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Improving groundwater management to enhance agriculture and farming livelihoods in Pakistan: Participatory Rural Appraisal: starting the co-inquiry into groundwater and livelihoods

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Participatory Rural Appraisal:

Starting the co-inquiry into groundwater and livelihoods

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Disclaimer

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1 Executive Summary

The ACIAR funded project LWR-2015036 “Improving groundwater management to enhance agriculture and farming livelihoods in Pakistan” is a collaboration through partnerships to address the complexity of achieving effective and fair groundwater management. This project aims to build capacity of researchers, farmers, farming communities and relevant government and non-government agencies to improve groundwater management in ways that enhance farming family livelihoods in Pakistan. Building capacity means building skills, knowledge and confidence, and providing relevant tools and processes.

This report describes the Participatory Rural Appraisals (PRAs) that were undertaken early in the project, to gather social information to underpin decision making in the initial stages of the government/community partnership. All project partners agreed that it is important to correctly identify the issues faced by farmers and their communities to guide the research into solutions.

PRA is a set of approaches, methods and behaviours that help people share reflections on their social and physical environment. PRA emphasises co-learning, both through learning alongside local communities, and by involving project stakeholders from a variety of backgrounds. PRA is an intensive, systematic but semi-structured progressive learning experience, compressed in time, and carried out in a community by a multi-disciplinary team.

PRA provided an opportunity to begin the collaborative process that underpins logic of the overall project. The PRA activity fit into a larger systems-framing that we are calling an on-going process of co-inquiry, that moves research beyond individual projects led by research academics into a process of inquiry that draws on, and enhances, the skills of multiple co-inquirers.

In this project the entire project team, regardless of discipline or experience, were invited to be part of the co-inquiry. Training in designing and undertaking PRAs was provided to a large group of project team members at Mehran University of Engineering and Technology, Jamshoro, Pakistan, in November 2016.

The primary aim of the PRAs was to enable selection of case study areas. The project application approved by ACIAR identified the focal areas within the selected three provinces, but selection of specific case study sites was an early, essential task. An all of team meeting was held in Faisalabad from the 3-6 of February, 2016, at which the case study purpose(s) and the criteria for selection were discussed. From this discussion a list of important hydrological, social, economic and logistical considerations was developed. This list was reconsidered and refined at a subsequent project team meeting in Lahore in August 2016.

PRAs were conducted by project team members in 2017 in Balochistan, Punjab and Sindh. Thee individual reports are brought together in this document. There is much detail about individual sites, highlighting the great variance across and within the provinces. A common lesson across all sites was that there is room for improvement in agricultural groundwater use, although the specifics of the adaptations will vary with context.

Following reflection on what was learned during the PRAs, and some further investigations these case study areas were selected for the remaining focus of the project:

> *Balochistan:* Malikyar and Zarghoon in the severely groundwater depleted Pishin Lora Basin, near Quetta, Balochistan.
>
> *Punjab:* The 1R and 11L distributaries of the Lower Bari Doab Command area, near Okara and Sahiwal respectively.
>
> *Sindh:* The Cheeho distributary in NaushahroFeroze district and Malwa distributary in Shaheed Benazirabad (formerly Nawabshah) district.

PRA takes time and resources, and can seem to hold back immediate action in a project. But the benefits of taking time to understand the geo-social landscape and its implications for the project have been shown many times. In this project the PRA process achieved three major outcomes, each associated with multi-disciplinary research.

One outcome is the rigorous and defensible selection of case study areas based on multi-disciplinary criteria. The project needed sites that met certain groundwater and socio-economic parameters, as well as being logistically possible in a short term project. We note, however, that there is great variation across all of the rapidly appraised areas, which has implications for scaling out findings and ideas from this project. Through this designed process sites with the most promise for research and change were selected, and other areas may be more resistant to positive change.

The second outcome was the involvement of a range of researchers and practitioners in 'social' research. Many project partners visited villagers, and listened to stories in ways they had not had the opportunity for before. This is a small step to reducing the silos in which all of us live our lives.

The third outcome was team building- travelling together, sharing stories and reflecting on what was told, and what it could mean, helped to create empathy and professional linkages among the project partners, building a good foundation for the remainder of the project.

2 Introduction

2.1 General introduction to the groundwater project

Water is essential for life on earth but only 2.5 percent of this water is fresh. Around 99 percent of all fresh water is available in underground aquifers (United Nations Environment Programme, 2002), and more than a quarter of the world's population draws water from these underground aquifers.

