Water management below the outlet – a survey-based analysis on the Indus Basin irrigation system in Pakistan

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Abstract: This article examines the prevalent management rules of farmers below the outlets – at the local level. The aim is to identify the institutional gaps, which – if corrected – could substantially result in a more efficient use of the scarce surface water resources among the farmers. The publication contextualises findings from personal interviews, field visits and a survey in three villages in Punjab, in 2018. With regard to management deficiencies, the most commonly described problem of an allocation asymmetry, also known as the head-tail problem, was not found in the survey. Nevertheless, this research found that other aspects such as the lining of watercourses, the clout of low ranked irrigation officers over determining water tariffs, and the missing links between different hydraulic levels of organisation are representing equally challenging thresholds for an efficient and equitable water usage.

Keywords: Pakistan; irrigation management; institutions; farmer's survey; sustainability; accountability; water allocation; equity in water management; water management; irrigation; agriculture; warabandi.

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1 Introduction

In the world, most large-scale irrigation systems are considered to exhibit low degrees of management performance (Huppert, 2000). The supply-based Indus Basin irrigation system (IBIS) of Pakistan – the largest irrigation system in the world (World Bank, 1994) – is no exception in this regard and is also considered to perform poorly (Amir and Blackmore, 2005). The continuous population growth with an increasing water and food demand has put additional pressure on the already scarce water resources (Amir and Blackmore, 2005). At the same time the inflexible water allocation of IBIS is overburdened to adjust to the current way of farming, with considerably higher and more flexible water requirements.[1] However, additional water resources cannot be developed since the available surface water resources are already used at its maximum (Amir and Blackmore, 2005). Most researchers regard this allocation problem as the result of weak and inadequate management rules along with insufficient investments in canal infrastructure and maintenance (Amir and Blackmore, 2005). However, while the official rules and practices of the irrigation system are well-known, there is insufficient knowledge about how water is managed at the lowest level, namely the watercourse. Thus, this research encompasses a survey with 152 farmers in three districts in Punjab Province, whose aim was to better understand how farmers manage their water at the local level. Before analysing the survey data, we assumed management problems, which – if solved – could lead to a more efficient use of water in irrigation.

The article is structured as follows: Section 2 gives a brief summary of the most prevalent management problems in the irrigation system. Section 3 explains the past attempts of the province's government to address those problems and presents the current institutional status. Section 4 introduces the design features of the survey and discusses the results of the survey; Section 5 sums up the previous results along with proposing potential solutions; last, Section 6 concludes the paper.

2 Water management problems of the IBIS

The IBIS in Pakistan is the largest irrigation system in the world. The network irrigates almost 140.000 km² and consists of 44 canal systems. Water is diverted into the main canals through a series of barrages and 12 inter-link river canals. These canals in turn deliver water to branch canals, distributaries, minors and eventually watercourses (Mekonnen et al., 2015). The IBIS in Pakistan was constructed to protect the region from the threat of famine and to open up new areas for settlement (Bandaragoda and Badruddin, 1992). With the objective of maximising the production per unit of surface water available, the water was spread thinly over as large as an area as possible to achieve maximal social benefits from the distribution of available surface water resources. This concept of irrigation is referred to as protective irrigation.[2] The provided canal water was only sufficient to irrigate only one third of the command area of each farmer.[3] Therefore, there was a demand for an infrastructure that could distribute water proportionally and equitably.

To achieve the most uniform and equitable allocation of water each farmer gets his water on a fixed-rotational cycle, called the warabandi system,[4] which normally repeats every week. According to the Canal and Drainage Act (Bandaragoda, 1998) the water is distributed in a specified year, day, time and duration of supply to each irrigator in proportion to the size of a farmer's landholding in the outlet command area (Bandaragoda, 1998).[5] The cycle of warabandi starts from the head and proceeds to the tail of the watercourse. During each turn, the farmer has the right to use all of the water flowing in the watercourse at his specified turn (Bandaragoda, 1998).[6] All farmers who are landowners or tenants are entitled to water in proportional relation to their field size (Bandaragoda, 1998). The water allocation rules (water rights) have more or less remained the same since the irrigation system started its operation. They are closely related to the design of the physical infrastructure, which means that all canals must continuously carry a fixed quantity of water to supply the farmers with their designated share of water (Bandaragoda, 1998). To limit human interference in the operation of the system, regulation points were minimised and the watercourses were provided with ungated tertiary outlets.[7]

In the recent past, research on the performance of these irrigation systems at primary and secondary sub-system levels by the International Water Management Institute (IWMI) (Bhutta and Vander Velde, 1992) showed that the distribution of canal water is neither proportional nor equitable anymore. This is mainly due to the immense population growth of the last decades in hand with a rising food demand. In order to meet this rising food demand, more water intense farming methods were introduced.[8] This led to an increased water demand that went beyond the originally designed water capacities of the system, which right from the very beginning had provided farmers only with a fraction of their water needs (Javaid and Falk, 2015). Consequently, farmers had a very strong incentive to seek for opportunities to enhance their water share. At the same time, the centralised and understaffed irrigation department was not able to maintain the deteriorating irrigation infrastructure, let alone to enforce the official irrigation laws among farmers and low ranked irrigation officials.[9]

The most prominent way of farmers to circumvent the official water allocation practices and enhance one's personal water share has been the tampering with the size of the outlets at the beginning of the watercourse. According to Rinaudo (2000) the manipulation of the size of the outlets is one of the main reasons for the unequal allocation of water within the distributaries and main canals.

