farmers along V3-V13 at B4 used to withdraw water from the same sub-BC which was eventually filled in, whereas the *milk* and *islah* farmers of B7 had different points for withdrawing water from the BC.

Figure 3.3: Layout of *Mesqa* B4



A special mention must be made of how the PS B11 was established to understand the interaction between the water users and the project implementation department. The pump station covers an area of 20 feddans that belongs to one rich family. During the discussion with the owner of the area, he mentioned, 'It is his special PS and no one else uses it. So there isn't any water issue'. He further added, 'When *tatweer* was being implemented I told the engineers that I would accept it only if I get an individual PS for my lands' (Interview 9, 26th May 2013). It also emerged from the discussion that neighbouring farmers also wanted to become a part of the pump station, but he convinced the engineers not to include other farmers' area under that pump station. This example shows how local power structures in the form of a dominating rich family influenced the implementation of the project.

It can be drawn from the evidence that the farmers of B7 were not adequately consulted during the planning and design phase. It also shows a lack of understanding of the local water management practices and organisational arrangements. Even though different *marwas* and parts have been brought under the same pump station, the earlier organisational arrangement around lifting points on the BC has been reproduced in the improved systems. On the other hand, B4 presents a case where the traditional arrangement has not been reproduced and farmers of different parts are successfully using the collective pump station. The layout of B4 is the result of participation of farmers in the designing and planning process, and has primarily been decided by the farmers.

Farm Hydrant Layout

It has emerged from the discussions that the participation of farmers in deciding the layout of the plot-level hydrants was high and the positions of hydrants in the plots were decided by the farmers themselves. Some farmers of both B4 and B7 also got extra hydrants installed after paying for them. At B7, a rich farmer who owns 5 feddans of land got a main valve and hydrant installed just for his area. A farmer of B7 explained the process, 'If a farmer wanted more valves, he could get them by paying extra. Also, the farmers did the manual work during the installation of the pipes and valves, and a farmer could ask the farmers (who were doing the installation) to fix an extra valve (by paying more). The engineer did not object to that.' (Interview 37, 19th June 2013). It was observed that the number of hydrants were more than the plot level divisions in some of the *marwas*, as discussed in the box below.

Box 3.1: **Hydrant layout – B4**

There are ten hydrants under V3, while there are eight plots. It was observed that one of the paddy fields had two hydrants. One of the farmers of that *marwa* explained the reason, 'Originally eight valves were installed on this *marwa*. But the farmer of this plot added the extra valves later, as the land changed hands and the new owner preferred more valves. The average plot size is around 12-16 kerat in this area, so the number of hydrants is also large' (Interview 22, 06th June)

It was also observed that the farmers preferred separate hydrants for each part under the *marwa*, rather than one for each feddan. Hamid, a farmer of B4, explained the reason, 'Each part needs a separate hydrant. Otherwise it might lead to conflict. If a rice farmer and cotton farmer share a hydrant, then it will lead to conflict.' (Interview 21, 06th June 2013). At the same time, some farmers also refused to install more than one hydrant. The command area of four feddans under V12 belongs to one family, who got just one hydrant installed for the whole area, and refused to install more because of the cost.

3.2 Crop pattern

Figures 3.5 and 3.6 show that rice dominates the crop pattern in both B4 and B7. Cotton is the second most popular crop in this region. The preference for rice is driven by profitability and urge for food sufficiency. Most of the farmers mentioned that rice was more profitable than cotton in terms of investment costs. At the same time, some farmers specifically pointed out that their first priority was to grow food for the family. The crop pattern is decided by the village cooperative which divides the total area into rice, cotton and dry crops areas. The crop pattern is not farmer specific, but it is area specific. A farmer who has two plots in two different areas might have to grow two different crops based on the pattern of the area. The farmers are expected to follow the pattern. Also, the rice farmers can shift to dry crops but the other way round is not allowed and fines might be imposed. But some farmers shift from dry crops to rice, though it is not a major shift. The president of BCWUA clearly stated, 'There hasn't been any major change in the area of rice cultivation in the last two years' (Interview26, 12th June 2013). The irregular nature of fresh water supply in the BC is not reflected in the crop pattern. There has not been any major shift to dry crops. One of the major reasons is the practice of supply augmentation as discussed later in Chapter IV.

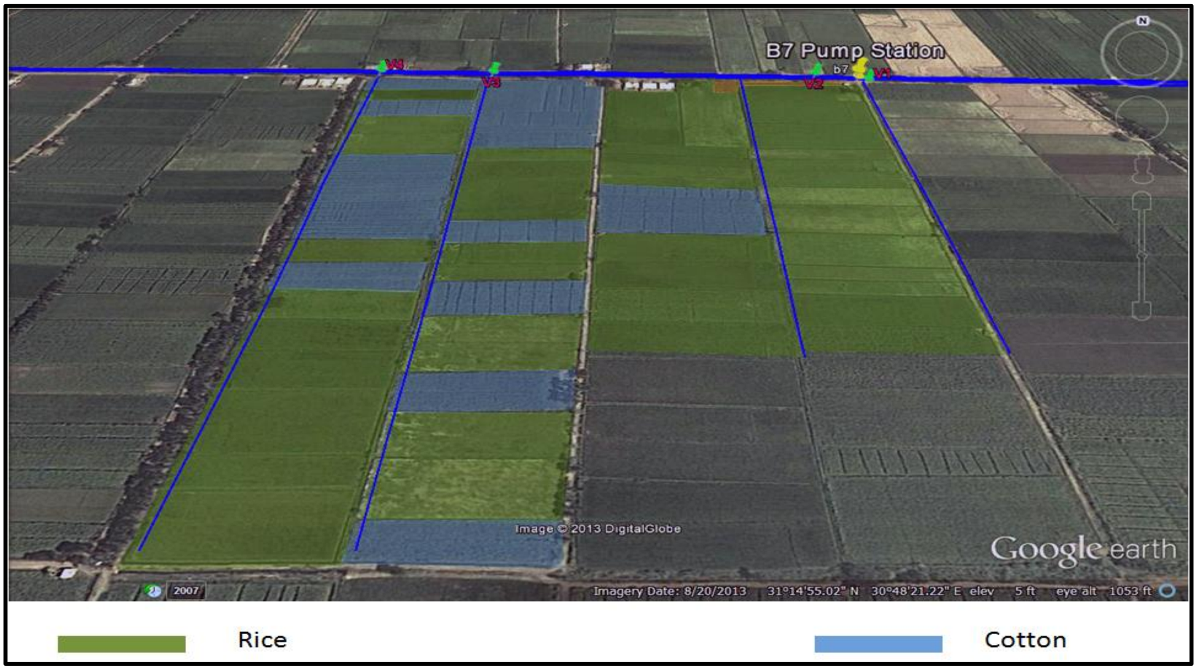


Figure 3.4: Crop pattern at B7

The crop pattern at B4 does give some interesting insights. In the area V1-V2, only four out of 17 plots have been planted with rice, and the rest are cotton and berseem. But on the other hand, most of the area under V3-V13 has been planted with rice. As Mohammad whose land is part of V1, explained, 'The farmers on the other side of the road (the road that was created by filling in the sub-BC between V3-V13 and runs parallel to the *mesqa*) plant more rice as they have more water because of the proximity from the drain. Farmers individually decide the crop they want to plant. But the government doesn't allow everyone to plant rice' (Interview 13, 1st June 2013). The broad crop pattern is decided by the government every year, as explained an official of the village cooperative when he said, 'The crop pattern is decided by the cooperative. The area is divided into three parts (rice, cotton, maize) and the sequence changes every year. The crop pattern has been there from the beginning for the *islah* farmers. So even after it was stopped by the government, they still planted according to the crop pattern.' (Interview 27, 12th June 2013). It was observed that most of the farmers still mentioned the government crop pattern as a broad rule which governed their crop decision. It was also observed that crop decision of a family was not only influenced by the accessibility of adequate water, but also by other factors like crop pattern, crops cultivated last year etc. The example of Kalam in the box below clearly explains this.

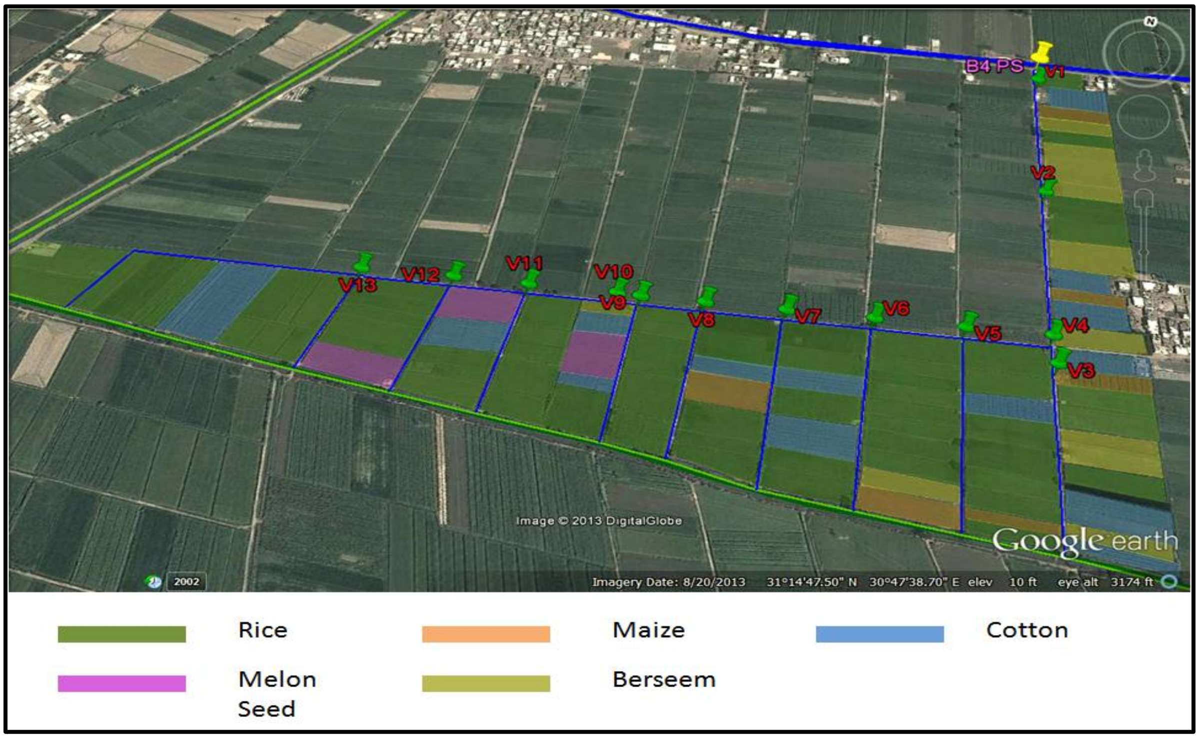


Figure 3.5: Crop pattern at B4

Box 3.2: **Crop preference**

Kalam owns land in both the B4 and B5 command areas. At B4, his plot is near the drainage where he planted berseem, whereas he planted rice in the B5 area. Even though he had access to adequate water at B4, he planted berseem there as he had been planting rice on that land for the last two years.

Source: Field Notes (2nd July 2013)

The example also points towards the rotation system of crop planning, in which the history of crops cultivated in the last couple of seasons influences the choice of crop in the present season. Farmers often keep a land fallow for a season in between two major crops.

3.3 WUA composition

During the project implementation phase, four or five farmers were selected on the basis of their socio-economic position to comprise the WUA. The selection was primarily done by the agency engineer, but some large land-owning farmers were also involved in the process.

Rural Egyptian society is patriarchal, and the interaction among villagers is heavily influenced by family ties and bonds. Based on the socio-economic status, education, and exposure etc, certain men in the society are regarded as wise and kind, and are respected by everyone in the village. Most of these men are also large land owners. When asked about the criteria for becoming a WUA member, all the respondents of B4 and B7 said that the WUA member should be rich with a large area, and should be a known and respected figure of the society. A person with a large area would have more ownership towards the operations of the pump station. Also, a rich person can help to tide over any emergency financial requirement.

The local social and power relations are often reproduced in the WUA (Narain, 2003). The composition of the B4 and B7 WUAs suggests the structural reproduction (Giddens, 1984) of the traditional socio-political division between *islah* and *milk* farmers. B4 WUA has five members while B7 has four members. Even though the *islah* farmers constitute a major part of the area under both B4 and B7, the WUAs do not have any *islah* farmer as the member.

Mehmoud, who owns land in B4 *mesqa*, stated, '*Milk* farmers are richer and more learned. And they also want to be at the centre of power. So they are the members of the WUA. They can also talk to the engineers or other external officials' (Interview 25, 12th June 2013). B7 WUA has two large landowners of the *mesqa* as members. A similar thought was echoed by Abdullah, who is a large farmer of B7, when he said, '*Islah* farmers did not want to become members of the WUA as they knew that they were not part of this area originally and they would not be selected' (Interview 32, 15th May 2013). It clearly shows the dominance of *milk* farmers over the *islah* farmers in the WUA composition.

The absence of women members in the WUA also suggests reproduction of the structural exclusion (Meinzen-Dick and Zwarteveen, 1998) of women in irrigation. In a focus group discussion with women, the participants stated forcefully that they could not become members of the WUA as a woman's position was fixed in the society and they were not supposed to cross the boundary. There were a few men present at the meeting, and they agreed with the women.

Organisations for common property resource management like the WUAs should build on existing local organisations (Uphoff, 1986; Cernea and Meinzen-Dick, 1993). Some of the WUAs have assimilated the existing conflict resolution institutions. There are some traditional conflict resolution institutions in the Egyptian rural society. Villagers refer to some specific men who are considered wise and kind, for advice and conflict resolution. The villages also have a traditional system of conflict resolution called the *Adal al Arab*. It is an informal committee comprising the respected men of the village and has five or seven members. The villages also have a mayor, *Omda* and the secretary of the mayor, *Sheikh al Balad,* who play a role in conflict resolution at times. Before the WUAs were formed, the farmers referred to these men or the committee for conflict resolution or for seeking advice regarding irrigation. But now some of them are members of the WUA. The B4 WUA shows the assimilation of the traditional institutions in the formal structure. The president of the B4 WUA is a member of the social committee *Adal Arab* and has been traditionally consulted for conflict resolution. He is consulted by the farmers in his capacity as both the president of the WUA and the member of the social committee. It must be added that his father was also a respected man of the society who was consulted for conflict resolution. It also must be mentioned that a similar assimilation was not observed in B7 WUA. The impact of the assimilation on the conflict resolution mechanism is discussed in later section 3.4.2.