Pakistan's population of over 180 million is dependent on water because it relies heavily on agriculture. Agriculture makes a significant contribution (~21 percent) to gross domestic production of country and provides livelihood to more than 43 percent of rural population (Government of Pakistan, 2014), but uses around 95% of the country's water.

The surface water supply in Pakistan is variable, particularly for farmers at the tail end of canals and distributaries in Sindh and Punjab provinces, so the agricultural sector is heavily dependent on underground water. Groundwater is accessed by tube wells, where a pipe is introduced into an underground aquifer, and the water lifted by a pump. Availability of subsidised electricity and locally made diesel engines has dramatically increased number of private tube wells in the country. Currently in Pakistan more than 0.8 million private tube wells are working and 90 percent of these tube wells are used for agriculture (Mangan, Nangraj, Laghari, Khooharo, & Buriro, 2016; Qureshi, McCornick, Qadir, & Aslam, 2008). With this intensity of use there are grave concerns about the sustainability and equity of groundwater use for agriculture (Ashfaq & Ashraf, 2006; Khair, Mustaq, Culas, & Hafeez, 2011; Qureshi, McCornick, Sarwar, & Sharma, 2010).

Pakistan is classified as one of the most water-stressed countries in the world because depletion and degradation of underground water in this country is very high. Pakistan is facing scarcity of per capita water in the near future (Asian Development Bank, 2016; Rahut, Ali, Imtiaz, Mottaleb, & Erenstein, 2016). In 1947 per capita availability of water in Pakistan was 5650 cubic meters while in 2013 it decreases to 990 cubic meters (Government of Pakistan, 2014; Lalzad, 2007). If this downward trend continues it will lead to reduced groundwater tables and it is expected that by 2020 per capita availability of ground water may be reduced to 800 cubic meters (Innovateus, 2014; Kahlown & Majeed, 2002).

The ACIAR funded project "Improving groundwater management to enhance agriculture and farming livelihoods in Pakistan" is a collaboration through partnerships to address the complexity of achieving effective and fair groundwater management. This project aims to build capacity of researchers, farmers, farming communities and relevant government and non-government agencies to improve groundwater management in ways that enhance farming family livelihoods in Pakistan. Building capacity means building skills, knowledge and confidence, and providing relevant tools and processes.

This report describes the Participatory Rural Appraisals (PRAs) that were undertaken early in the project, to gather social information to underpin decision making in the initial stages of the government/community partnership.

2.2 Participatory Rural Appraisal (PRA)

Participatory Rural Appraisal (PRA) is based on co-learning by people from various disciplines and backgrounds (Allan & Curtis, 2002). PRA is a set of approaches, methods and behaviours that help people share reflections on their social and physical environment. PRA is based on a willingness to listen, to share power and knowledge, and to be self-critical in order to foster communication and understanding (Chambers, 1994, 1999). PRA also emphasises co-learning, both through learning alongside local communities, and by involving project stakeholders from a variety of backgrounds (Pretty, Guijt, Thompson, & Scoones, 1995). One way to identify researchable and relevant problems is to conduct a diagnostic information gathering survey with a

farming systems perspective (IRRI, 1986). The two key elements of the diagnostic survey are that it can be carried out rapidly and that it is interdisciplinary (Nagy, Sabri, & Stubbs, 1998), so this approach sits well with PRA.

It is important to correctly identify the issues faced by farmers and their communities to guide the research into solutions. PRA is a technique used by the researchers to collect/ create the primary data. It is an intensive, systematic but semi-structured progressive learning experience, compressed in time, and carried out in a community by a multi-disciplinary team which includes community members as well. PRA allows the rapid collection of information. PRA can also be used to develop a further understanding of farming systems and to better define farmers problems (van der Veen, 1996).

2.3 PRA in the groundwater project LWR-036

PRA provided an opportunity to begin the collaborative process that underpins the LWR-036 impact logic (Figure 1). While following well documented PRA methods, the PRA activity fit into a larger systems-framing that we are calling an on-going process of co-inquiry (Allan et al., 2020; Ison, 2010). Co-inquiry moves research beyond individual projects led by research academics into a process of inquiry that draws on, and enhances, the skills of multiple co-inquirers. The co-inquiry process is based on collaborative partnerships:

- Partnerships to shape the research
- Partnerships to do the research
- Partnerships to report the research
- Partnerships to use the research
- Partnerships to continue for the long term

In this project the entire project team, regardless of discipline or experience, were invited to be part of the co-inquiry. Acknowledging that this is a new approach for many in the project PRA capacity building was provided at a workshop at Mehran University of Engineering and Technology, Jamshoro, Pakistan, in November 2016. This workshop aimed to