This criminal activity is usually collectively organised by the entire watercourse involved, or at least by most of the farmers, through bribing some low-level officials of the irrigation department. Usually, the whole watercourse benefits from this arrangement and the losers are the farmers further downstream the distributary (Rinaudo, 2000). As a matter of fact, tampering with the outlets has become common practice in Punjab and is rarely prosecuted. Farmers usually even know the price for bribing the irrigation official, who will look away for a certain period of time and then set the size of the outlet back to its designed size until this cycle is repeated again (Schulze and Zimmermann, 2019).

The additional socio-economic pressures in combination with the dysfunctional surface water allocation has brought the irrigation system to the brink of collapse. The fact it has not collapsed yet is only due to the extensive exploitation of groundwater resources. However, the excessive use of groundwater has simultaneously aggravated the head-tail problem (Briscoe and Qamar, 2005). This is because farmers towards the tail disproportionally have to supplement surface water with groundwater, which is not only much more expensive but also inferior in quality. This discrepancy between the low water price for surface water and the high energy costs for pumping groundwater[10] further creates a considerable income gap between the farmers with privileged access to surface water at the head and the farmers at the tail (Government of Pakistan – Food and Agriculture Section, 2012).[11]

3 Attempts to reform the irrigation system and the present institutional situation

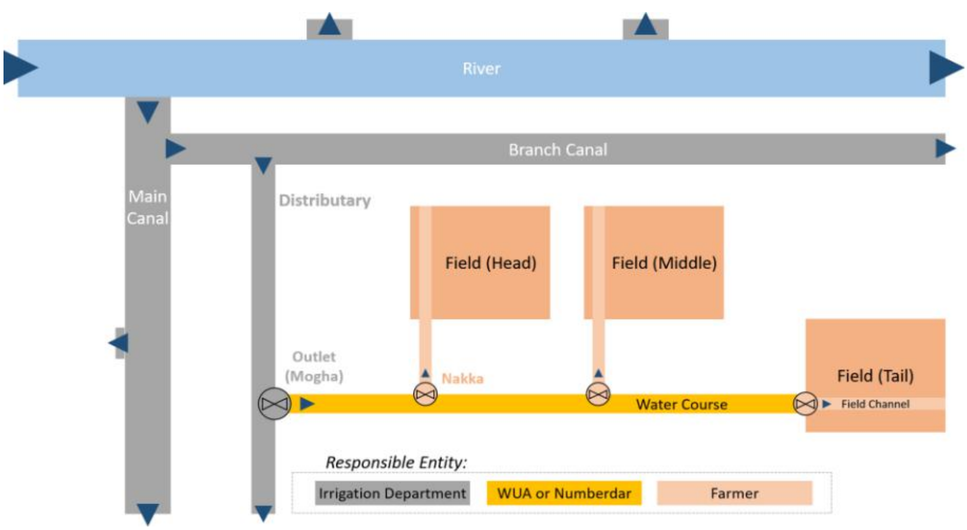
To address the low performance of the irrigation system with its deteriorating infrastructure the Government of Pakistan decided to implement a reform to decentralise the management of the irrigation sector through farmer participation. The main motivation for this reform was to lower the costs of the irrigation department that had only be sustained through government subsidies.

The reasoning behind the empowerment of farmers was largely based on the opinion that water users themselves can carry out the maintenance, allocation of water abstraction, monitoring and sanctioning, as well as water fee collection of their watercourses more promptly and at much lower costs (Qureshi, 2014). Moreover, the way the irrigation sector as a whole had been organised was dysfunctional. For example, the collection of water fees had been assessed and collected by the provincial revenue department, while the irrigation department was funded by the province government directly on an annual basis, independently on their performance of water services to the farmers and the level of collected water fees. Consequently, the basic idea of the Punjab

Irrigation and Drainage Act (PIDA) of 1997 was to decentralise water governance and to include farmers in the management of the irrigation system. In Punjab this reform process – called irrigation management transfer (IMT) – was initially tested in five pilot regions with the intention of expanding the changes to the entire province (Bell et al., 2015). The IMT process was meant to replace the former Punjab Irrigation Department with three new organisations mostly represented by farmers with specific tasks for each of them.