It is evident from the composition of the WUAs that the local power, social and gender structure have been reproduced in the formal organisational arrangements promoted for water management. New institutions like president, treasurer etc which have been created by the project, have further strengthened the existing power structures as only rich and large landowning men have been selected for those positions. But any new power and social structure created by these new institutions in the community was not observed. Further exploration is required to analyse this.

3.4 Role of WUAs

The WUA board comprises president, secretary, treasurer and two other members. A point must be made here regarding the perception of WUA among the water users. Even though WUA is technically the association of all the water users, the water users do not consider themselves part of the WUA and perceive it as an association of only the selected members.

An interesting observation was the dominance of some individuals over the operations and management of the collective pumping system, at some of the pump stations. The impact of dominance of an individual over operations and management can be drawn from B7 where the WUA functioning and the pump station operations are totally controlled by the president. It was observed that the president also abused his dominant position in various ways as explained in the following sections on the role of the WUA. The operator of B7 stated it as a matter of fact, 'The President received the pump station after project completion and so he also acts as the treasurer' (Interview 58, 5th July 2013). The president is a large landowner who also has a cattle business. On the other hand, it was seen that the various responsibilities were distributed among different members of the WUA at B4 where the responsibilities of the three positions lie with three farmers.

It was observed that WUAs were primarily involved only in collection of money from the farmers for operations and maintenance like charging pre-paid electricity card, pump maintenance etc. In addition to that, some members like the President are consulted for conflict resolution. As mentioned earlier, WUAs were formed to ensure collective pumping and to maintain the irrigation schedule, along with other O&M activities. But the observations and the discussions with the farmers suggested limited role of WUA in water management in the *mesqa*. It is discussed in details in Chapter IV.

Most of the respondents pointed out the following responsibilities of farmers associated with the WUA or the WUA members:

Activity	Actor and Role
Operations and water management	Operator
Financial management	The treasurer is involved in collecting money for the O&M.
Conflict resolution	The President or other members of the WUA are consulted for conflict resolution.
Maintenance	The *mesqa* and *marwa* maintenance activities are the responsibilities of individual farmers while the pump station maintenance is the responsibility of the operator.

It was observed that the responsibilities are dependent on individual farmers or WUA member, rather than the WUA as an organisation. It must be mentioned here that formal WUA meetings were not observed during the period of field work. The respondents unanimously agreed to this observation and said that formal meetings were not held. It was further observed that the mode of communication among the WUA members, or between the users and members or between the operator and WUA members was informal, and part of daily conversations rather than any formal mode of interaction.

The activities are discussed in details in the following sections.

1.1.1. Financial management

One of the objectives of the irrigation reform was to increase the participation of farmers in operations and management of the improved infrastructure. As mentioned earlier, the farmers have to repay a part of the infrastructure cost in the form of an annual instalment payment. The farmers also have to pay for the electricity charges, along with other operation and maintenance costs. The major costs involved are:

- Electricity charge
- Operator's salary
- Maintenance cost

One of the major responsibilities of the WUA is the financial management of the pump stations. The treasurer has the responsibility of managing the finances. It was stated by all the respondents of B4 that the treasurer collected the money for O&M and got the electricity pre-paid card for pump operations. The treasurer keeps the money as the WUAs do not have any bank account. Some other farmers are also involved in collecting the O&M charges from the water users. One of the farmers of each *marwa* has been given the responsibility by other farmers to collect the money, and give it to the treasurer. This process was mainly observed at B4, but some other pump stations like A1 and A4 also had a similar system. Sometimes, one of the rich farmers also chips in with the required sum for the O&M, while the money is collected from all the water users. The water users have to pay a certain amount for all the costs mentioned above. At B4, the users have to pay 60 EPs/season while at B7, the fee is around 35-45 EPs/season. The difference in the amount is due to the difference in the number of motors (and the electricity cost) for B4 and B7 respectively. The fee might change in different seasons according to the electricity charges. It must be added that the operators are paid 150-200 EP/month. The electricity pre-paid card is recharged once for a season, and it is also done by the treasurer. All the respondents of B4 were aware of the role of the treasurer, and it was observed that the process of money collection was well established among the water users.

At B7, the process was not as well established as B4 and the president acted as the treasurer. Farmers give money to the President or the operator when they are asked for it. Some farmers of B7 also raised questions on the financial management by the president. Some of the *islah* farmers complained that they were asked to pay more when they wanted to become a part of the pump station a year ago. And one of the major reasons which triggered decision of the *islah* farmers was the acute shortage of fuel for individual pump last year. An *islah* farmer of part V4 who wanted to rejoin the pump station, explained, 'I wanted to become a part of the pump station and was asked by the president to pay 2 EPs/kerat and was also told to get at least 2-3 farmers from his *marwa* as it was not possible to give water to only one farmer of the valve. The normal charge is 1 EP/kerat.' (Interview 60, 5th July 2013). The thought was also echoed by Doaa who was an *islah* farmer and owned land in V3, and was asked to pay 4EP/kerat by the President when she wanted to become a part of the pump station (Interview 44, 23rd June 2013). As mentioned earlier, the *milk* farmers did not want the *islah* farmers to join the pump station during the implementation.

The following example below shows that the process of getting the electric card recharged is not well established at B7, and the president is not proactive towards the financial management responsibilities.

Box 3.3: **Electricity card recharge management – B7**

On 5th July, it was observed that the PS had stopped working, and the reason was that the low balance of the pre-paid electricity card. The operator said he could not understand it earlier as he could not read the counter in the electric meter, as he could not read English. The water users were not sure about the initial recharge amount of the electric card, as it was done by the President. The operator added that the card was recharged once before the beginning of the season and it was supposed to suffice for one season.

Source – Field notes (5th July, 2013).

It can be drawn from the evidence of B4 and B7 that a major difference is the well defined role of the treasurer along with an established process of money collection at B4 as compared to that at B7.

1.1.2. Conflict resolution

There was a visible difference in the levels of conflict between B4 and B7 farmers. It was found that 40% of the initial water users had opted out of the collective pump station at B7 citing conflicts as the primary reason. The reasons of the conflicts are analysed in Chapter IV. B4 presents a different example where none of the farmers have opted out of the collective pumping system. A major reason is the difference in the conflict resolution mechanism at B4 and B7.

It was observed that the conflict resolution mechanism consisted of the following layers:

- Operator
- WUA President
- Respected men of community
- Family/Neighbourhood ties

Life in rural Egypt revolves around family and neighbourhood ties. One of the major conflict resolution mechanisms is the relationship between the farmers based on their family or neighbourhood ties. All the farmers of a specific area are related to each other through some extended family ties or live in the same neighbourhood. Hence, in minor conflicts, family members or neighbouring farmers try to mediate and resolve the conflict. The operator of B7 explained the process, 'People call a man from the nearby village for conflict resolution. The Omda is also consulted. But after *tatweer*, people try to resolve the conflicts through the WUA first and then go the respected man or the police station' (Interview 30, 14th June 2013). The president of the BCWUA also clearly stated, 'If a conflict happens now, the farmers consult the WUA first. If it can't resolve the conflict, then farmers consult the responsible men. Those men talk to both the parties and try to resolve the issue. The conflicts have reduced a lot since *tatweer* because of the rotation rules and the total system' (Interview 28, 12th June 2013). It was observed that most of the on-field conflicts were resolved with the help of the operator or other neighbouring farmers. The president of the WUA or the respected men of the village are consulted only if the operator and neighbouring farmers cannot resolve the conflict. Also, multiple conflict resolution mechanisms can be at work at the same time, which is explained by the example below.

Box 3.4: **Conflict – A4**

The pump station had stopped working during the middle of the field work because of a conflict among the farmers. One of the farmers had opened his hydrant out of turn, during another farmer's (Sarfaraz) irrigation turn. He had not sought permission from Sarfaraz. When Sarfaraz got to know about this, he turned the pump stations off, locked the room and kept the key with himself. It must be added that Sarfaraz is also a WUA member. The farmers were trying to resolve the conflict by getting all the water users together and talking it out. As added by one of them, 'We plan to get all the farmers together and then make the guilty farmers swear over the Holy Quran that they would respect the rotation system.' (Interview 36, 17th June 2013). Eventually, the farmers talked to each other and Sarfaraz gave the key to the operator to start the pump station. The pump station was inoperable for eight days.

This example shows that multiple conflict resolution mechanisms can be at work at the same time. As mentioned earlier, the president of the B4 WUA has been traditionally consulted for conflict resolution. His traditional and socially acceptable role has ensured a strong conflict resolution mechanism at the WUA level. On the other hand, it was observed that the conflict resolution mechanism at the WUA level at B7 was not well established and the president or the operator did not actively participate in conflict resolution.

1.1.3. maintenance

It was observed at both B4 and B7 that specific individuals or members of WUA were involved in the maintenance of the collective pumping system. Maintenance activities at the *mesqa* and *marwa* levels were observed in the following activities:

- Cleaning of *mesqa*, *marwa* and field-level drain - The *marwas* and drains have to be cleaned periodically and the weeds have to be removed. It was observed that farmers clean the part of the *marwa* or drain which corresponds to their fields. It is the individual responsibility of the farmers. Water users of both B4 and B7 were often seen cleaning their *marwas* or the drain. It was also observed at other pump stations. Sarfaraz stated, "Farmers clean the *marwa* in front of their own fields. Once or twice a year, farmers do it together and sometimes they don't." (Interview, 22nd June 2013). Any attempt by the WUA to facilitate the cleaning of the *marwas* or to advocate the need for the same was not observed at any of the *mesqas* under the Masharqa canal. Figures 3.7 and 3.8 shows a well-maintained *marwa* and drain.
- Maintenance of pipe and valve system - It was observed that many valves and farm hydrants were partially broken in most of the pump stations. Most of the respondents said

that the valves were not repaired as it was expensive to do so. Even though the hydrants are individual properties, the maintenance of the hydrants is often regarded as a collective activity. It can be drawn clearly from an instance of A4 where most of the valves are broken. When Munif, a farmer of A4 was asked why water users did not get the valves repaired, he explained, “The valves need to be fixed, and I have asked all the farmers (part of that *marwa*) to contribute 10 EP each, but they just keep saying that they would contribute and they don’t.” (Interview 61, 5th July 2013). Most of the valves at both B4 and B7 are partially broken, but the wear and tear of hydrants at B7 is more than those of B4. Even though most of the respondents stated their unhappiness and helplessness over the situation, none of them seemed keen enough to get the hydrants repaired. It also must be noted that a broken hydrant helps a farmer in getting some water out of turn. The farm level hydrants installed as part of the project have a pin-system for opening and closing, as seen in figure 3.9. It was pointed out by some of the respondents that the wear-and-tear was high for the pin system and it led to water leakage. Figures 3.11 and 3.12 shows how farmers use local innovative solutions to control the leakage. Some farmers at other pump stations like A3, A4 etc have converted their own pin-system hydrants to a cap system, as seen in figure 3.10.

- Maintenance of collective pump station – The operator is responsible for the maintenance of the pump station. Local mechanics are called for fixing any issue in the collective pumps. It was observed that the operator of B4 was more proactive in getting the pump fixed, than the operator of B7. An informal flow of information between the operator and the president regarding the maintenance of the pump station was also observed at both B4 and B7. In most of the cases, the operator always informs the president if the pumps develop any snag or need to be repaired. It was further observed that the operators gave the key only to trusted neighbour or family member, in case of their absence during irrigation schedule.

The example of B8 and B9 must be mentioned here to understand the impact of heterogeneity of the community on collective maintenance. As discussed earlier, the area under these pump stations is mostly cultivated by sharecroppers based on the rent system. The owners do not feel the need to get the pump stations fixed, whereas the tenants also don’t have the urge as they don’t own the land. The lack of collective maintenance is directly linked to difference between the water users and the owners.

An instance of collective maintenance, discussed in box 3.4, was also observed which pointed towards the relationship between the scale of the maintenance activity and the collective participation of the farmers.

Box 3.4: **Collective maintenance of sub-BC**

A sub-BC of the Masharqa canal supplies water to the area under B6. Some farmers of B7 also draw water from the sub-BC. An instance was observed when the farmers of the area under B6 and B7 who used the sub-BC got together to get the canal cleaned. It was also driven by the long period of water shortage in the Masharqa canal. The sub-BC had not been cleaned for the last two years. The farmers had asked the *islah* cooperative to send a machine for cleaning, and the cost of the machine would be added to the farmers’ accounts at the cooperative which they could pay at the end of the season. All the users of the sub-BC were present during the cleaning. It also must be mentioned that any prominent role of WUA of B6 and B7 or the BCWUA was not observed during the whole exercise. It also emerged that the farmers always asked the coop to arrange for the machine, as they could pay for the machine in instalments to the coop.

The evidence suggests that the all the maintenance activities except the pump maintenance are performed by individual farmers. There are also instances when the farmers do not keep their *marwa* and drain clean, but that depends on the farmers. Any specific involvement of WUA in collective maintenance of the pipe and valve system or the pump station was not observed.

Figure 3.6: Well-maintained field drain

Figure 3.7: Well-maintained field *marwa*

Figure 3.8: Hydrant with pin system

Figure 3.9: Hydrant with cap system

Figure 3.10: Stone used to close the pin cap

Figure 3.11: Polythene bag and wood used to close cap

1.1.4. Day-to-day management

A primary objective of this study was to understand the day-to-day management of the collective pumping system. There was a visible difference between the management at B4 and B7 as discussed below.

Around 25 farmers have opted out of the collective pump station B7, whereas none of the water users have opted out at B4. All the 25 water users comprise *islah* farmers, with the exception of one *milk* farmer under V1. Also, it was observed that it was easier for *milk* farmers than the *islah* farmers to opt out and join back in the next season. It must be added here that the process of opting out is not well defined at any of the pump station, and farmers who want to opt out just inform their neighbours and the operator. A farmer who has opted out of the CPS A4, explained the process in simple words, 'I just informed my fellow farmer Mahsub who is also a WUA member that I would be opting out, and then stopped using the CPS.' (Interview 3, 19th May 2013). The president of B7 WUA also explained the process, 'A farmer doesn't have to inform the WUA if he wants to opt out of *tatweer*. He just stops paying the electricity money.' (Interview 31, 14th June 2013). Other water users do not try to stop those farmers from opting out, which is somehow understandable because the pump capacity will now be distributed over a smaller area. It must be added that land-owners who have opted out of *tatweer* still have to pay the annual instalment for *tatweer* charges.

As discussed earlier, the WUA members of B4 do not participate in the regular operations and maintenance activities. On the other hand, the president of B7 tries to dominate over the operations and management activities. It also must be added that the boundary separating the roles of the president, treasurer etc is not well drawn at most of the pump stations. Instances of discrepancies in management by various actors were also observed. Some specific examples are explained in the box below.