- Create a shared PRA training package for the three provinces
- Enculturate project team and partners in co-inquiry paradigm
- Train provincial team based co-inquiry teams
- Develop provincial team based research questions and approaches
- Develop provincial team based action plan for PRAs
- Help team members become comfortable with being researchers
- Empower team members to act

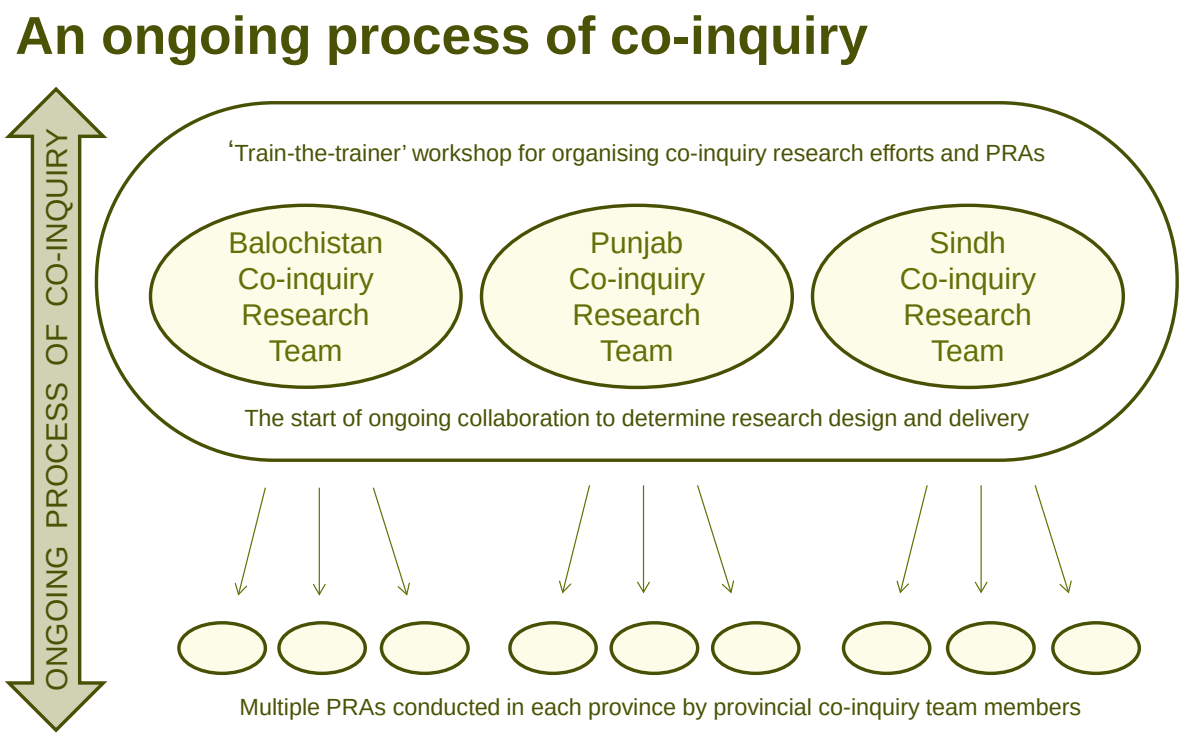

Figure 1 A schematic of the approach to pra training and implementation in the project

Figure 2 Participants in the Train the Trainer workshop, MUET, November 2016

The approaches created and discussed at the MUET workshop were developed and tested further within each province in early 2017.

PRA was used to provide a sound basis for a number of approaches and activities within the LWR-036 project's three focal areas comprise different agro-ecological settings across three provinces:

- Pishin Lora Basin in Balochistan
- The Lower Bari Doab Command area in Punjab
- the Shaheed Benazirabad (formerly Nawabshah) and Naushahro Feroze Districts of Sindh

These activities were primarily to provide foundational understanding for the case study site selection; understanding the groundwater situation; the development of the socio economic (household) survey and the development of forums. Each of these is discussed briefly below.

2.3.1 Case study site selection

The project application approved by ACIAR identified the focal areas within the selected three provinces, but selection of specific case study sites was an early, essential task. An all of team meeting was held in Faisalabad from the 3-6 of February, 2016, with the aim of scoping the entire LWR-036 project. A session at the workshop was allocated to discussing the case study purpose(s) and the criteria for selection. From this discussion a list of important hydrological, social, economic and logistical considerations was developed. This list was reconsidered and refined at a subsequent project team meeting in Lahore in August 2016. The final agreed criteria are presented in Figure 3.