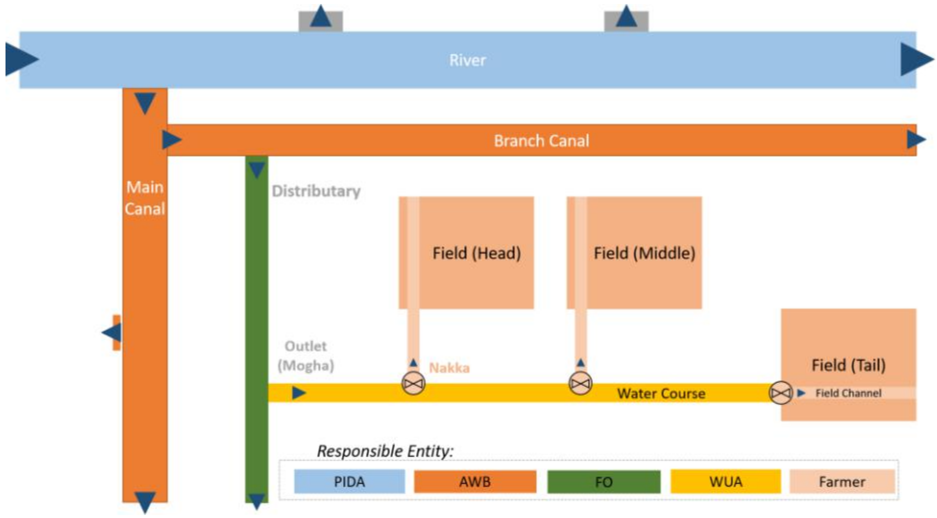
Provincial irrigation departments (PIDs) would become financially autonomous authorities, with responsibility for the large canal infrastructure from barrages to canal headworks. Area Water Boards would have been established around all canal commands to take over and manage the irrigation and drainage system from canal headwork to distributaries and minors. Furthermore, farmer organisations (FOs) would have taken over the operation and maintenance of distributaries, minors, and lower level drainage infrastructure. Essentially, FOs are a federation of the smallest hydraulic organisations within IBIS, which are located at watercourse level and referred to as water user associations (WUAs). Hence, in a farmer's organisation each WUA – from head, middle, and tail reaches along a distributary canal – nominates one member to represent their watercourse in the federation (Mekonnen et al., 2015). Even though WUAs take up a central role within the newly formed FOs, they themselves were not part of the formal IMT process. Instead, WUAs continued to operate under an earlier provincial ordinance. However, the original purpose of this water users' ordinance had been primarily to introduce a temporary law for the rehabilitation of field channels, and only to a very limited degree the empowerment of farmers (Mekonnen et al., 2015). In other words, in Punjab the reorganisation of the irrigation management as defined by the irrigation reform did not include the tertiary level. Figures 1 and 2 illustrate the administrative changes at different hydraulic levels. The newly created FOs (Figure 2) replaced the irrigation department (Figure 1) through the PIDA of 1997.

Figure 1 Before the reform, the irrigation departments were in charge of most of the irrigation system: from the main canals up to the watercourses (local/tertiary level), which begin after the outlets of the distributary canals (see online version for colours)



Notes: On average a watercourse serves around 20 farmers.

Figure 2 The irrigation reform introduced new participative hydraulic bodies with elected farmer representatives that correspond to the physical canal infrastructure to enhance a stronger representation of farmers and to have more financial regional autonomy (see online version for colours)



Notes: At the top the Punjab Irrigation Department Authority (PIDA) for the Province of Punjab, Area Water Boards (AWBs) for main canals, and FOs for distributary canals. At the local level farmers were organised as WUAs by an earlier legislation for each watercourse.

As a simple summary, the reform organisations have only been established in less than one-fifth of canal commands across Punjab and Sindh, attributable in no small part to resistance from the PIDS, which do not want to give up their authority and thus sabotage the reform (Bell et al., 2015). Thus, the reform failed in its attempt to disintegrate the top-down managed irrigation departments, which have been run by technical engineers for decades, and replace them with three new autonomous FOs with elected farmer's representatives in charge.

Currently, the institutional situation can best be described as blurred. The primary and secondary canal system is for the most part still managed by the Punjab Irrigation Department. At the tertiary level below the outlets, there are watercourses that have introduced the new partially self-organised WUAs with an elected representative – a so-called KP chairman, while others are still under the grip of the traditional authorities or village elders known as Numberdars.[12] More importantly, because at the next higher hydraulic level, the federations of WUA formed for each distributary canal, the FOs, are either not functioning or have not been installed for watercourses along the distributaries but are still managed by low ranked government officials. The most prominent public official is the Patwari.[13] A Patwari is usually responsible for two to three villages. The Patwari holds a very powerful role within the farmer's community as he is responsible for keeping the land records and charging the water fees (UN Habitat, 2011). Since water fees for crops are charged differently due to their broad variation of water needs, this gives him a tremendous amount of clout over the water allowance. Thus, it used to be quite common that a Patwari would falsely charge for certain crops and then keeps some part of the fee for himself or accepts bribes to lower the water fee (Government of

Pakistan – Food and Agriculture Section, 2012).[14] The government of Punjab recognised this problem and between 2003 and 2004, replaced the crop-based water charge with a flat rate system to curtail the incentive of the Patwari to engage in rent seeking activities and to lower administrative costs.

Since then water charges per acre are fixed at PKR 85 for Kharif season (sugarcane, rice, cotton and maize) and at PKR 50 for Rabi season (wheat, oilseed, vegetables).[15] Yet, its biggest flaw is that it does not reflect water consumption by crops.