Box 3.5: **Irrigation management – B7**

Farmer Ali (valve 3) comes to meet the operator. He wants to irrigate his land today. The operator tells Ali that he let him irrigate out of turn last time, but he can't allow that today. But after sometime he informs Ali that he can irrigate at the end of the day.

Source – Field notes (21/06/2013)

Fiscal management - A4

During the field work, it was observed that the operator of A4 had stopped working. He explained the reason, 'I was not paid regularly and that's why I had stopped working. I have not been paid since the electric counter was fixed 6 months back'. Water users of that pump station agreed to this, and also added, 'The operator is a kind man and he worked without a salary for a long time.' (Interview 35, 17th June 2013). He got back to his work after being requested by the water users, and on the promise that he would be paid soon.

The first example clearly shows that the operator sometimes lets water users irrigate out of turn, which might lead to conflict later, while the second example points towards the organisational ineffectiveness of the WUA at A4.

It also emerged that at some of the pump stations like B7, B10, and B12 etc, the water users wanted to change the WUA members but were not aware of the process. The composition of the WUAs at all the pump stations has not changed since the inception. None of the members have been replaced or re-elected. But it must be added that the operator has been changed at some of the pump stations. Along with the lack of awareness, some of the respondents also pointed out other reasons for this. As a farmer in B4, pointed out, 'It is difficult to change the WUA members as all the farmers will have to come together for that' (Interview 5, 22nd May 2013). A major issue at B12 is the dominance of two brothers in the operations of the pump station and the management of the WUA. Ahmed, a farmer of B12, stated clearly, 'I want to change the members. But the brothers have told me that I would have to go to Tanta office to change the members, as they have their signatures on the documents there. Hence, it is not possible to change the members' (Interview 8, 26th May 2013).

The evidence provides an interesting insight into the significance and role of the WUA. Even though the WUA is not involved as an organisation in the day-to-day operations and maintenance, some WUA members try to exploit their position as the president or secretary and take undue advantage in terms of irrigation schedule or pump operations.

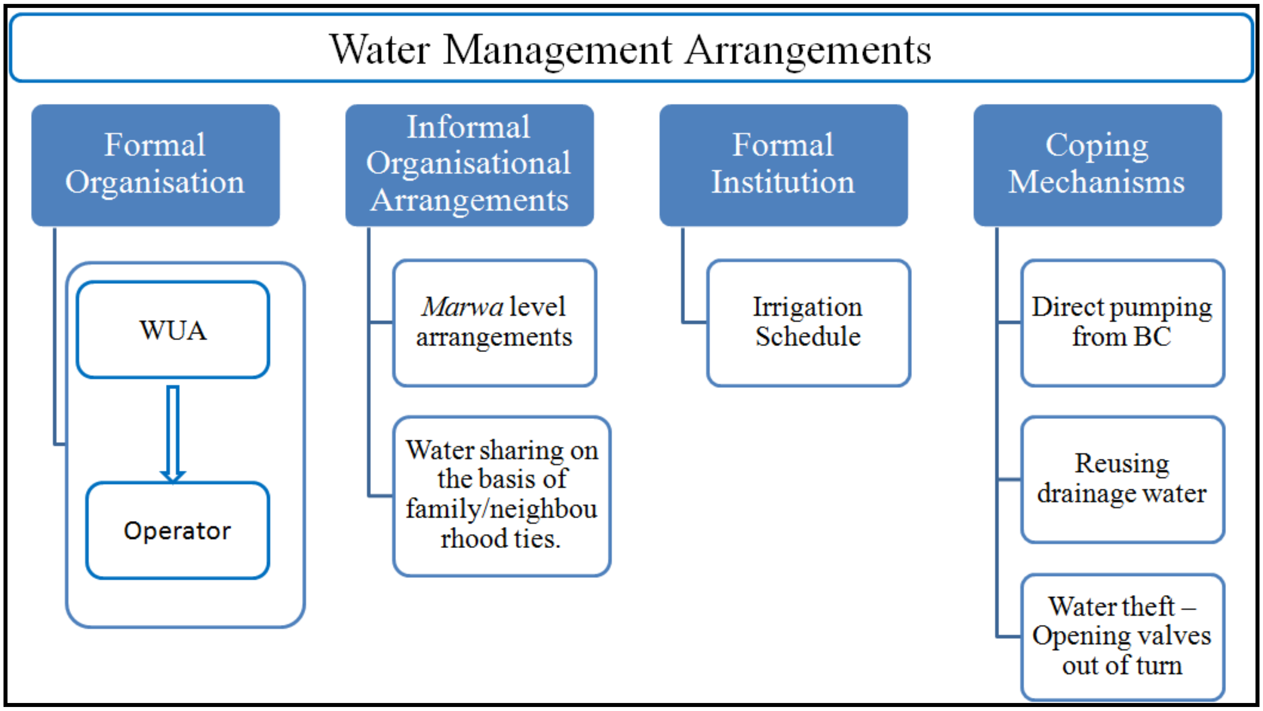
4 Water management arrangements

Irrigation management practices are shaped by the interactions among the agro-ecological and technical infrastructure, agrarian structure and the state and civil society institutions (Mollinga, 2003), and the irrigation tasks are socially organised (Hunt R. and Hunt E., 1976). This chapter discusses the water management practices based on the case studies of B4 and B7, but also draws from the practices observed at other pump stations.

One of the major objectives of the socio-technical package was to regulate water use by replacing all the individual pumps by one collective pump at the head of the *mesqa*. WUAs were promoted to manage the collective pumps and the water supply at the *mesqa* level. It was also expected that the combination of collective pump and pipe system would make the system more equitable for the tail-end farmers and reduce the practice of drainage water reuse (MWRI, 1998; World Bank, 2010). During the field work, it was found that the water management practices were based around a number of formal and informal organisational and institutional arrangements as shown in the figure 4.1.

Even though the arrangements have been shown separately with clear boundaries in the figure for clarity's sake, it must be added that the boundaries between the various arrangements are not well drawn.

Figure 4.1: Water Management Arrangements



The following sections attempt to unpack the organisational and institutional arrangements around water management.

4.1 Irrigation schedule

An operational rule (Ostrom, 1990) in the form of the irrigation schedule has been designed at each pump station of the study area for water distribution through collective pumping. The rule is based on a proportional system (Levine and Coward Jr., 1989) in which water is allocated on the basis of the area. Every *feddan* of land gets water for a fixed duration of time. The rule has been designed by some large landowners, operator and the respective WUA members for each pump station, based on the following factors, 1) total area and number of main valves in the *mesqa*, 2) pump capacity, and 3) irrigation requirement of crops, primarily rice which needs irrigation every 3 days. Hence, in *mesqas* with a small area, the duration of water allocation is more than those with a large area. It must be added that the rule was finalised after a trial-and-run exercise for one season after implementation. Based on the irrigation schedule, all the main valves are allocated a fixed duration of water time according to the area under the respective valves. It also must be mentioned that the rule is applied only during summer, while the system is demand-driven in winter. The pump station is operated as per the demands of the farmers in winter.

The irrigation schedule at B4 shows the influence of these factors. There are 13 main valves and 109 farm hydrants in B4 *mesqa* which cover an area of 72 feddans. The valves are installed at the beginning of each *marwa* which control the water flow in the *marwas*. Four successive main valves are opened sequentially during a period of 24 hours and then the next four valves, and the sequence is repeated after every three days. Each *feddan* of land gets an hour of water. Irrigation schedule is the key to collective pumping, and to ensure that farmers irrigate according to the water allocated to their plots. It also must be added that the farm hydrants along one given *marwa* pipe are also opened sequentially, and the irrigation starts alternatively from the beginning and the end of the *marwa* respectively, for each irrigation cycle. Similarly, at B7, every two main valves are opened sequentially for 24 hours, and every feddan of land gets two hours of water. The sequence is repeated after every two days.

The irrigation schedule is based on the rotation system that was used for *sakias*. A *sakia* served an area of 9-10 feddans, and every farmer got the turn to irrigate one-by-one. Also, if the *sakia* stopped working before the turn of some farmer due to reasons like a lack of water in BC, the rotation started from the turn of that farmer when the *sakia* started working again. The president of B4 WUA explained it clearly, 'Farmers already had an idea of *sakia*-based rotation system. The *sakia* system was designed for a smaller area, whereas the pump station has a bigger area' (Interview 29, 13th June 2013). But the irrigation schedule of the collective pump station is not changed or postponed if the pump station stops working mid-way due to electricity cuts. If there is a power cut during irrigation turn of any farmer, the schedule is not changed to account for the lost turn. A farmer of B4, who was waiting for his irrigation turn, explained the system, 'I will wait for electricity to come until the end of my turn (the time). After that, if other farmers don't agree to give me some time from their rotation period, I will have to wait for the turn to return after 3 days' (Interview 18, 4th June 2013). If the schedule is adjusted according to the electricity cuts, all the farmer would have to be informed which might prove to be complicated because of the large area under pump stations, as compared to *sakias*.

It was also observed that the schedule was not rigid as it was also modified at times, depending on the water availability and the need of farmers. When the B4 pump station was switched on after a brief period of water scarcity in the BC, the irrigation schedule was modified and two or more main valves were opened at the same time, rather than just one. As a farmer explained, 'Usually one main valve is opened at a time, but now two main valves will be opened at a time because of the current peak irrigation requirements after the end of water deficit in the BC. Also, the rice fields will get the water first, and then the maize plots' (Interview 15, 2nd June 2013). The irrigation schedule was converted to a need-based system covering a larger area, to meet the immediate irrigation needs.

The irrigation schedule starts from transplantation of rice and ends after the harvesting. Before transplantation, the pump station is used as per the demand of water users. A WUA member of B10 explained the system clearly, 'The rotation system will be in place till the end of the rice season. As the water requirement reduces, farmers might let go off their turns. Also, the farmers might use only 2 hours out of their 3. If the irrigation of a part is finished before the scheduled period, then the PS will be shut down for the day.' (Interview 56, 3rd July 2013). The arrangements around sharing of water at the *marwa* level are discussed at length in the next section.

It also must be mentioned here that the operation at B7 has become more demand-based than schedule-based. As mentioned earlier, most of the farmers of the *islah* area and a few farmers of the *milk* area have also opted out of the collective pump station. So, the pump station has to serve a smaller area of 25 feddans now compared to the original area of 45 feddans, and the existing water users use it as per their convenience. It was observed that there wasn't a fixed duration of irrigation for each feddan and farmers used the pump station as per need.

There is therefore a distinct difference between adherence to irrigation schedule at B4 and B7 respectively. It was observed that the water users of B7 did not adhere to the rules of the irrigation schedule. Opening the farm hydrants out of turn is a common practice. All the respondents of B7 also cited this as a primary reason for the conflicts. Husain, an *islah* farmer of B7, stated quite clearly, ‘Farmers don’t maintain the rotation system, and open their valves out of turn which leads to conflicts. The *milk* farmers use the PS as per their need. So I am happy with my IP as I get all the water that I need’ (Interview 39, 20th June 2013). This practice was not observed at B4, except some minor instances.

Hvidt (1996) argues that WUAs play an important role in managing the water distribution through the collective pump station and have increased the water control of the farmers in the improved systems. It was found during this study that the influence of the WUA on irrigation practices was the least among all the organisations involved, and has not changed the water control dynamics at the lowest level. As a farmer in the B4 *mesqa*, stated, ‘The WUA does not have any role in maintaining the water allocation rule. It is maintained by the farmers themselves’ (Interview 24, 8th June 2013). A major part of the study was to understand the role of WUA in various tasks of irrigation management.

It is interesting to note that the various tasks of irrigation management are primarily done by key individuals rather than the WUA. At both B4 and B7, it was observed, that the WUA as an organisation, did not have any role in water management. Most of the respondents also said that the irrigation schedule is maintained by the WUA, even though such an engagement of the WUA was not observed during the field work. Water users relate the key individuals with the WUA. On the other hand, some respondents clearly stated that the WUA did not have any role in maintaining the irrigation schedule. It was observed that the main actor involved in the implementation of the irrigation schedule was the operator, who is in general not a member of the WUA board.

Role of Operator

The operator is employed by the WUA for operations and maintenance of the pump station. In the operation of the irrigation schedule, the operator only has to ensure that each main valve is opened for the allocated duration of time. The role of the operator in ensuring the adherence to the irrigation schedule can be drawn from the water management practices in various pump stations.

At B4, the operator is proactive towards his responsibilities of operation and maintenance. The irrigation schedule is implemented as per the design. Also, it was observed that the farmers of B4 did not have to ask the operator for opening the main valves as per the schedule. But at B7, the farmers had to ask the operator to start the pump and open the main valves as per their requirement. Also, the availability of the B4 operator on field was more than that of B7 operator. The accessibility of the operator during peak irrigation period is also a critical factor in the operations. If the operator can be easily reached by the farmers or is present on the fields, it helps in better management and conflict avoidance. An interesting observation was the role of the brother of the operator of B4. The brother helps with the operation of the pump station and the valves in the absence of the operator, which ensures a smooth operation.

It was observed that the schedule-based system at B4 runs more smoothly than the demand-based system at B7. At B7, the farmers inform the operator whenever they have to irrigate, and the operator switches the pumps on. But the operator did not stay near the pump station for the whole day, and farmers had to often wait for him to come and switch the pump on. The operator stated it explicitly when he said, ‘Farmers come at odd hours and tell me to start the pumps, but I can’t stay all the time at the pump station’ (Interview 42, 21st June 2013). The example below explains the attitude of the operator towards his responsibilities and its impact. It was further observed that the absence of the operator from

> Box 4.1: **Role of operator in maintaining irrigation schedule – B7**
>
> Discussion with Kamran, a farmer of B7:
>
> Kamran tells us about a rotation related issue that he faced yesterday. Some other farmer had his turn from 11-3pm for his two feddans. But the operator let him use the water till the evening. But when Kamran asked for his turn (which was after the other farmer), the operator switched off the PS and said that he wouldn't be able to wait in the evening and told him to irrigate his land the next day. Kamran complained to the WUA president, and he also told him the same thing. He adds that the operator has a special relationship with the other farmer and that's why he did that.
>
> Field Notes (19/06/2013)

the pump station when farmers needed to irrigate, also led to conflicts. Some farmers have opted out of collective pumping to avoid such conflicts. The transaction costs involved with demand driven collective pumping is also a factor that influences the shift to individual pumping. It must be added that the operator needs to be present on-field all the time, in case of a schedule-based system.

The importance of the operator can be drawn from another instance that was observed at A4. The operator of A4 had stopped working during a period of 15 days in June due to conflicts over water management and non-payment of salary. In that period, the pump station had stopped working and all the farmers were using their IPs for irrigating directly either from the BC or the El-Nashar drain. Most of the IPs are based on the BC whereas El-Nashar drain is used by very few farmers.