Case study site selection criteria*

1. Availability of data
2. Having farming families, communities and partners who can facilitate change (i.e. a place where we can work towards achieving behavioural change; good chance of success given presence of well-organised community and their willingness to participate)
3. Potential to connect with/ build on the irrigation efficiency improvement Farmer Field Schools established by the ACIAR project LWR/2014/074
4. Usefulness for replication
5. Suitability of fit with a reasonably closed hydrological system
6. Relevance for exploring multiple key issues associated with groundwater management
7. Availability of multiple sources of water for irrigation
8. Groundwater areas that are moderately over-stressed and/or over-exploited and where there is potential for resource conservation and/or areas where groundwater resources are degraded or vulnerable and/or prone to waterlogging and salinity
9. Prevalence of poverty where potential for livelihood impacts are measurable and achievable, and where there is lack of capacity of stakeholders
10. Potential for high value crops of high economic return/ viability of economic options, and proximity to input (finance) and output market
11. Practical/ financial feasibility as a place where tools can be tested
12. Accessibility and areas with safety and security
13. Areas which have good prospects for finalising case study activities within the life of the project

*As identified by project team, Faisalabad, Feb 2016, supplemented by case study selection criteria identified at the August 2015 workshop in Lahore

Figure 3 Case study selection criteria

As the criteria were considered over the early stages of the project known differences in groundwater level and social aspects among the head, middle and tail sections of surface water distributaries were also considered as needing to be reflected in the case study selections.

A PRA reporting template was developed to enable the free flowing, qualitative discussions of the PRA to inform the case study selection criteria.

2.3.2 Understanding the groundwater situation

The PRAs help contextualize groundwater, presenting it as part of a complex system with social, cultural and economic elements interacting with the biophysical. The insight gained through the PRAs will help produce groundwater models that are useable, rather than simply reports stored on shelves. Information on the condition of the groundwater from the farmers' perspective, and their perceptions of its condition and change over time are important, but it is possible that other issues take priority. The key project objective directly relevant to the development of the groundwater model is to develop, with stakeholders, groundwater management tools and options that have the potential to enhance livelihoods of farming families. The PRAs provide a solid base for that development.

2.3.3 Socio Economic Survey

Household level surveys are a well-regarded method of gaining quantitative data for economic modelling. The qualitative data from the PRAs complements and guided the household level surveys.

2.4 Research Ethics

Research that involves humans- either as direct participants, or as sources of data-should be undertaken in respectful ways that seek to minimise harm to participants while ensuring that the research has benefit (Israel & Hay, 2006). Research undertaken as part of the PRA followed the procedures of the participating research institutions.

2.5 How to read this report

This project report includes the individual PRA reports from each of the three provinces, bookended by the general introduction above, and an overall discussion of key themes and recommendations. References from various sections of the report are collated in once list at the end of the report, and appendices from the various sections follow the references.

3 Balochistan report

3.1 Authors

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Abdul Rashid Tareen

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Zamina Khan

3.2 Introduction

In Balochistan irrigated agriculture depends on both surface and groundwater resources. The main sources of surface irrigation are the Khirther, Pat Feeder and Lasbela canals of the Indus Basin Irrigation System (IBIS). Another important source of surface water is the floodwater that flows through streams. Some 97 percent of the area was cultivated under irrigated crops, and only 3 percent was under rainfed/*Sailaba* farming during 2014-15 (Government of Balochistan, 2015). An estimated 30 per cent of floodwater has been harvested for agriculture through *sailaba* diversions, storage dams and minor perennial irrigation schemes. Groundwater is available for irrigated agriculture through Karezes, springs and tube wells. Groundwater irrigates around half of the irrigated area of Balochistan and the main source is tube-wells.

The growth of tube-well-led agriculture in Balochistan has caused manifold increase in the agricultural production, but the groundwater resources in many basins of Balochistan are under tremendous pressure. Water tables are declining sharply at the rate of 2 to 5 meters annually which is very alarming situation because many areas are running out of water and farmers are losing their source of livelihood.

The Project aims to provide an enabling environment for communities to participate in the research process and to develop socially acceptable solutions. The PRA in Balochistan provides a basis for community participation in the project in this province.

The PRAs are initial rapid field assessments that will establish the more detailed design for case study investigation in the context of study area. The PRA will help understand and achieve the first research objective of the Project LWR-036 which is “develop and articulate a shared understanding of sustainable groundwater use for agriculture and the need for improved management in Balochistan, Punjab and Sindh.” Specifically, the PRA will help start discussion among stakeholder interests to determine and share their views. Moreover, the PRA will help build on in-depth understanding of the socio-political and institutional context to effectively address the above mentioned project objective. In this regard, different sites in the Kuchlak and Pishin sub-basins of PLB were surveyed via PRA discussions.