4 Survey

4.1 Survey design

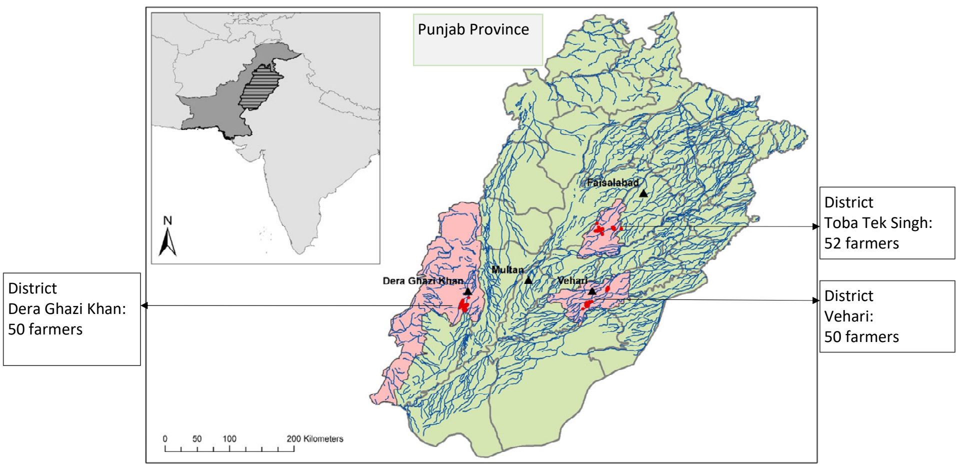
In order to have a closer look at the irrigation management on watercourse level, we drafted a survey that was conducted by students of the Institute of Agriculture and Resource Economics of the University of Agriculture Faisalabad[16] in the months from July to August 2018. The information gathered in the survey is complemented by findings from two different workshops and group discussions with farmers, additional expert interviews and 20 qualitative in-depth interviews in 2017 and 2018. In some of the qualitative interviews a pre-version of the questionnaire was tested, which helped to solidify the correct understanding of the questions by the interviewees. The analysis and arguments in this paper will mainly be based on survey data, but information deriving from the workshops and interviews is used for interpretation and explanation.

Several survey questions assess what kind of practices are prevalent when farmers manage their watercourses. 'Being a farmer' was a precondition to take part in the survey. In our survey, a 'farmer' is a person whose main source of income is agriculture. We assume that farmers are to some extent actively engaged in managing farming activities and corresponding irrigation practices. The survey questionnaire contained 52 questions about the status quo of agricultural water usage, the allocation infrastructure, organisational patterns, and individual behaviour. The questions were bundled in five different clusters,

1. consisting of the basic information of the respondent
2. current situation of water allocation
3. ground water and canal water situation
4. involvement of different actors
5. current way of farming.

The local focus of this research lies on cotton-growing areas in Punjab, Pakistan, which is why we purposely choose to conduct the survey in the three districts of Toba Tek Singh, Dera Ghazi Khan, and Vehari, where cotton is one of the major crops (Figure 3). All three districts lie in a semi-arid climate zone but receive a varying amount of rainfall (Spielman et al., 2016). As in most parts of Pakistan, the agricultural year is organised along the two crop seasons Rabi and Kharif. Rabi crops are usually grown in the months from November to April and Kharif crops from May to October (Mekonnen et al., 2016). Villages in the three districts were selected by a random sampling strategy. The selection of farmers within these villages depended upon the availability of farmers and their willingness to participate in the survey. The interviewers contacted 205 farmers and completed 152 interviews in 21 settlements. The respondents were interviewed in face-to-face in the vernacular at their homes or at a public space for gatherings in the village. To gain more specific information about the location of the farmers' fields, the interviewers also went to the field of the farmer and took the location by GPS.

Figure 3 Map of Pakistan's Punjab, which shows the three survey areas (see online version for colours)



Übersicht über die drei Umfragegebiete in Punjab, Pakistan

4.2 *Descriptive statistics*

In all three districts, the sample of the survey shows a mix of farmers who either own land to work it themselves or who rent out some or even all of their land to other farmers, who do not own land but are nevertheless equally included in this survey. The agricultural land of the farmers is both situated at different locations along the distributary canals, as well as within the community owned tertiary canal system, the watercourse. With regard to the location along these irrigation canals, we speak of head, middle or tail. A watercourse is a key unit in irrigation management practices on the tertiary level – the lowest administrative and hydraulic unit within the irrigation system (see Figures 1 and 2). According to the interviewers' observations, most of the watercourses in our sample have been lined (cemented) so that there is less seepage loss of irrigation water. Most of the interviewees owned farmland but six were only tenants. All of the participants were male. The distribution of land among the interviewed farmers is as follows:

a on the watercourse: 20% (head), 20% (middle), 60% (tail)

b at the distributary: 18% (head), 28% (middle), 54% (tail).

Similar to the average size of watercourses consisting of 40 farmers in Punjab (Ganewatte and Pradhan, 1995), the watercourses in our sample, have on average 38.5 farmers. The smallest consists of four farmers only. The biggest has 200 irrigators. A majority of the participating farmers had indeed planted cotton, among other cash crops and vegetables, throughout the last year. All of the participants were male and 91% of the respondents were married. The median age was 42 and on average, the respondents went through 10 years of formal schooling, with a great span ranging from 0 to 19 years.

This average duration of schooling is significantly higher than the average schooling level in the rural community in Punjab [compared to *Pakistan Rural Household Panel Survey 2012 (Round 1): Household Characteristics*) (Nazli et al., 2012)]. The average size of owned farmland was 5 acres, which relates quite well to the average farm size of 5.6 acres[17] in Pakistan. However, the sizes varied between 0 (only tenant) and 100 acres, hence, the sample includes small, medium and large farms according to national statistics.

About 75% of the participants indicated that they do not hold a special position in the local community such as Numberdar, a form of village section head, or similar offices. Yet, the number of Numberdars (24%) who participated is quite high and should be taken into consideration when interpreting the data. Two participants indicate to be a member of a Khal Committee, an important informal institution consisting of respected people who deal with irrigation matters on the lowest local level. The average annual net income is 250,000 PKR (around 1.756 Euro on August 24, 2018) but, similar to the size of agricultural land holding, varies strongly between a minimum of 45,000 PKR and a maximum of 6,000,000 PKR earned per year. However, it is noteworthy that the average income of farmers in our survey is significantly higher than the average income in Pakistan.[18] It has to be acknowledged that the indicated income does not derive from the cultivation of cash crops only but might include other agricultural activities such as dairy farming and side businesses.