It has been discussed earlier how the operator is also part of the conflict resolution mechanism. It is important to understand how the operators are identified and selected by the WUA. The WUA members of B4 explained the selection criteria of the operator, 'He should own a considerable area of land as that would make him more responsible towards the operation of the PS. He should be kind, hard working and should be able to make others listen to him.' (Interview 41, 20th June 2013). Similar criteria are used for selecting the operator at other pump stations.

4.2 Informal organisational arrangements

The boundaries of the irrigation schedule are not rigid and arrangements around water management are shaped by the traditional institutions and daily practices (Bourdieu, 1977) of the farmers and managed through a network of relationships and family ties, rather than the WUA. A farmer in the B4 *mesqa* explained the driving factor, 'We don't need anyone to monitor the water distribution. It has become a habit. Even before *tatweer*, some farmers used to share individual pumps and they also had some water sharing and distribution understanding among themselves' (Interview 14, 1st June 2013).

A number of informal water sharing and distribution arrangements were observed at the *marwa* level, based on the traditional organisational arrangements which were first-come-first-serve systems or priority-based systems. Most of the informal arrangements are based around division of collective water time and sharing water at *marwa* level. The sharing of water at the *marwa* level is decided by the farmers of that *marwa*, and is not influenced by the operator or any of the WUA members. The operators of both B4 and B7 stated explicitly that they were only responsible for the operations of the main valves, while the farm hydrant water division was the responsibility of the farmers of each *marwa*. It must be mentioned here that the *marwa* level arrangements have evolved around the irrigation schedule which is maintained by the operator.

As mentioned earlier, this study could not find the existence of any kind of project driven *marwa* committees (MCs) at the *marwa* level. The following types of organisational arrangements were observed at the *marwa* level:

- The farmers of a particular *marwa* are supposed to open the farm hydrants for their plots sequentially for a duration proportional to the respective plot area. But they often open more than one hydrant at the same time and share the water time. Karim, the brother of the operator of B4 *mesqa* who is also a farmer of one of the *marwas*, explained, 'We open more than one hydrant at a time and then share the collective time, as per requirement, as someone might need the water for a duration less than that allocated by the irrigation schedule, and someone might need more' (Interview 17, 4th June 2012). This arrangement has developed around the water distribution technology in the form of the farm hydrants. It is important not to treat water distribution technology as a black-box while analysing collective action (Narain, 2004).
- It was also seen that the sharing of water depended on the crops cultivated by the farmers in the *marwa*. Rice needs irrigation every three days, while cotton is irrigated once in fifteen days. So rice farmer gets the share of the cotton farmer for irrigating the rice once every three days, while the cotton farmer gets the priority when the cotton crop needs irrigation. It was also observed that the farmers with dry crops like berseem often let their turns pass, which were utilised by other farmers of the same *marwa*. A berseem farmer of V2 in B4 clearly stated, 'Even though every farmer is supposed to get an hour of water for a feddan, but many farmers like me let go off their turn if they don't need water' (Interview 16, 2nd June 2013).
- Farmers with immediate irrigation requirement like extremely dry field or for fertiliser application etc get higher priority than other farmers who are part of the *marwa*. The example below explains the arrangements based on need.

Box 4.2: Need based priority – B3

Waleed tells us that rotation system of B3 has been suspended due to the shortage of water. Now people just use it as per need and priority. He points out the farmer at the beginning of the *marwa* and tells us that he has to transplant his rice and he will use the water first and then Waleed and his friend. In sometime, another farmer passes by and talks to Waleed about irrigation. Turns out that some other farmer on sub-valve 4 has opened his sub-valve as he has applied fertiliser in his paddy, and the other farmers decide to give priority to him and to wait for a night. Waleed also mentions that this will avoid conflict.

Field notes (31/05/2013)

Some farmers under different main valves also share their water times based on their family or neighbourhood ties. Salim, a farmer in B2 *mesqa*, explained the water sharing system, 'A farmer can ask his neighbour for water, if he needs to irrigate out of turn. He will not have to pay for this water. He can repay in similar terms when the neighbour needs water in the future.' (Interview 4, 22 May

2013). It must be added that any kind of monetary exchanges between water users was not observed. These arrangements are based on the understanding between the farmers, and do not involve the operator or the WUA members. A farmer who has his land under V9 in B4, gave his examples to explain the system, 'I and my brother have 4 feddans of land in this part. One of the plots is in the earlier part (valve 8). So we collectively get 4 hours of water which we distribute among our crops as per requirement' (Interview 23, 8th June 2013). The informal organisational arrangements are more pronounced at B4 than at B7. As mentioned earlier, the irrigation at B7 is primarily demand-based because of the reduction in the number of water users and the area to be served. The collective pumps are operated as per the need of the existing water users. Hence, farmers of a *marwa* at B7 do not have the water sharing arrangements, as seen at B4.

A major difference was observed between the water management practices around farm hydrants at B4 and B7. At B7 that many hydrants are kept partially open, out of their turn as seen in figure 4.2. It is a common practice amongst the farmers. It is also a major reason of conflict among the water users. It was further observed that many of the hydrants were broken and could not be completely closed. The situation was well explained by the operator in one of the discussions, 'The farmers open their hydrants out of turn and no one listens to me. Even if farmers have opted out, they still open their hydrants. Also, most of the hydrants are broken. Farmers also try to get more water than their scheduled duration.' (Interview 42, 21st June 2013). It points towards the impact of water availability on the collective management of water users. As the availability of water reduces, the urge of water users to collectively manage the water also reduces, and they tend to develop individual mechanisms for irrigation. It is discussed at length in the next section.

Some instances of water theft at the *mesqa* level at B4 were also observed when some farmers opened the main valve at the head of their *marwa* and then their own valves out of turn. But this is the last resort, and farmers prefer not to do it to avoid conflicts.

Figure 4.2: Hydrants kept partially open

Giddens (1984) has pointed out that practices are institutionalised through a structure of rules and interaction among the agencies. It can be seen from the practices that the distribution is not driven by the proportionality rule, as designed for collective pumping. It has been argued by mainstream institutional scholars that making and maintaining rules is the core of organisational effectiveness (Kolavalli and Brewer, 1999) and a set of operational rules (Ostrom, 1990) is required for effective common property resource management. It can be seen that a set of operational rules in the form of the irrigation schedule has been designed for each PS, but the division of water at the *marwa* level is managed through a set of informal rules that are 'social arrangements between people' (Cleaver, 2012:8) and are 'embedded in design and social relationships' (Narain, 2003:8). It must be added that the *marwa* water management arrangements do not affect the implementation of irrigation schedule. Some of the rules have in place traditionally, while others have evolved from the water management practices of the farmers. The rules are applied irrespective of whether the water users are tenants or land-owners.

Even though a major aim of the project was to make the water distribution equitable through an irrigation schedule driven by collective pumping, the *marwa* level organisational arrangements divide the allocated water as per the rules set by the farmers. It must be mentioned here that the project views equity as the equal division of water as per the area, along the *mesqa*. But it can be drawn from the evidence that the water division between various hydrants at the *marwa* level is not equal. Also, the water distribution arrangements are driven by crop pattern which changes every year. Hence, a farmer who has less water requirement in the current year might have a larger requirement next year. Another major factor that influences the water management is the use of conjunctive sources for supply augmentations which is discussed in details in the next section.

4.3 Coping mechanism

Some informal organisational and institutional arrangements are also based around the irregular supply and deficit of water in the branch canal or the inadequate allocation as per the irrigation schedule. As mentioned earlier, the farmers in the middle region of the BC face occasional water deficit, especially during the peak irrigation season of rice transplantation. Also, the irrigation duration as per the allocation rule is not adequate at many the pump stations with large command area, during high water requirement stages of the crops. It is a major issue at B4 where the water users get an hour of water for each *feddan* of land.

It has been pointed out by some Mainstream Institutional scholars (Uphoff *et al.*, 1990; Fujiie *et al.*, 2005) that collective action is affected by the physical scarcity of water in the canal, but they often fail to explain how the collective action is shaped (Mehta *et al.*, 1999). Farmers adjust to water deficit or irregular supply in the main canal by various means of supply augmentation like reusing drainage water etc, or conservation like shifting to less water consuming crops etc or allocation practices (Molle *et al.*, 2010). The major strategies in this area are individual supply augmentation and allocation practices. The crop patterns as discussed earlier in Chapter II suggest that the irregular supply has not resulted in a major shift from rice to less water consuming crops like cotton or maize. Direct pumping from the drain or the branch canal is one of the most important means of supply augmentation. Three types of direct pumping were observed:

- Farmers irrigate pump water directly from the BC or drain to open *marwas* using their individual pumps. Most of the *marwas* at B7 have been kept uncovered even after switching to the pipe system for this purpose.
- Farmers pump directly from the sub-surface or field-level drain using their individual pumps.
- The farmers have introduced some technical changes for supply augmentation. Special inlet points have been constructed at the end or the beginning of the *marwa* pipes (based on the proximity of the conjunctive source) for connecting the individual pumps, as shown in the figures 4.3 - 4.6. When the farmers of a particular *marwa* need to use their pumps, they close the main valve of that section and connect the pump to the special inlet points. The inlets were collectively constructed by the farmers of each *marwa*, after the implementation of the project. At B4, most of the inlets have been constructed for pumping

from the drain, whereas at B7, the inlets have been constructed for pumping directly from the BC.

These *marwa* arrangements are based on the traditional first-come-first-serve system or a priority-based system. The individual lifting points also show the influence of the socially embedded arrangements. As mentioned earlier, the farmers used to lift water using their own pumps or *sakias* before the implementation of the project. The lifting points were fixed for each *mesqa* and *marwa*. It was observed that the IPs have been installed at those specific points for each part, and farmers lift water only from those points. Farmers who have installed their IPs at a specific point do not encourage farmers of other areas to lift from those points. The supply augmentation mechanisms are primarily individual-based, and hence the structural differences observed in terms of *islah-milk* differences are not observed in these mechanisms. The only visible impact was the installation of individual pumps on the traditional lifting points. It also must be added that tenants utilise the existing augmentation infrastructure created by the owners.

Figure 4.3: Direct Pumping from BC

Figure 4.4: Direct Pumping from the Drain

Figure 4.5: IP connected to *marwa* end.

Figure 4.6: IPs connected to air-vent of *marwa*

Figure 4.7: Direct Pumping from sub-BC at B7

Figure 4.8: String of IPs set beside B7 PS

It is important to discuss the farmers' perception of quality of water in drainage and BC respectively, to understand the supply augmentation practices. It was pointed out by all the respondents that the drainage water was not good for the crop because of its salt content which affected the yield. A farmer of V13 was quite vocal about the quality of water when he said, 'The poor quality of water affects the yield and hence the younger generation of men is leaving the village (agriculture) to work in the big cities like Cairo' (Interview 29, 13th June 2013). It was observed that the practice of reusing drainage water was extremely common along the El-Hodad drain, whereas it was not the case along the El-Nashar drain. Figure 1.2 in Chapter I shows that E-Nashar and El-Hodad define the right and the left boundary of the command area of the Masharqa canal respectively. Also, the differentiation between the drainage water and the BC water is different on each side. There is visible difference between the qualities of water in the two drains. The El-Nashar drainage is highly contaminated with the sewage waste of Masharqa village. A farmer, who owns land in A5 near the drainage, stated clearly, 'Even though the drain is close to my field, I don't use that water as it is just human sewage water.' (Interview 10, 26th May 2013). Figure 4.10 clearly shows the presence of sewage and the stagnant characteristics of the drain. But the discussions with farmers of the other side suggested that the water of El-Hodad drain was considered at par with the BC water. A major reason is that drainage water constitutes a major part of the water in the BC and hence the qualities of both the drainage water and the BC water are considered equal. Many farmers also believe that the drainage water is better than the BC. Mammun, a farmer of B4 clearly stated his preference for the drainage water, 'Drainage water is better than the canal water because of the human sewage in the canal' (Interview 1, 19th May 2013). Water from El-Nashar drain is rarely used by the farmers, whereas El-Hodad drain is a regular conjunctive source of water.

Figure 4.9: El-Hodad Drain

Figure 4.10: El-Nashar Drain

As mentioned earlier, the drainage water reuse is extremely high at B4 due to its proximity to the local drain, whereas it is not a common practice at B7 where farmers reuse the sub-surface and field-level agricultural drainage water, if they need a conjunctive source of irrigation. Water users of B7 pump directly from the BC as seen in figure 4.8. It was observed that all the farmers of V3-V13 at B4 had access to individual or shared pumps for pumping directly from the drain. One of the most interesting examples of supply augmentation was seen once at V4 in B4, where it was observed that the farm hydrants of that *marwa* were getting water both from the BC and the drain at the same time. The hydrants under V4 were getting water from the collective pump as part of the irrigation schedule, while the farmers had also connected an IP to the other end of the *marwa* pipe for pumping directly from the drain. One of the farmers explained the reason, 'I need more water as I need to prepare my field for transplantation. And the other two hydrants are being used for irrigating the rice field. So, I had to pump directly from the drain, along with the irrigation schedule.' (Interview 19, 4th June 2013). Similarly, all the farmers of B7 have access to individual or shared pumps for irrigating directly from the BC. Some farmers pump directly into the open *marwas*, while most of the farmers connect their individual pumps to the *marwa* pipes through the special inlet points.

All the respondents who had their plots at the end of the B4 and B7 *mesqas* also raised the issue of low pressure at the hydrants. Two major reasons were observed for the occasional low pressure at the valves:

- Capacity of pumps: At B7, the pressure at the tail end is extremely low if only one of the pumps is operated on its own. The relationship between pump capacity and the need for supply augmentation was explained by a farmer who had his turn to irrigate his land in the V4 area in B7. He clearly stated, 'The pressure at the hydrant is low as only one out of the two pumps was working.I will wait for my turn to finish, and then use my IP to directly pump from the BC to my field.' (Interview 31, 14th June 2013). Similarly at B4, this issue is observed at the tail end if the high capacity pump is operated instead of the combination of the smaller pumps. A farmer of V6 in B4 explained the role of pump capacity, 'Farmers irrigate from the drainage as water from the PS rotation is not enough. . If two motors work together, then they get enough water but otherwise it's not enough.' (Interview 45, 23rd June 2013).
- Sequential operation of main valves: The main valves are connected in a series. As per the irrigation schedule, the main valves are operated sequentially. But if two or more main valves are opened at the same time, the pressure at the latter valves reduces. It is a major issue at B4, as the length of the *mesqa* is long.

The example in box 4.3 clearly explains the impact of pump capacity on drainage water reuse.