Table 1 Most relevant demographic data of survey respondents at a glance

Demographic data of respondents n = 152; 100% male							
		Total number [n]	*Mean value*	*Median*	*Min*	*Max*
Age		152	42.8	42	19	80
Education: years of schooling		152	7.7	10	0	19
Farm land [acre]	Owned [n = 148]	126	12.67	5	0	100
	rented out [n = 152]	3	0.43	0	0	50
	rented in [n = 152]	63	4.95	0	0	95
Special position in community	None	114	-	-	-	-
	Numberdar	36	-	-	-	-
	Member of Khal committee	2	-	-	-	-
Net annual income [PKR]		152	705,230.26	250,000	45,000	6,000,000

5 Presentation of main results

5.1 Head-tail problem in the survey areas

The purpose to present demographic data on age, net annual income, owned farmland, and education/years of schooling was – apart from broadly illustrating the socio-economic context of our survey areas to the reader – to test any potential deviations from other studies. However, most of the data did not differ substantially from the demographic data of other cotton areas (Nazli et al., 2012) except for the years of schooling, which was significantly higher in our survey areas than the national average. Unfortunately, our survey does not provide any reason for this deviation in education of our farmers compared with the national average nor can we offer any kind of informed guesses how this higher level of education impacts local decision-making, attitudes and preferences of the farmers. Thus, we focused our analysis specifically on finding evidence for the in chapter two described head-tail problem. Moreover, we tried to draw conclusions from the responds of the farmers that shed light on the question on how farmers on a local level cooperate horizontally with neighbouring farmers as well as vertically with regional and state authorities along with the question how water fees are raised and collected. Both of these questions are closely related to the intended institutional changes of the irrigation reform described in chapter three.

Figure 4 Comparing how farmers assess their surface water supply by location: head, middle tail along watercourses (see online version for colours)

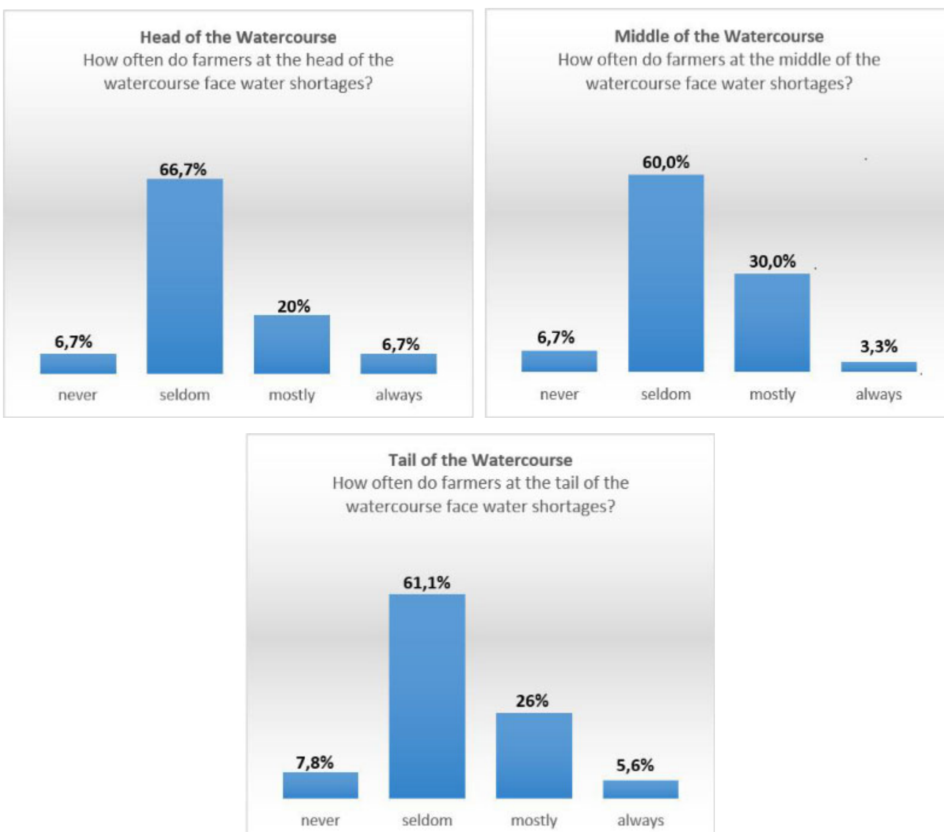
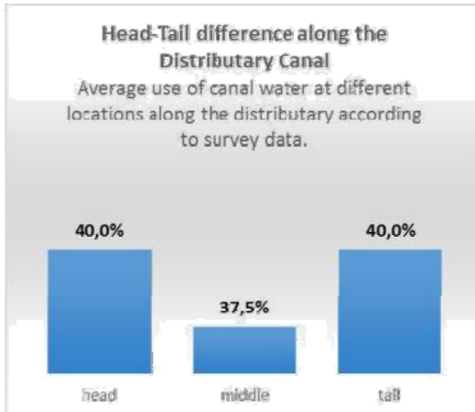


Figure 5 Difference of the share of surface water (the missing percentage is groundwater) by location: head, middle tail along watercourses along the distributary (see online version for colours)