Box 4.3: **Drainage water reuse – Driven by design constraint**

Imtiaz owns land in both B2 and the area under V13 at B4. Figure 3.1 in Chapter III shows the area under V13, whereas the spatial position of the B2 area with respect to B4 can be understood from figure 1.2 in Chapter I. The plots are under different pump stations because of their spatial positions which fall under different command areas. He pumps directly from the local drainage to irrigate his V13 land regularly, whereas he depends only on the collective irrigation schedule for the B2 land. He explained the reason for using drainage water at B4, 'I use mostly drainage water for my land in

B4 as the pressure is not much in the valve and I don't get enough water from the PS.'. He further added, 'Every feddan gets an hour of water in B4, while it is 3 hours here at B2. So, I get more water here and don't have to use the IP'. (Interview 46, 23rd June 2013). This example clearly shows that the use of drainage water is also driven by technical constraints like pump capacity and large command area.

It must be added that the motors are not operated as per the valve sequence under the irrigation schedule. Farmers think that the pressure at the tail-end hydrants is adequate if two smaller motors are operated together. The motors are operated on alternately a time-based schedule. Hence, at B4, there might be instances when the combination of two smaller motors is switched on during the irrigation turn of the valves at the end of the *mesqa*. And there might be instances when the big pump is switched on for supplying water to those valves. The situation is similar at B7 and other pump stations.

It was further observed that farmers sometimes pump directly from the local sub-surface drain if none of the other sources of water are available. Figures 4.11 and 4.12 show the different types of arrangement for pumping from the local drain. One of the arrangements is to keep the IP on the surface and put the intake pipe inside the manhole which is connected to the underground collector drain for pumping directly. But it must be added that the water availability in such collector drains is quite low. A more popular practice is to pump directly from the field-level drain adjacent to the land. A farmer of V2 in B7 explained the reason to us while fitting his IP over the local drainage. He said, 'The local drainage water is the same. The BC is also full of drain water. So it does not matter. I use the field-level drainage when I need water out of turn or if the pump station doesn't work.' (Interview 59, 05th July). It was further observed that farmers re-used the sub-surface or field-level drainage water if there was absolute water scarcity in the BC. The practice is visible more at B7 than B4. As the local drainage (El-Hodad) is easily accessible for most of the farmers of B4, they do not have to use the sub-surface drainage.

Figure 4.11: Direct Pumping from field-level drain

Figure 4.12: Direct pumping from sub-surface lateral collector

It was expected that the WUAs would enforce collective pumping and that the water users would shift from individual pumping to collective pumping based on an irrigation schedule. But it can be drawn from the discussion that individual pumping is an established and sanctioned practice among farmers, and the organisational arrangements of farmers do not always promote collective management. It was observed that most of the farmers in the middle stretch of BC had access to or had set up an individual lifting point on the drainage or the branch canal. It can be seen from figure 4.8 how farmers of B7 have set up a lifting intake for the individual pumps right next to the pump station. An instance of collective effort of the farmers for setting up a common intake point was observed at B4 as explained in box 4.4.

Similar intake points have been set up at all the pump stations in the middle stretch. It must be added here that all the farmers do not own individual pumps. Some pump owners share their pumps with farmers who do not own IPs. Also, land owners provide the IPs to tenants if the sharecropping system is based on yield sharing. An interesting thing to note is that any form of collective coping mechanism like reducing irrigation time, was not observed.

Box 4.4: **Collective Intake Point – B4**

Farmers of V1-V2 set up an inlet point on the BC to connect their individual pumps to the *marwa* pipes, after a long period of water deficit in the BC. The area V1-V2 belongs to *milk* farmers, and the inlet was setup to serve only the V1-V2 area. It demonstrated collective action by the farmers of V1-V2 as a reaction to the water scarcity. As mentioned earlier, the BC faced a period of acute water scarcity when water from the Meet Yazid canal was not released for two week. The PS had stopped working eventually due to the high intake level. It coincided with the peak irrigation season of rice transplantation. The farmers got together to construct the special inlet point that would enable them to connect the IPs to the *marwa* to pump the last drop of water from the BC. It cost the farmers 3000 EP which they collected among themselves. It was observed that the initiative was driven by a couple of farmers, who mobilised others for the same. It must be added that the WUA was not involved in this initiative.

The example mentioned above presents an interesting insight into the dynamics of collective action. The farmers collectively set up the inlet point that would help in individual direct pumping. It points towards collective action initiated by the farmers towards aiding individual pumping rather than collective management of the water. A farmer of A4 *mesqa* explained the reason why farmers prefer individual pumping over collective pumping, 'Everyone knows that the individual pump and the water coming out of the pump are the farmer's property, and he could fight for his right if someone tries to steal water while he is irrigating. But the collective pump is a common property, and everyone has a right on that and that leads to conflict.' (Interview 34, 17th June 2013). Farmers' perceptions of private and common properties also influence the collective action. The arrangements suggest that there is an informal consensus among farmers about using individual pumps rather than depending completely on the collective pump. Rahim, another farmer of the A4 *mesqa*, explained the reasons for using the individual pumps, 'Farmers use individual pumps if they need water before their next turn according to the irrigation schedule, or to avoid conflicts. Crops can wait, but if a farmer has an individual pump, he would irrigate whenever he wants to' (Interview 47, 26th June 2013). It has been argued by Ostrom and Gardner (1993) that users' participation in collective management is driven by the urge to reduce the transaction costs of participation. But the examples discussed above suggest that farmers often prefer individual pumping over collective pumping based on perception of private and common properties or to avoid social conflicts. It is interesting to note that conflict avoidance might also driven by the urge to reduce transaction costs related with conflicts that arise out of collective pumping. It is discussed in details in the next section.

Another major reason of using individual pumps is the frequent electricity cut which disrupts the irrigation schedule. Wasim, a farmer of B7, explained the need, 'Farmers might miss their rotational turn during electricity cut and then they have to use IPs. Also the land might get dry before the next turn, and so farmers have to use the IP.' (Interview 48, 26th June 2013). This thought was echoed by most of the respondents. A farmer of A4 also had similar views when he said, 'The farmers use the IP if there is electricity cut or there isn't enough water in the BC. The electricity cut is for 2 hours every day. But sometimes, the period is longer. Farmers miss their rotation during electricity cut.' (Interview 53, 27th June 2013). It was observed during the field work that electricity cut was a recurring issue, but it could not be quantified.

A project built coping mechanism must be mentioned here. All the water towers have an extra inlet which can be connected to external diesel pumps, if required. It was observed that farmers have connected a diesel pump at most of the pump stations, as seen in figures 4.13 and 4.14. Such pumps are privately owned, but used by other farmers as well. But a special mention must be made here about A1. The farmers have collectively bought a diesel pump which has been connected to the water tower through the extra inlet. The reason was clearly stated by a group of farmers of A1, 'We have connected a collective diesel pump at the PS which is used when there is an electricity cut or when someone needs water out of turn or during some other emergency.' (Interview 49, 26th June 2013).

It can be drawn from the evidence that the practices of direct pumping from the BC and reuse of drainage water are primarily driven by the irregular supply in the BC. Other factors like occasional electricity cut, size of command area, limitations of pump capacity etc also influence the practices. But the practices are also driven by the preference for individual pumping over collective pumping among water users. This factor has been discussed in details in the next section.

Figure 4.13: Diesel pump connected, at B6

Figure 4.14: Diesel pump set up, at A1

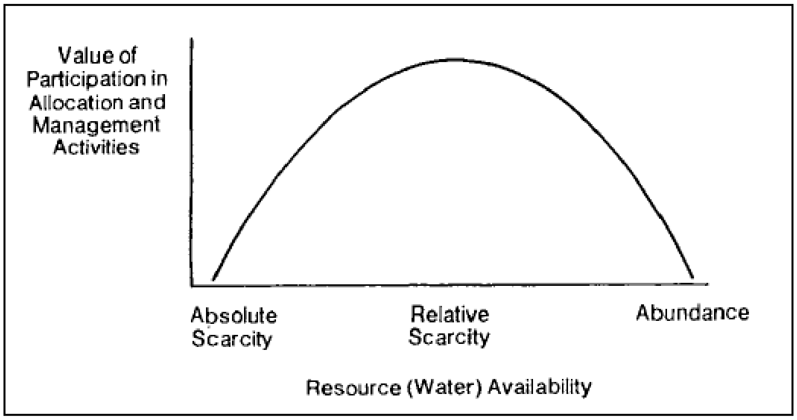
4.4 Response against varying levels of water supply

The evidence discussed in the earlier sections, point towards a clear pattern of reaction of water users at different points of time against varying levels of water supply in the BC.

As discussed earlier, the irrigation schedule is implemented only after the transplantation of rice, to avoid conflicts. The one-time water requirement is highest during the transplantation. Also, farmers want to transplant on-time to get a good yield. During the transplantation season, the system is based on a first-come-first-serve driven by a demand system. At B10 it was observed that farmers did not use the collective pump station at all until after transplantation. A farmer of that *mesqa*, Amir, explained the reason, 'All the farmers would want to irrigate their farms at the same time for transplantation, and it would lead to conflicts. So farmers use their individual pumps' (Interview 7, 25th May 2013). As the water requirement reduces with the growth of the crop, the irrigation schedule is also well implemented if water availability is adequate in the BC. It has already been discussed earlier, how farmers let go of their turns in the later stages of rice cultivation.

The relationship between the level of participation of farmers and the physical scarcity of available water resembles an inverted U shaped curve which peaks at a medium level of scarcity (Uphoff et. al, 1990). Figure 4.15 shows the relationship between the two. If there is absolute scarcity of water, then it reduces the incentive for farmers to participate in collective management of water. On the other hand, if the water is abundant, it might not need collective management. Relative scarcity of water increases the incentive of farmers to participate in collective management.

Figure 4.15: Relationship between water availability and collective participation



Source: Uphoff et. al (1990)

The evidence from B10 points towards the impact of water scarcity on the collective participation of farmers. Farmers avoid collective pumping during the peak irrigation period.

A correlation of the irrigation schedule operation with the availability of water along the BC was also observed. In cases of water abundance at the beginning or the end of the BC where each feddan is allocated adequate water, it was observed that the adherence to the schedule was strong. But as the availability of water decreased towards the middle of the BC, the adherence to the rules also reduced. The adherence to the irrigation schedule was high at B1, B2, B3, B10, B12, A1, A2, A3, and A6 as compared to the other pump stations. As discussed earlier, it is common practice to open the hydrants out of turn at B7 as compared to B4. The departure from collective management to individual coping mechanism, like water theft at B7, can be linked to the difference in the water availability at B7 and B4.

Also, the irregular nature of the supply forces farmers to irrigate whenever they can get the chance, during periods of water shortage. The organisational arrangements during the period of acute water shortage in the BC also suggest that the level of collective management reduces greatly in times of absolute water scarcity. At one point, it was observed that all forms of pumping (collective or individual) had stopped, due to the absolute scarcity in the BC. It extended over a period of two days. It was further observed that many farmers were even sleeping near the BC, so that they could connect their IP whenever some water collected in the BC. These arrangements were all based on first-come-first-serve, rather than any collective arrangement. But at the same time, farmers of Masharqa village got together to protest against the water situation, and collectively complained to the irrigation department. Similarly, most of the farmers were involved in the cleaning of BC and sub-BC during the water scarce period, as discussed earlier. While all forms of collective management of water had stopped during that period, the water users collectively initiated protests and supported maintenance activities.

The collective arrangements at the *mesqa* level are affected during absolute water scarcity. But the *marwa* arrangements are not affected much, as most of the arrangements are based on first-come-first-serve or need-based priority. Also, the inlets and farm hydrants play important roles in individual coping mechanisms. Collective management in the pump stations of the middle stretch of the BC during absolute water scarce periods or during peak irrigation periods also leads to conflicts among farmers. It was observed that farmers prefer to avoid such conflicts, and eventually opt out of the collective pumping system. The next section discusses this in details.

4.5 Preference for conflict avoidance

One of the reasons of using individual pumps that emerges from the observations, is that farmers prefer to avoid conflicts that arise out of collective pumping. It has been pointed out by Cleaver and Franks (2005) that preference for conflict avoidance is often a major factor that shapes the water management practices, and encourages individual coping mechanisms. The evidence presented in the earlier section also shows that the irrigation schedule is implemented after the transplantation at all the pump stations to avoid conflicts.

An understanding between the upstream and downstream users was observed regarding fresh water sharing at the branch canal level. It was observed that downstream water users did not mind direct pumping by upstream users, as all the users felt that it was driven by need. The farmers of A1 were unanimous in their view when they said, 'Fresh water doesn't reach here, except in winter. The farmers at head of the BC use more fresh water whenever it is released. The whole system is based on need. Even when there isn't much water at the beginning of the BC, the farmers of this area don't stop using the PS. Similarly when the farmers upstream get fresh water, they don't stop using their PS' (Interview 49, 26th June 2013). A similar thought was echoed by Kalam, who owns land in the B4 area, 'An allocation system is not possible in the BC as farmers will irrigate whenever they get water. A thirsty man will drink water whenever he sees water, and will not wait.' (Interview 55, 2nd July 2013). It was also mentioned by some farmers that an allocation rule for the BC had been set by an engineer earlier, which forbade upstream users to irrigate until the water reached the end of the BC. But it could not be maintained for a long time, and farmers reverted back to their original usage pattern. It must be added that any kind of conflict over water allocation between the upstream and downstream users was not observed during the study period. It must also be mentioned that the understanding between the upstream and downstream users is socially acceptable in the community. A point of caution must be added here that this understanding is based on the fact that downstream farmers are not dependent on only the fresh water because of the regular infusion of drain water in the branch canal. The situation might be difficult in other branch canals.

The preference for conflict avoidance can also be understood from the case of Wasim who owns land in V1 at the head of the B7 *mesqa*. He opted out of the collective pump station this year, even though his plot is the first one in the *mesqa*. When asked about the reason, he said, 'I opted out of the PS due to conflicts over irrigation schedule. It is better to pay more for fuel than to get involved in conflicts. Now I can irrigate whenever I want' (Interview 48, 26th June 2013). Even though the operation is demand based, it still leads to conflicts among farmers. The organisational arrangement at B7 where most of the *islah* farmers have opted out of the collective pumping system, and are using their individual pumps to irrigate from the branch canal, is also shaped by the preference for conflict avoidance. Conflict arising out of collective pumping along with the *milk* farmers was pointed out as one of the major reasons for opting out of the collective pumping system by most of the *islah* respondents. As discussed earlier, the structural differences between the *islah* and the *milk* farmers have been reproduced in the water management practices at B7. The *islah* and *milk* farmers still prefer to pump separately. It can also be drawn from this evidence that the *milk* farmers draw more benefits from the technical package than the *islah* farmers, in terms of irrigation cost and time. The limitations of the Mainstream Institutional approach in understanding collective action has been pointed out by many scholars (Mosse, 2003; Mehta, 2007; Cleaver, 2012) who have argued that the this approach fails to take the local political and historical understanding of collective action into consideration, and rather views the community as a homogenous entity. But the heterogeneity of community in terms of the structural *islah-milk* division affects the collective management of water. Also, the benefits are not shared equitably in the community.

It can be drawn from the discussion in the earlier sections that the farmers in the *marwas* V3-V13 get more water than the farmers in V1-V2, as they have access to the drainage water along with the collective water. When asked if an irrigation schedule taking this factor into account can be designed, Waleed who owns land in V1, stated, 'Farmers at the end get more water as they get water from the drain and also from the BC (as part of the rotation). The rotation is same for them as they pay the same amount. It is not possible to set different rotation systems as it will lead to conflict. So, they get more water.' (Interview 12, 31st May 2013). It suggests that farmers adhere to the irrigation schedule based on an equal division of water, to avoid conflicts. The role of direct pumping on conflict avoidance can be drawn from the water management practices at B4. Mammun stated quite clearly, 'There are some conflicts because of the large command area. But there are not many conflicts over water as end farmers take water from the drain while the farmers at the beginning take water from the canal whenever they need water.' (Interview 1, 19th May 2013).

The evidence discussed above suggests that water management is shaped more by informal organisational and institutional arrangements among the water users. It also must be added that the *marwa* water sharing arrangements are based inside the irrigation schedule. As discussed earlier, the WUA does not play a role in water management, but the operator is the primary actor in ensuring the maintenance of the irrigation schedule. The informal organisational arrangements have evolved out of the formal irrigation schedule. The impact of the arrangements on the equity of water distribution has been discussed in the next section.

4.6 Equity of water distribution

The study tried to understand the farmer's perception of equitable water distribution in terms of formal and informal allocation practices. We define equitable water distribution as a system that is considered fair by the farmers, and is socially accepted.

The evaluation reports (MWRI, 1998; World Bank, 2007; Gouda, 2009) suggest that technical and institutional reforms have made water distribution more equitable as all the farmers get water proportional to the area, regardless of the spatial arrangement. It is important to understand the distribution of water within the context of water availability and water management practices. The question of equitable water distribution becomes important only when water becomes scarce (Svendsen and Small, 1990). Based on a study in the W10 area, Simas *et al.* (2009) argue that the technical design has improved the equity of water distribution along a *mesqa* as farmers at the head cannot capture water anymore and the tail-ender farmers get the water they need.

It was observed that the distribution of water at all the main valves along the *mesqa* was on the basis of the allocation rule, irrespective of the spatial location. All the respondents mentioned that the allocation rule and the pipe system ensure water distribution proportional to the area of the plot everywhere along the *mesqa*. The concept of equitable distribution cannot be unpacked, without taking the informal water distribution arrangements into consideration. As discussed earlier, the water distribution at the *marwa* level is shaped by the informal organisational and institutional arrangements, and is not based on a proportional division of water. The distribution rules practiced by farmers are not always equitable technically (Levine and Coward Jr., 1989), but are based on the perception of fairness of the farmers. Diemer (1998) argues that in farmer built systems, water is distributed among right-holders while in agency built systems the unit of allocation is the plot. I tried to understand the farmers' perception of equity through the water distribution practices and I did not come across any instance or complaint of inequitable water distribution. The water distribution at the *marwa* level, as per the needs of the farmers, is a socially acceptable and fair system.

It can be drawn from the discussion in the earlier sections that the farmers do not view equitable distribution as a system based on proportionality, rather as a system based on access to adequate water. It is considered perfectly justified if some farmers use direct pumping from the drain or the canal to supplement their irrigation or decide to opt out of the collective pump system and use individual pumps. As mentioned earlier, the water distribution is also driven by the preference for conflict avoidance. Some instances of unequal access to drainage water were observed, but it was not viewed as inequitable by the farmers. At B4, farmers in *marwas* closer to the drainage get more water than those at the beginning of the *mesqa* as the farmers near the drain use their individual pumps to irrigate directly from the drainage, and also get water from the canal as part of the irrigation schedule. Mustafa, who owns land in V2, said, 'Farmers at the end get more water as they get water from the drain and also from the canal. I am fine with it as all farmers are part of the *rabta* [2](association) of neighbours and family' (Interview 11, 31st May 2013).

Equitable water distribution is not seen just in terms of collective water distribution; rather it is seen as a system based on access to adequate water, through the collective pump or the individual pumps. It was observed that all the farmers had the freedom to pump directly from the branch canal or the drainage whenever they wanted. The social, power, and gender structure that is reproduced in the WUA composition, does not have an impact on the equity of water distribution. The socio-economic and power differences between the *islah* and *milk* farmers do not have an impact on the access to irrigation water. Doaa, an *islah* farmer who has opted out of the collective pumping system, said, 'Even though individual pumps are more expensive to use, I can irrigate whenever I want'(Interview 44, 26th June 2013). It was reiterated by all the respondents of the *mesqa*. I also could not observe any instance of social, gender or intergenerational inequity (Phansalkar, 2007) among the water users. Farmers do not view distribution of water only in volumetric terms, but in terms of access rights and adequacy.

It can be drawn from the discussion that the informal arrangements and the sanctioned practice of direct pumping play important roles in shaping the equity of water distribution.

4.7 Impact of the Improvement Package

Although this study could not analyse the quantitative aspects of the impact of the technical package, observations and the discussions with the farmers provided interesting insights. Most of the respondents pointed out the benefits of the package in terms of the irrigation time and irrigation cost which have reduced. The loss of water has reduced after replacing the open *marwas*

[2] Rabta means association in Arabic. And it is used to refer to the WUA. It is also used to refer to the feeling of togetherness among farmers.

with pipe and valve system. Many respondents also mentioned that *tatweer* had made irrigation easier as farmers could irrigate just by opening the valve and hydrants.

Some farmers also pointed out the impact of collective pumping on inter-personal relationship. Waleed, a farmer in the B4, explained this impact, 'Rabta was there even before *tatweer* but it has become stronger because of *tatweer*. Before *tatweer*, everyone used their own IPs. Now farmers have a rotation system which connects every farmer together' (Interview 12, 31st May 2013). Waleed referred to rabta as the feeling of togetherness and solidarity among the farmers.

An old farmers of B4, put it clearly, '*Tatweer* has brought the farmers together as everyone needs to cooperate for the rotation now' (Interview 26, 12/06/2013). It must be added that the opposite impression is also common, such as water users of pump stations like B8 and B9, who blamed *tatweer* for increasing the conflicts among the farmers. There are contradicting perceptions regarding the impact of the project on the conflict among water users. Some respondents complained that the conflict had increased after *tatweer*, while others said that it had decreased due to irrigation schedule.

Some reports (World Bank, 2007) have pointed out a positive impact on the land prices after project implementation, but no major change in land prices was reported by the respondents. The price of the land primarily depends on the ease of accessibility for commutation and electricity supply. Hence, price of land near the road is more than others. But it must be added here that these prices could not be compared with prices of lands in non-project areas.

The impact of the project on the crop yield could not be quantified. Most of the respondents complained of decrease in yield after project implementation due to the high use of drainage water. But at the same time, the farmers also believe that the situation would have been a lot worse without the drainage water. The water users also mentioned other negative impacts of the project. A farmer of V4 at B4 clearly stated that it was easier for him to irrigate before the project, 'It was better before *tatweer*. Earlier I could just use my IP on the sub-BC right next to my field, whenever I wanted. But *tatweer* closed that canal, and now I have to wait for my turn to get water.' (Interview, 1st June 2013). Some farmers also mentioned that they cannot irrigate for as long as they want, since the implementation of the project. Mehmoud clearly stated, 'As the *marwa* was open earlier, and many farmers used to take water from the *marwa*, the farmers at the end did not get enough water. Since *tatweer*, everyone gets the same amount of water as the duration is fixed for every farmer. But the water is not enough. Earlier, I could irrigate for as long as I wanted' (Interview 14, 12/06/2013). As discussed earlier, the farmers have adapted to the situation with various supply augmentation practices like direct pumping from the drain and BC.

A major objective of the project was to convert the flow in BC to a continuous system. But this has not been achieved yet. One of the major issues raised by the farmers was the irregular supply in the BC. Many farmers also claimed that the situation was better before the implementation of the project.

5 Discussion and conclusion

The pump trajectories of B4 and B7 present two distinct cases of the need for adequate participation of farmers in the design and layout of pump stations. The farmers of B4 were actively involved in the planning of the command area, as opposed to the B7 users. It was observed that, barring some exceptions like A1, B4, A3and B11, the water users were not consulted during the planning and layout. B7 has also demonstrated that the project brought different *mesqa*/*marwa* with different lifting points under the same pump station, which was not accepted by the farmers. Similar examples of lack of adequate consultation with farmers regarding the layout can be drawn from other pump stations. Mesqas with different lifting points were brought under the same command area at pump stations like A4 and A5, which eventually led to conflicts among the farmers.

The case studies also point towards the limited involvement of the WUA as an organisation in the operations and management activities. Also, the WUA is identified only with the board members, and the water users do not consider themselves the members of the association. The evidence further raises questions on the Mainstream Institutional theory of collective management by WUAs. WUAs do not always result in collective operations and management. Examples from B8, B7 etc show that it is important to understand the community heterogeneity and dynamics before setting up a collective pumping system.

Every pump station, with the exception of A3 and B11, has a well-defined irrigation schedule, like B4 and B7, based on a two-day or three-day rotation. At the same time, the water at the *marwa* level is divided according to the informal organisational arrangements. But farmers prefer to have separate lifting points for each *marwa* at the *mesqa* level, rather than a collective arrangement. Project promoted organisations and institutions are affected by informal organisational arrangements and social institutions of farmers. It has been seen earlier how the implementation of irrigation schedule is influenced by the structural heterogeneity in the society. It must be added that these arrangements are primarily applied in summer, and not in winter. One of the reasons why these arrangements have not been fully institutionalised is the periodic nature of implementation. The composition of WUAs shows the influence of the structural divisions and at some of the pump stations, the WUAs have assimilated the social institutions for conflict resolution.

A primary technical constraint that affects the operations of all the pump stations is the frequent electricity cut, which is a major issue during peak irrigation season. It affects the collective pumping at all the pump stations. Another major constraint is the limited pump capacity. At W10, the pump capacity has been reduced to increase the number of hours that the pump station can be used. As discussed earlier, the pump stations are used for 20-22 hours, but at the same time, low pressure at the tail-end hydrants in large *mesqas* is a major issue.

Even years after the implementation of the project, the flow in the BC is still based on a rotational schedule. Farmers have developed various coping mechanisms as a response to the water supply. The practice of direct pumping is also chiefly driven by the irregular supply in the BC. The case studies of B4 and B7 effectively explain the various factors responsible for reusing drainage water and direct pumping from the BC. The factors were also visible at other pump stations in the middle stretch of the BC. Farmers prefer to have flexibility of options, and it can be observed from the irrigation practices and adaptation of the *marwa* improvements by the water users. Masharqa canal presents a special case where the BC gets water from the primary drainage regularly. The situation might not be similar at other branch canals. It needs to be critically assessed if continuous flow is at all possible in the BCs, along with the rising diversion of the water to the reclaimed areas and to other sectors like urban usage etc. The water management practices of the farmers should be viewed within the context of water supply in BC. The continuous reuse of drainage water also points towards the high efficiency of water use at the higher system level.

It can be drawn from the evidence that many factors like availability of water, technical constraints, structural divisions in the community etc affect the collective management of water. It has been seen how water users avoid collective water management during the peak season of rice transplantation. Similarly, water users prefer individual pumping over collective pumping under water deficit conditions to avoid conflicts. The evidence shows that farmers often prefer to spend more on fuel for their IPs than to get involved in conflicts over collective pumping. Some water users prefer to opt out of *tatweer* and use their IPs, rather than get involved in regular conflicts. It must be added that the farmers have to pay *tatweer* instalments irrespective of whether they use it or not. These users are aware of the benefit of the package in terms of cost of irrigation, but for them, social conflicts weigh more than the benefits of collective pumping for many water users. It points towards a clear departure from the classic cost-benefit analysis based on institutional economics.

As discussed earlier, there is a distinct difference between the operations and water management at pump stations with large command areas and those with smaller command areas. Farmers get adequate water from the irrigation schedule in smaller *mesqas*, whereas it is a major issue at bigger ones. It emerged clearly that the impact is more positive at pump stations with small areas or at the head or tail of the branch canal. Respondents of these pump stations held the view that the project had improved irrigation system broadly, but the opinion of the farmers in other pump stations was mixed or inclined more towards the negative.

The acceptance of the socio-technical package among the farmers is mixed. The acceptance of *marwa* improvements like farm hydrants is higher than that of the collective pumping station. Farmers have adapted the pipe and hydrant system by integrating it with their individual pumping system. The hydrants have made it easier for the farmers to divide water, as per need and their informal arrangements.

The findings of this study raise important questions on the planning and implementation process of the improvement projects. They also point towards the need to revisit the design and the documented impact of the improvement projects.

Conclusion and Recommendations

The study shows that the impact of the socio-technical package cannot be viewed simply in terms of head-tail equity, efficiency etc. It is important to understand how the improvements shape the water management practices of the farmers, and also the contribution of various coping mechanisms in achieving the objectives of equity or efficiency.

Along with the evaluation of the water management practices, this study also presents evidence on the need to view collective action and organisational arrangements beyond the mainstream institutional paradigm. The report also raises questions on the impact of the improvement projects and the acceptance of collective pumping by farmers. Further quantitative studies are required to explore how much drainage water reuse and direct pumping from BC fulfil the irrigation requirement of farmers, and the contribution of collective water. At the same time, the social impact like acceptance of improvements, conflicts etc need to be considered in cost-benefit analysis of the projects.

It must be added here that this study covered just one branch canal, and similar studies on other canals are required to draw the pattern at the macro level. Also, the water management practices at the secondary and main canals need to be understood to fully analyse the effectiveness of the projects.

Based on the findings, this report recommends the following set of suggestions that might help to improve the result:

- Planning smaller command areas for pump stations, in the tail-end or the middle stretch of branch canals, where water availability is a major issue.
- Adequately consulting farmers regarding their traditional water management arrangements during planning of command area.
- Not organising farmers in *marwa* committees, as farmers have their own socially acceptable arrangements at the *marwa* level.
- Focusing on the selection and grooming of a pool of operators.
- Understanding the importance of drainage water reuse at the *marwa* level, and direct pumping from the canal, as socially acceptable means of supply augmentation.
- Analysing the need to integrate the technical changes made by farmers in the technical design of the project.
- Involving BCWUAs in operations and management of the branch canal water allocation system.