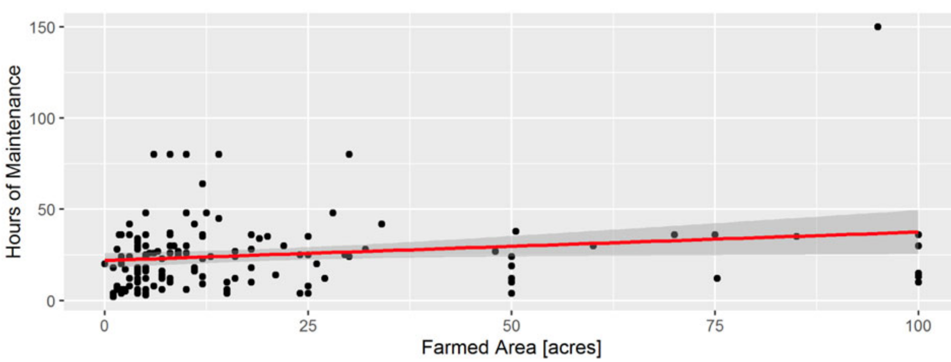
Considering the prominently described allocation problem within secondary and tertiary canals (Bhutta and Vander Velde, 1992), it came as an unexpected finding that the survey did not provide any indication for the so-called head-tail problem. In all three survey areas no significant difference between head-middle and tail farmers was found with regard to how farmers asses their personal surface water supply. Neither within watercourses nor along the distributary canals. We asked farmers, if they get enough canal water to irrigate their fields and correlated their responses with their recorded GPS data to see where the exact position of their fields are.

One may critically object that this question was highly subjective and imprecise, because it did not ask for any quantitative information (what exactly means enough?) and did not provide any kind of comparison. A more solid evaluation of equity of water allocation could only be made in a quantitative instead of a qualitative assessment. This would require not only to consider measuring all secondary and tertiary canals but also to measure the water flow of the upper tier primary canals. Furthermore, all canals would need to be measured against their designated design discharge to understand how much water farmers are supposed to receive (Shah et al., 2016). Nevertheless, we presume that if there is a strong difference in water availability between head and tail farmers their subjective perception on their water availability should still somehow reflect this difference in their answers. Moreover, we also correlated the ratio between their use of canal water and tube well water with their specific location.

Again, we could not find a significant head-tail variation and found no evidence that head farmers show different canal-/groundwater usage patterns in relative terms. On average, head, middle and tail farmers cover roughly 40% of their water consumption via canal water. This is an additional argument to presume that there is no head-tail problem and surface water is allocated more or less equally. A possible explanation for the non-existence of a head-tail problem on a watercourse level could be that those watercourses are all lined. Yet, this would mean that the decisive factor for the misallocation of surface water is rather a physical/technical one than an institutional problem. This presumption is supported by a study in the Munghi distributary in Punjab where gauges had been installed in unlined watercourses. The measures showed that from head to tail one-third of the water gets lost due to seepage (Fareed, 2019). Another effect of the lining of watercourses is that substantially less maintenance and cleaning work is needed (Fareed, 2019). We presume that this can at least partly explain why in the survey we did not find a significant alteration in hours spent for maintenance between head and tail farmers. From other studies we learnt that the head-tail problem has also been very strongly reflected in the cleaning and maintenance work of unlined watercourses (Mekonnen et al., 2015). This is because if in unlined watercourses cleaning and maintenance work is neglected farmers towards the tail are over proportionally receiving less surface water (Muhammad, 1998). Hence, tail farmers are more likely to spend time and costs for maintenance and cleaning of watercourses because they have a stronger incentive to do so (Mekonnen et al., 2015).

Moreover, we presume that beside less need for cleaning and maintenance farmers in the survey areas have found appropriate arrangements to organise those activities appropriately. This presumption is supported by the positive correlation of farmer's land size and maintenance time. In other words, a majority of farmers with larger landholdings say they are comparably spending more time and effort in cleaning and maintenance work (Figure 6).[19]

Figure 6 Correlation of hours spend for maintenance and owned farmland according to the survey (see online version for colours)



5.2 *Other relevant management aspects at tertiary level from the survey*

In the previous chapter, it could be shown that an allocation problem with regard to surface water and maintenance work seems not to be present. Yet other management aspects of the tertiary level seem to be working less optimal such as the cooperation with other watercourses and the irrigation department along with an ineffective water pricing system that provides no incentive for farmers to conserve water. Additionally, the survey revealed that harmony within the irrigation community is a strong social norm. Yet, it is unclear whether this has a positive or negative impact on the water management below the outlets.