6 Appendix

List of interviews quoted in the paper

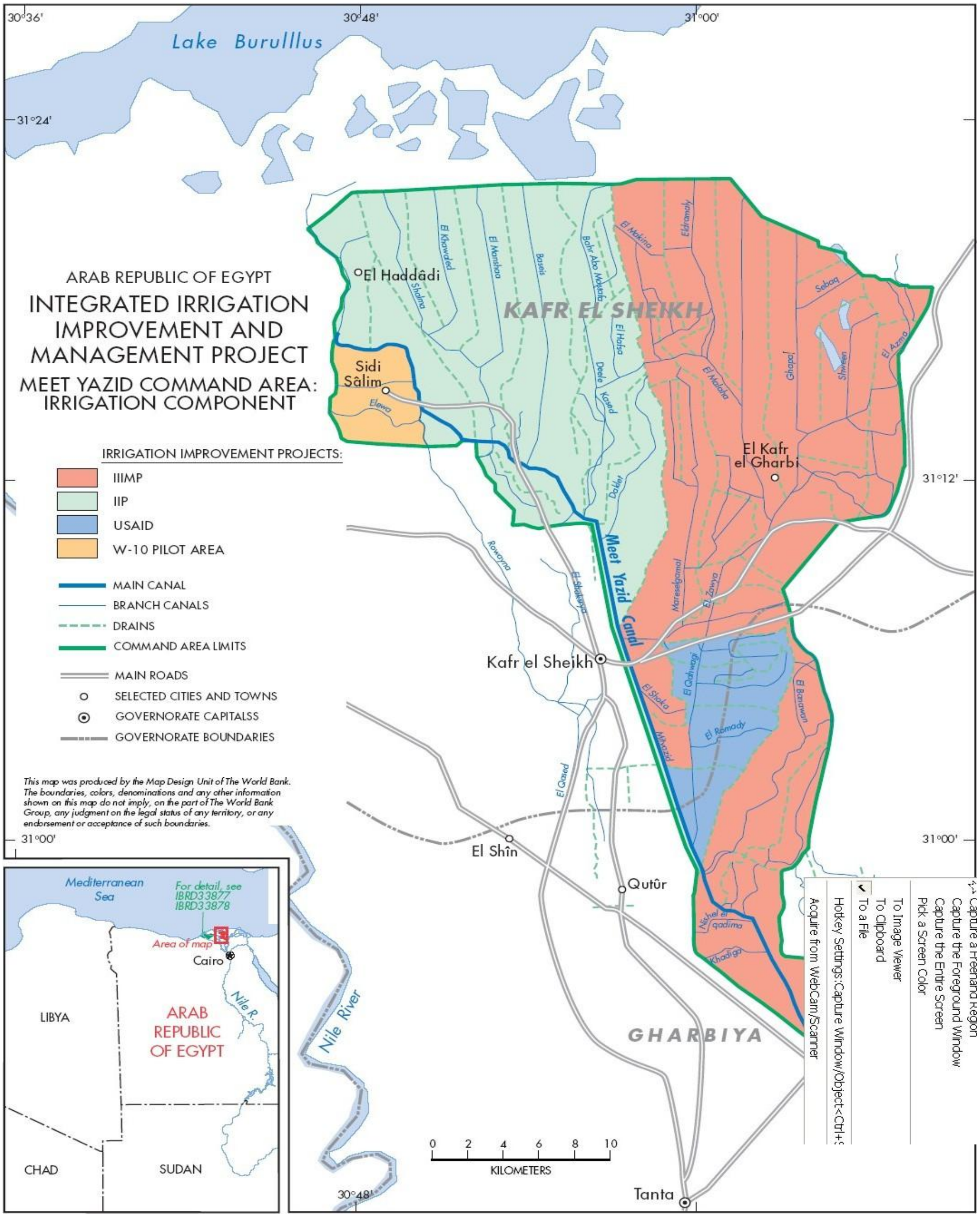
S. No.	Interview number	Location	Date of interview
1	Interview 1	B4	19/05/2013
2	Interview 2	B4	19/05/2013
3	Interview 3	A4	19/05/2013
4	Interview 4	B2	22/05/2013
5	Interview 5	B2	22/05/2013
6	Interview 6	B4	22/05/2013
7	Interview 7	B10	25/05/2013
8	Interview 8	B12	26/05/2013
9	Interview 9	B11	26/05/2013
10	Interview 10	A5	26/05/2013
11	Interview 11	B4	31/05/2013
12	Interview 12	B4	31/05/2013
13	Interview 13	B4	1/6/2013

14	Interview 14	B4	1/6/2013
15	Interview 15	B4	2/6/2013
16	Interview 16	B4	2/6/2013
17	Interview 17	B4	4/6/2013
18	Interview 18	B4	4/6/2013
19	Interview 19	B4	4/6/2013
20	Interview 20	B4	6/6/2013
21	Interview 21	B4	6/6/2013
22	Interview 22	B4	6/6/2013
23	Interview 23	B4	8/6/2013
24	Interview 24	B4	8/6/2013
25	Interview 25	B4	12/6/2013
26	Interview 26	B4	12/6/2013
27	Interview 27	Cooperative	12/6/2013
28	Interview 28	BCWUA	12/6/2013
29	Interview 29	B4	13/06/2013
30	Interview 30	B7	14/06/2013
31	Interview 31	B7	14/06/2013
32	Interview 32	B7	15/06/2013
33	Interview 33	A4	17/06/2013
34	Interview 34	A4	17/06/2013
35	Interview 35	A4	17/06/2013
36	Interview 36	A4	17/06/2013
37	Interview 37	B7	19/06/2013
38	Interview 38	B7	19/06/2013
39	Interview 39	B7	20/06/2013
40	Interview 40	B4	20/06/2013
41	Interview 41	B4	20/06/2013
42	Interview 42	B7	21/06/2013
43	Interview 43	A4	22/06/2013
44	Interview 44	B7	23/06/2013
45	Interview 45	B4	23/06/2013
46	Interview 46	B2	23/06/2013
47	Interview 47	A4	26/06/2013
48	Interview 48	B7	26/06/2013
49	Interview 49	A1	26/06/2013

50	Interview 50	B8	27/06/2013
51	Interview 51	B8	27/06/2013
52	Interview 52	B8	27/06/2013
53	Interview 53	A4	27/06/2013
54	Interview 54	BCWUA	28/06/2013
55	Interview 55	B4	2/7/2013
56	Interview 56	B10	3/7/2013
57	Interview 57	Irrigation dept.	4/7/2013
58	Interview 58	B7	5/7/2013
59	Interview 59	B7	5/7/2013
60	Interview 60	B7	5/7/2013
61	Interview 61	A4	5/7/2013

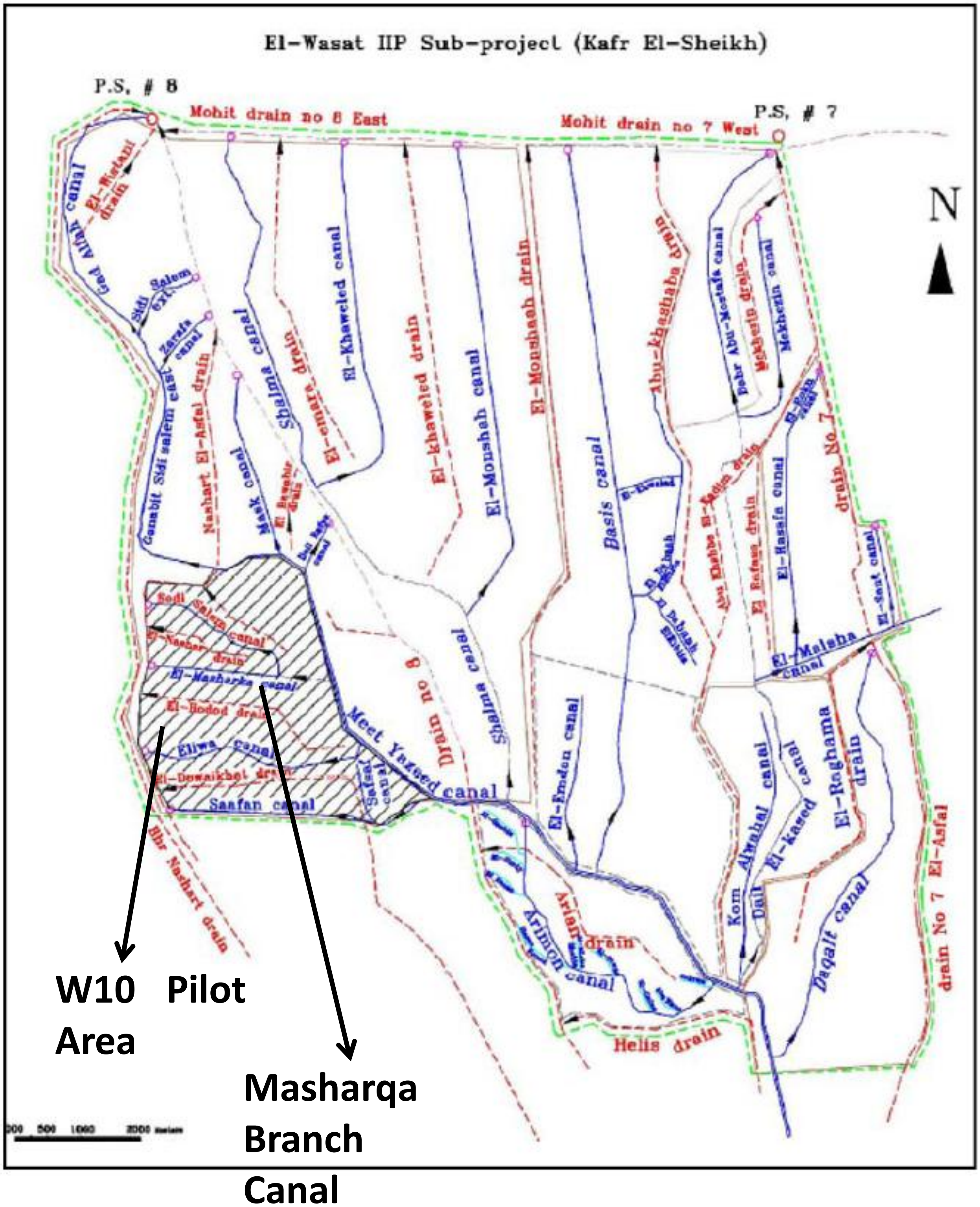
Appendix 2

2.1. Location of W10 in Meet Yazid Command Area



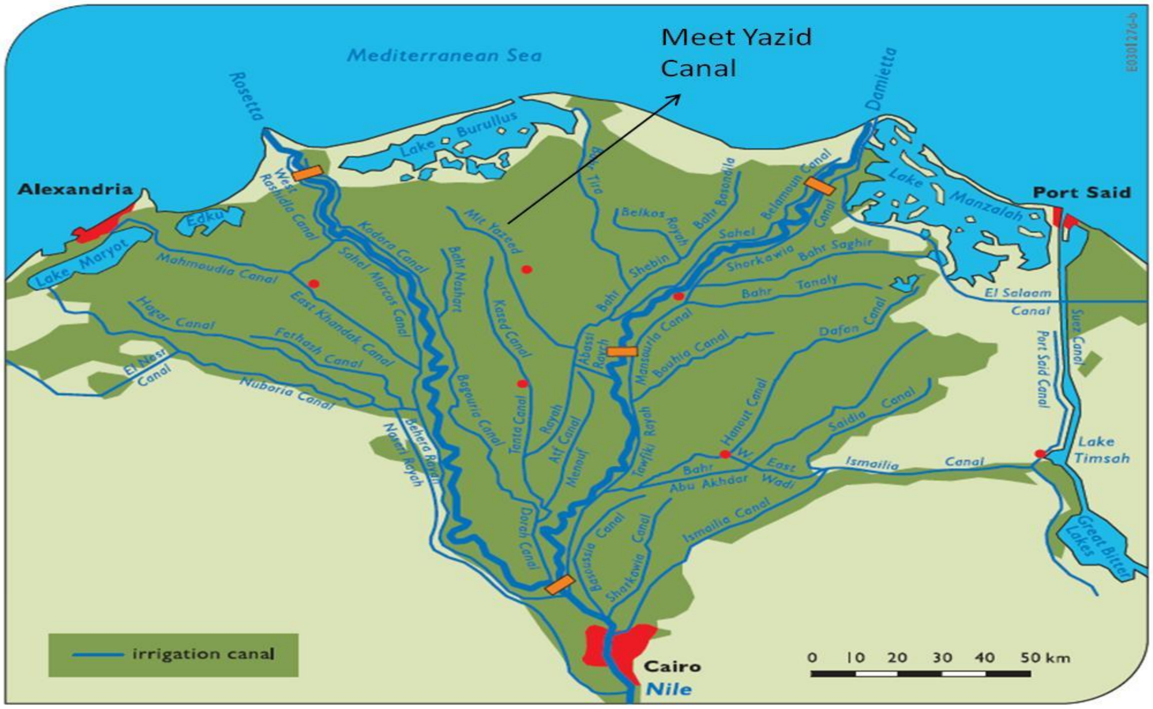
Source: World Bank (2005)

2.2. Location of Masharqa Branch Canal in Meet Yazid Command Area

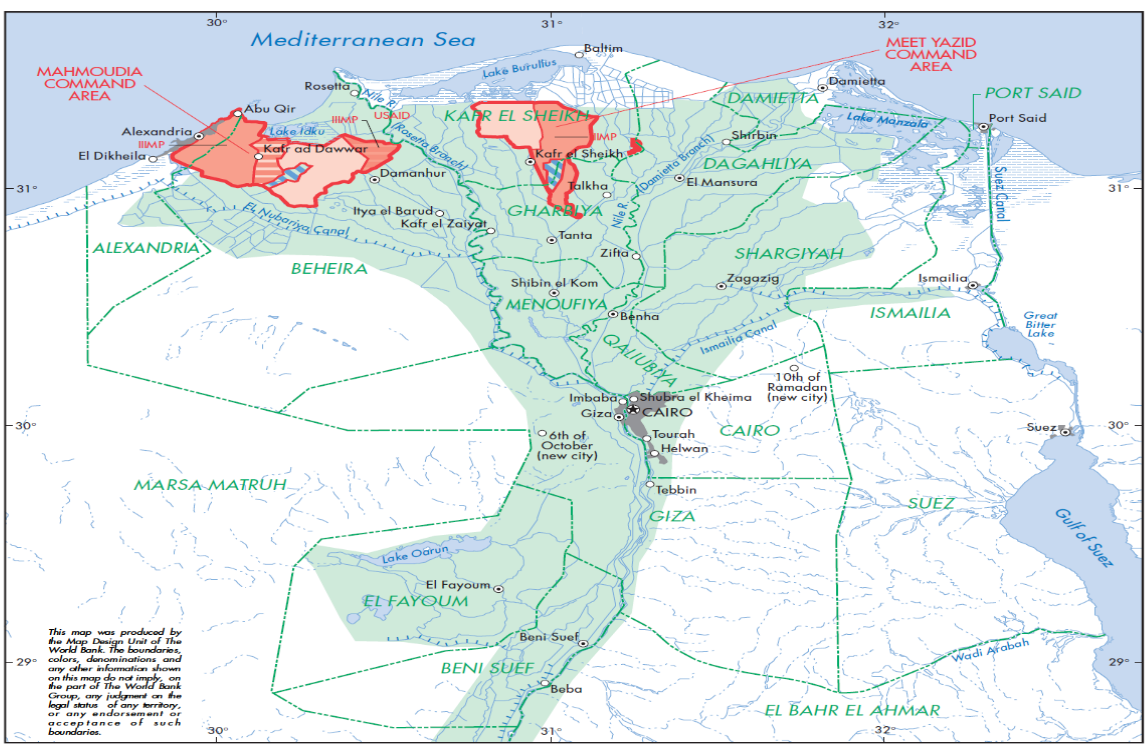


Source: Kheira (2009)

2.3. Location of Meet Yazid Command Area in the Nile Delta



Source: MWRI (2005)



Source: World Bank (2005)

Appendix 3:

3.1. Matrix ranking of all the *mesqas* in Masharqa canal

Mesqa	Water Deficit (quantity)						a under p station	Conflict among Farmers	Total
A1	1	1	1	3	1	1	8	2	18
A2	1	2	1	1	1	1	1	3	11
A3	1	1	1	1	3		6	1	14
A4	4	3	3	4	6	6	8	5	39
A5	10	8	10	7	10	1	10	8	64
A6	5	4	3	5	4	1	1	3	26
B1	1	1	1	5	1	1	1	1	12
B2	1	3	1	6	1	6	7	4	29
B3	2	2	1	4	1	6	5	4	25
B4	6	6	4	1	10	10	8	8	53
B5	7	3	1	4	10	1	5	3	34
B6	8	8	10	10	10	10	5	8	69
B7	10	6	4	1	10	10	8	8	57
B8	10	5	10	10	10	1	5	2	53
B9	10	10	10	10	10	10	6	6	72
B10	5	5	1	4	10	1	1	5	32
B11	2	1	1	1	3	3	1	1	13
B12	1	6	1	5	3	4	1	5	26

The scoring was done on a scale of 10 where 10 represented the maximum score of the factor

7 Bibliography

Allam, M., El-Gamal, F., and Hesham, M. (2005) 'Irrigation Systems Performance in Egypt', in N. Lamaddalena, F. Lebdi, M. Todorovic, and C. Bogliotti (eds) *Irrigation Systems Performance.* Ciheam: 85-98.

Allam, M.N. (2004) 'Participatory Irrigation Water Management in Egypt: Review and Analysis', in A. Hamdy, M. Tüzün, N. Lamaddalena, M. Todorovic, and C. Bogliotti (eds) *Participatory Water Saving Management and Water Cultural Heritage*, Ciheam: 123-31.

Aziz, Y. A. (1994) 'Irrigation management transfer: Development and turnover to private water user associations in Egypt', paper for the International Conference on Irrigation Management Transfer, International Irrigation Management Institute, 20- 24 September.

Bourdieu, P. (1977) *Outline of a theory of practice*, Cambridge: Cambridge University Press (Translated by Richard Nice).

Cernea, M. M. and Meinzen-Dick, R. S. (1993) *Design for water user associations: organisational characteristics*, Environment Department, World Bank.

Cleaver, F. and Franks, T. (2005) *How institutions elude design: River basin management and sustainable livelihoods*, BCID Research Paper No.12, Bradford centre for international development, University of Bradford.

Diemer, G. (1998) 'The technocratic vision of equity in water distribution: a matter of context', in R. Boelens and G. Dávila (eds) *Searching for Equity: Conceptions of Justice and Equity in Peasant Irrigation*, Assen, The Netherlands: Van Gorcum.

El-Agha, D. E., Molden, D. J. and Ghanem, A. M. (2011) 'Performance assessment of irrigation water management in old lands of the Nile delta of Egypt', *Irrigation and Drainage Systems*, 25.4: 215-36.

El-Nahrawy M. A. (2011) Country Pasture/Forage Resource Profiles. FAO, Rome.

Fujiie, M., Hayami, Y. and Kikuchi, M. (2005) 'The conditions of collective action for local commons management: the case of irrigation in the Philippines', *Agricultural Economics*, 33.2: 179-89.

Ghazouani, W., Molle, F. and Rap, E. (2012) WaterUsers Associations in the NEN Region: IFAD Interventions and Overall Dynamics, Draft Submitted to IFAD.

Giddens, A. (1984) The constitution of society: introduction of the theory of structuration, Cambridge [Cambridgeshire]: Polity Press.

Gouda, M. D. (2009) *Field Ditch (Marwa) Improvement in the Nile Delta in Egypt,* Egyptian-German Water Resources Management Reform Programme, GTZ.

Hamza W. and Mason S. (2005) 'Water availability and food security challenges in Egypt',in A. Hamdy and R. Monti (eds). *Food security under water scarcity in the Middle East: Problems and solutions,* Ciheam: 249 -59.

Hopkins, S. N. (1999) 'Irrigation in Contemporary Egypt', in A. Bowman and E. Rogan (eds).*Agriculture in Egypt:From Pharaonic to Modern Times,* Oxford: Published for the British Academy by Oxford University Press, Vol. 96:367-87.

Hunt, R. C., Hunt, E., Ahmed, G. M., Bennett, J. W., Cleek, R. K., Coy, P. E. B., ... and Wellmann, I. (1976) 'Canal Irrigation and Local Social Organization [and Comments and Reply]', *Current Anthropology*, 17.3: 389-411.

Hvidt, M. (1996) 'Improving irrigation system performance in Egypt: first experiences with the WUA approach', *International Journal of Water Resources Development*, 12.3: 261-76.

Kheira, A. A. A. (2009) 'Comparative assessment of new design criteria for irrigation improvement in Egypt', *Water resources management*, 23.11: 2317-42.

Kolavalli, S. and Brewer, J. D. (1999) 'Facilitating user participation in irrigation management', *Irrigation and Drainage Systems*, 13.3: 249-73.

Kotb, T. and Boissevain, W. (2012) *Water Saving Due to Irrigation Improvement in the Nile Delta*, http://balwois.com/2012/USB/papers/789.pdf [accessed 5 March, 2013]

Levine, G. and Coward Jr., E. W. (1989) E*quity Considerations In The Modernization of Irrigation Systems,* ODIIIMI Irrigation Management Network Paper 89/2b.

Manning, J. (2012) *Water, irrigation and their connection to state power in Egypt*, Unpublishedmanuscript, www.econ.yale.edu/~egcenter/manning-2012.pdf [accessed 25 July 2013].

Mehta, L., Leach, M., Newell, P., Scoones, I., Sivaramakrishnan, K. C. and Way, S. A. (1999) *Exploring understandings of institutions and uncertainty: new directions in natural resource management*, IDS Discussion Paper 372, Brighton: IDS.

Meinzen-Dick, R. and Zwarteveen, M. (1998) 'Gendered participation in water management: Issues and illustrations from water users' associations in South Asia', *Agriculture and Human Values*, 15.4: 337-45.

Molle, F. (2009) 'Water scarcity, prices and quotas: a review of evidence on irrigation volumetric pricing', *Irrigation and Drainage Systems*, 23.1: 43-58.

Molle, F., Venot, J. P., Lannerstad, M. and Hoogesteger, J. (2010) 'Villains or heroes? Farmers' adjustments to water scarcity' *Irrigation and Drainage*, 59.4: 419-31.

Mollinga, P. P. (2003). On the waterfront: water distribution, technology and agrarian change in a South Indian canal irrigation system, Hyderabad: Orient Blackswan.

Moustafa, M. M. (2004) 'Can farmers in Egypt shoulder the burden of irrigation management?', Irrigation *and Drainage Systems*, 18.2: 109-25.

MWRI (1998) *Egypt's Irrigation Improvement Program. Report No. 7*, prepared by IRG/Winrock International and Nile Consultants through UASID funded project on Agricultural Policy Reform Program in Egypt, APRP.

MWRI (2005) *Integrated Water Resources Management Plan,* http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2005/11/09/000160016_20051109091008/Rendered/PDF/341800EGY0whit11public10Action0Plan.pdf [accessed 24 August 2013]

Narain, V. (2003) Institutions, technology and water control: Water users associations and irrigation management reform in two large-scale systems in India. Hyderabad: Orient Longman.

Narain, V. (2004) 'Brackets and black boxes: research on water users' associations', *Water policy*, 6.3: 185-196.

Ostrom, E. (1990) Governing the commons: The evolution of institutions for collective action, Cambridge: Cambridge university press.

Ostrom, E., and Gardner, R. (1993) 'Coping with asymmetries in the commons: self-governing irrigation systems can work', *The Journal of Economic Perspectives*, 7.4: 93-112.

Phansalkar, S. J. (2007) 'Water, equity and development', *International Journal of Rural Management*, 3.1: 1-25.

Radwan, L. S. (1998) 'Farmer responses to inefficiencies in the supply and distribution of irrigation water requirements in delta Egypt', in P. P. Mollinga (ed.) *Water control in Egypt's canal irrigation: a discussion of institutional issues at different levels*, Liquid Gold Paper3, Wageningen Agricultural University.

Saad, R. (1999) 'State, landlord, parliament and peasant: The story of the 1992 Tenancy Law in Egypt', in A. Bowman and E. Rogan (eds).*Agriculture in Egypt:From Pharaonic to Modern Times,* Oxford: Published for the British Academy by Oxford University Press, Vol. 96:387-402.

Simas, J., Morelli, J and El Sadani, H. (2009) 'Egypt: Irrigation Innovations in the Nile Delta', in V. N. Jagannath, S. A. Mohamed and A. Kremer (eds) *Water in the Arab World. Management, Perspectives and Innovations*, World Bank.

Springborg, R. (1991) 'State-Society Relations in Egypt: the debate over owner-tenant relations', *Middle East Journal*, 45.2: 232-49.

Svendsen, M., Trava, J. and Johnson III, S. H. (2000*) A synthesis of benefits and second-generation problems. Case Studies in Participatory Irrigation Management,* World Bank Institute Learning Resources Series, World Bank Institute, Washington, DC: 139-157.

Turral, H. (1995) Devolution of management in public irrigation systems: cost shedding, empowerment and performance, Working Paper 80, London: Overseas Development Institute.

Uphoff, N. T. (1986) Getting the process right: improving irrigation water management with farmer organization and participation, Ithaca: Cornell University.

Uphoff, N., Wickramasinghe, M. L. and Wijayaratna, C. M. (1990) ‘"Optimum" Participation in Irrigation Management: Issues and Evidence from Sri Lanka’, *Human Organization*, 49.1: 26-40.

WMRI (1996) *Strategy of Rice Cultivation in Egypt*, WRSR Publication Series No. 8, Water Resources Strategic Research Activity, Water Management Research Institute, Egypt.

World Bank (2005) *Egypt - Integrated Irrigation Improvement and Management Project*, Washington D.C. - The World Bank, www.documents.worldbank.org/curated/en/2005/04/5795592/egypt-integrated-irrigation-improvement-management-project [accessed 27 May 2013].

World Bank (2007) *Egypt - Irrigation Improvement Project*, Washington D.C. - The World Bank, www.documents.worldbank.org/curated/en/2007/06/7926125/egypt-irrigation-improvement-project [accessed 23 May 2013].

World Bank (2010) *Egypt - Farm-level Irrigation Modernization Project*, Washington D.C. - The World Bank, www.documents.worldbank.org/curated/en/2010/11/13155141/egypt-arab-republic-farm-level-irrigation-modernization-project [accessed 23 May 2013].

Yin, K. R. (2008) Case Study Research: Design and Methods (Applied Social Research Methods), 4th Edition, Sage Publications, Inc.

8 Reports by IWMI/WMRI

1. IWMI and WMRI. 2013. An exploratory survey of water management in the Meet Yazid Canal command area of the Nile Delta. Water and Salt Management in the Nile delta Project Report No. 1. IWMI, WMRI: Cairo, 2013.

2. Duttra, S. 2013. Understanding mesqa and marwa water management practices in IIP areas of the Nile Delta. Water and Salt Management in the Nile delta Project Report No. 2. IWMI, WMRI: Cairo, 2013.

3. Molle, F. and Rap, E. 2014. Brief Retrospective on Water User Organizations in Egypt. Water and Salt Management in the Nile delta Project Report No. 3. IWMI, WMRI: Cairo, 2014.

4. Molle, F.; Rap, E.; Al-Agha, D.E.; Ismail, A.; Abou El Hassan, W. and Freeg, M. 2015. Irrigation Improvement Projects in the Nile Delta: promises, challenges, surprises. Water and Salt Management in the Nile delta Project Report No. 4. IWMI, WMRI: Cairo, 2015.

5. Molle, F.; Abou El Hassan, W.; Salama, S.; Al-Agha, D.E. and Rap, E. 2015. Water and salt dynamics at the meso-level in IIIMP areas, Mares El Gamal canal. Water and Salt Management in the Nile delta Project Report No. 5. IWMI, WMRI: Cairo, 2015.

6. Al-Agha, D.E.; Closas, A. and Molle, F. 2015. Survey of groundwater use in the central part of the Nile Delta. Water and Salt Management in the Nile delta Project Report No. 6. IWMI, WMRI: Cairo, 2015.

7. Al-Agha, D.E.; Molle, F.; El Baily, M.; El Desouqy, E.; Abou El-Hassan, W. 2015. Spatial and temporal variability of water quality in the Nile Delta. Water and Salt Management in the Nile delta Project Report No. 7. IWMI, WMRI: Cairo, 2015.

8. Rap, E.; Molle, F.; Al-Agha, D.E.; Ismail, A. 2015. Branch Canal Water User Associations in the central Nile Delta. Water and Salt Management in the Nile delta Project Report No. 8. IWMI, WMRI: Cairo, 2015.

9. Molle, F.; Gaafar, I., Al-Agha, D.E. and Rap, E. 2016. Irrigation efficiency and the Nile Delta water balance. Water and Salt Management in the Nile delta Project Report No. 9. IWMI, WMRI: Cairo, 2016.

10. Gaafar, I.; Abou El-Hassan, W.; El Tahan, N. and Mustafa. 2015. Fishpond water management in the Lake Burullus area. Water and Salt Management in the Nile delta Project Report No. 10. IWMI, WMRI: Cairo, 2015.