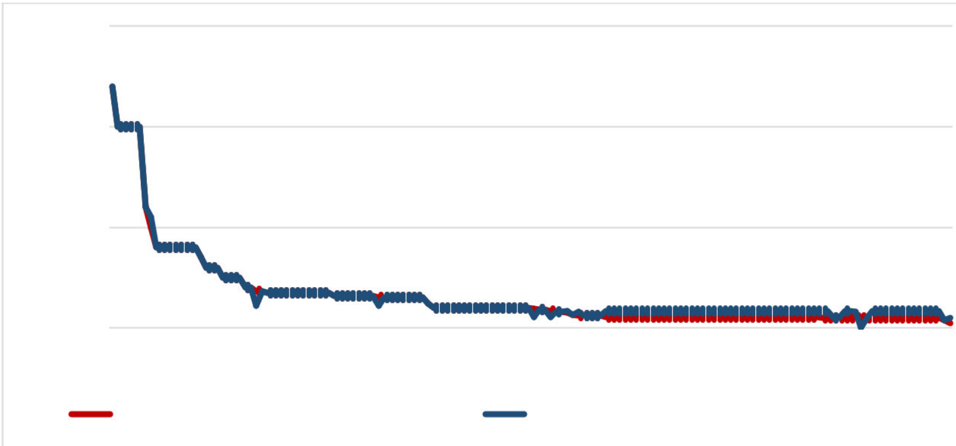
To begin with, the survey revealed that despite the ongoing reform efforts the old traditional Numberdar-system is for the most part still in place in all three survey areas[20] with a traditional village leader called Numberdar. Only 26 out of 151 farmers stated that there is a water user's organisation (Khal Panchayat) in their watercourse with an elected chairman as their representative. Interestingly, about half of the farmers in a watercourse with a KP chairman said the KP chairman does not represent their interest. This seems to confirm what other studies have found, which is that the introduction of a water users association alone is not a guarantee for ensuring collective choice arrangements since they are not immune against the problem of elite capture and clientism (Nakashima, 2000).

However, more problematic about the fact that the old traditional Numberdar-system is still in place is the missing cooperation of water management on a horizontal and vertical level, which also has been a cornerstone of the irrigation reform. The survey confirmed this organisational deficiency by showing that there is basically no periodic communication between hydraulic levels. Of the 24% Numberdars of the survey, who often represent their watercourse, almost 69% responded that they never get in touch with the irrigation department. The remaining 31% stated that they rarely get in touch with them. This is a remarkable and somehow peculiar result since one would expect that in an irrigation system with notorious downtimes, a low water tariff collection rate, and a stagnant irrigation reform there would be many things to discuss between the local level and the irrigation department. This is an important management aspect since a large irrigation system is a comprehensive system that consists of many mutually dependent subsystems. Its interdependent nature makes an effective and close coordination between all levels imperative (Uphoff, 1986).

Another important management deficiency at the local level is the way irrigation water is charged in a rather obscure and non-transparent way. As discussed in Section 3, the Patwari-system leaves too much room for rent seeking opportunities through the excessively powerful position of the Patwari. This became most obvious in the distorted way how the water tariffs are charged. At present, there seem to be two different tariff models in use simultaneously, which are based on fundamentally different basis of calculation. The old crop-based tariff charges water depending on the grown crop, whereas the flat rate does not consider the different water consumption by the crops. Interestingly, for the most part the stated water charges of the farmers match neither with the old crop-based tariff nor with the new flat rate tariff. Instead, most farmers state that they pay more or less the same for both seasons even though water availability as well as water consumption by the crops between Kharif and Rabi vary significantly. On average, they claim to pay about PKR 95 for Kharif per acre and 97 PKR for Rabi per acre. Noteworthy is also the wide range of what they assert to pay from 25 PKR per acre to 1.200 PKR per season per acre. Even though not all of the provided information should be taken at face value, it is plausible to assume that farmers are charged on the basis of both water tariffs: crop-based and flat rate.

Above all, it is striking that the rate of the water fee differs enormously between the farmers and is completely detached from seasonal scarcity aspects. Our presumption is that this reveals two shortcomings: first, the collectors modify the rate of the fee according to their personal opinion, and second, farmers either do not know about the correct amount or they just do not claim their right to pay the official lower fee. Both shortcomings can be attributed to a lack of transparency.

Figure 7 Different rates of water fee paid per acre of farmland (see online version for colours)



	Max	*Median*	*Modus*	*Min*
Rabi	1,200	97.5	55	25
Kharif	1,200	95	85	0

Notes: x axis = number of farmers, y axis = water tariff rate according to the information given by the farmers.

The farmers' indifference towards claiming their designated right can also be rooted in the desire to keep harmony in the community and the acceptance of the given social structure including the tolerance of privileges. As a matter of fact, the desire of farmers for harmony was voiced very clearly by the farmers and could be identified as a predominant social norm. There is reason to assume that this social norm contributes a lot to keep a certain level of respect for common rules and practices. Our supposition is, that this includes the voluntary obligation of many farmers with privileged access to water to restrain themselves from taking full advantage of it, as well as the willingness of large land owners to take over a bigger part of the cleaning and maintenance duties. On the other hand, this social norm in many instances seems not to be strong enough to prevent elite capture and opportunistic behaviour. An indication for this notion is the fact that many farmers stated that their irrigation leader does not represent their interests. Without doubt, harmony within their watercourse is regarded as the most valuable social norm. Further research on how this social norm influences discipline and respect for common agreements should be conducted.

6 Conclusions

The survey attempted to disclose some of the most significant institutional challenges farmers are facing to manage their watercourse below the outlet. In contrast to previous research, the survey did not find evidence for a strong inequity among head and tail farmers in terms of water quantities allocated to them – both within watercourses as well as along distributary canals. The most obvious explanation why there seems to be no allocation problem is that watercourses are lined. Furthermore, we conclude from the answers of the interviewed farmers that there is also no major problem with the tampering of the outlets. At least not to a degree that significantly affects the water allocation among farmers. The issue of equity was also addressed with regard to how much time farmers spend on maintenance work of the watercourses. Against common perceptions a head-tail problem could not be confirmed. On the contrary, in the survey farmers at the head were even spending relatively more time and resources on maintenance.

Unfortunately, despite those clearly positive management findings at the tertiary level we discovered other management aspects that threaten a sustainable and equitable water supply for the future. In particular, the way water is priced and charged by local authorities. Officially, it is priced through a recently introduced flat rate tariff, which is fully detached from scarcity aspects and thus undermines any incentive for farmers to conserve water. Clearly, such a water tariff model is unsustainable as water scarcity is projected to increase within the next decades. To establish a tariff system that reflects water scarcity adequately and consistently two things must be considered simultaneously: Firstly, a comprehensive monitoring system must be put in place that provides reliable information on water availability to farmers in real time. Secondly, the discretion of provincial, regional and local authorities over water and fee collection must be curtailed through an interwoven system of checks and balances across administrative levels to achieve a greater level of transparency and accountability of people in charge. The reform attempted to do that but the answers from the survey suggest that even in areas where the reform had been implemented their participative approach could not prevail against the deep-rooted norm that favours harmony and conformity within the community over individual rights. In other words, even though a reform may look good on paper and has the right intentions it will take time and perseverance to achieve a more equitable and transparent water management at the local level. With regard to establishing a functioning monitoring system a good approach may be to assign this task to an independent organisation that is neither politically nor financially attached to the organisation that operates the irrigation system.

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Notes

1 This is mostly due to more water consuming farming methods with cropping intensities that are on average 125%.

2 Jurriens et al. (1996) have described the concept of protective irrigation in depth. This protective irrigation system concept can also be characterised as a supply-based system – which does not respond to changes in demand. It features low design cropping intensities and high water 'duties'.

3 In fact, canal water was provided to protect the crop from failure, which is reflected from the fact that a farmer is supposed to pay full water tax, provided his crop reaches maturity, even if he receives only one irrigation turn during the whole season (Kuper, 1997).

4 The term warabandi means 'turns' (wahr) which are 'fixed' (bandi) (Bandaragoda, 1998).

5 The warabandi schedule is framed under Section 68 of the Canal and Drainage Act (VIII of 1873) in which rights to form and maintain water distribution schedules for watercourses are vested with the canal officers of the irrigation department (Bandaragoda, 1998).

6 The main canals, distributaries and minors are managed by the PIDs and deliver water at the head of watercourses through a fixed sized outlet, which is designed to provide a quantity of water proportional to the culturable command area of the watercourse. In order to meet its objective to distribute water equally the design concept of warabandi assumes that each distributary canal, by and large, maintains a flow close to 75% of the full supply level.

7 Those outlets have fixed size water orifices made of concrete to prohibit that the water share of the watercourse can be changed.

8 Basically, farmers started to grow more than one crop on their fields in an agricultural year. In agriculture this is expressed through the concept of cropping intensities = (gross cropped area / net sown area × 100), which went from originally 75% to 125%.

9 Additionally, the respect and obedience of laws have been weakened by the parceling of land along with the democratisation process that enhanced clientism had destabilised the existing formal water rights and the ability of the irrigation department to enforce them (Javaid and Falk, 2015).

10 Farmers have to spend 15 to 20% more for diesel fuel to pump groundwater each season. To be precise comparing the prevailing fixed Abiana rates in Punjab (Rs. 135 per acre per year for two cropping seasons) reveals that it is 15–20 times lower than the cost of tube well irrigation

water per acre per year in the same vicinity (Government of Pakistan – Food and Agriculture Section, 2012).

11 However, according to Bell et al. (2016) the latent willingness of farmers to spend comparably high amounts of their income of the qualitatively inferior groundwater suggest that, under the right conditions, this money could potentially be redirected toward water-use fees (known as Abiana in Pakistan) to enable a more reliable surface water supply.

12 The Numberdar (or 'Lambardar' as is the term used in Punjabi) constitutes a link between the landowners in his village and the government officials. Even though he is appointed by the Revenue Department (Revenue Collector), he does not hold any formal office in Pakistan government services. Hereditary claim, good family background and ownership of land within the same village are important considerations for appointment as a Numberbar (Shah et al. 2000). In the context of irrigation, he is specifically responsible for:

a collecting water charges from farmers in his village

b helping the Patwari to register or correct irrigation records

c reporting to and helping irrigation staff and the revenue department staff to invest cases of water theft, and breaks and cuts in canals.

As a remuneration for performing these services, the Numberdar is provided 12.5 acres of land and receives and 5% of the assessed Abiana. At the same time Numberdars are subject to a penalty if they fall short of a certain threshold level of collection (Shah et al., 2000).

13 The Patwari is a public official who belongs to the provincial revenue department of the province government and mainly responsible for keeping the land record of the farmers.

14 Fortunately, this situation is changing through the digitalisation and publishing of the land records on a public website. Not only does this make individual water assessments transparent and traceable, it also effectively diminishes room for arbitrary decisions on the side of the Patwari.

15 A special Abiana rate for orchards of 250 PKR/acre/season has to be considered as one reason for deviation.

16 The authors like to express their gratitude to Dr. Azhar Abbas from the Institute of Agricultural & Resource Economics of the University of Agriculture in Faisalabad for their great support and hospitality.

17 The average cultivated area is 5.1 acres. In fact, two thirds of the farms in Pakistan are smaller than 2 hectares (about 4.94 acres).

18 The average household income in Pakistan is 162,230 PKR according to the Population Census 2017 (Ur Rehman, 2018).

19 Research utilising behavioural games with farmers which showed that the equal investment in water infrastructure seems to be a strong social norm, even though those in disadvantageous positions (tail-users) earn less than those who have preferential access (head-users).

20 Only 19 out of 159 farmers have a water user's organisation.