3.3 Description of project area

3.3.1 Pishin Lora Basin (PLB)

The focal area selected for the project initiative is Pishin Lora Basin of Balochistan. The total area of Pishin Lora Basin (PLB) is about 18,133 km2, and hydrologically the basin is divided into eleven sub-basins namely Pishin, Kuchlak, Quetta, Kolpur, Kolpur, Mastung, Shirinab, Patki Shahnawaz, Mangochar, Kalat and Kapoto (Figures 4 and 5). According to the Census of 1998 the population of PBL was about 35% of Balochistan, of which majority live in Quetta (Halcrow, 2008). The main occupation of the people of the area is agriculture farming.

Figure 4 Pishin Lora Basin of Balochistan

PLB receives low rain fall (200 mm to 250 mm annually), high rates of evaporation and high temperatures.

Pishin Lora Basin is one of the major river basins of the Balochistan Province. Pishin Lora is the main river of the area. The PLB enters Afghanistan from Killa Abdullah district, and re-enters Pakistan's territory near Nushki at Zangi Nawar Lake. The drainage direction of the major streams is from north to south in the northern parts and from south to north in southern parts. The streams tend to flow towards west after meeting the principal stream (Pishin Lora). The main streams are Shore Rud, Bostan-Lora and Pishin- Lora. The Shore Rud drains the southern part of the basin (Kalat, Mastung, and Shirinab), the Bostan-Lora drains the south eastern part (Kolpur, Quetta and Kuchlak) (Halcrow, 2008).

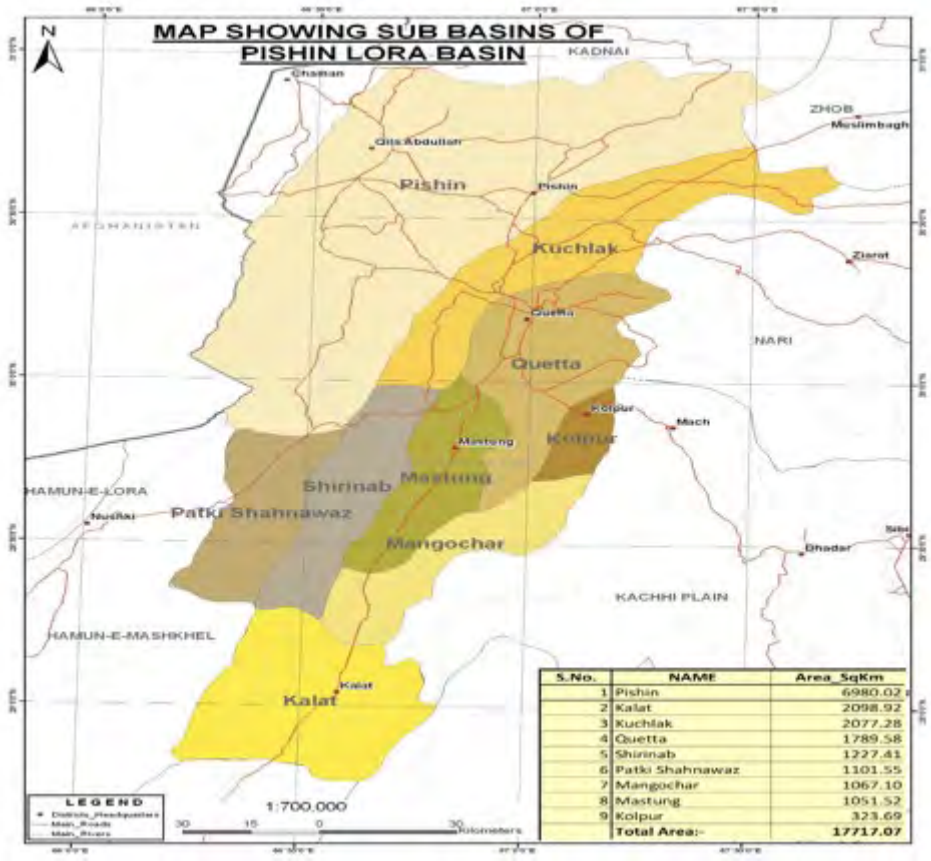

Figure 5 Sub-basins and study sites at Pishin Lora Basin

3.3.2 Pishin Sub-Basin

Pishin sub-basin is part of PBL and located in the northeastern part of Quetta, encompassing about 174565 hectares or 1746 km^2 . The major Pishin River and its tributaries Barshor Lora, Tormurgha Nala, Thang Manda, Loe Sokhta Manda and Surkhab Manda drain the Pishin sub-basin. The surface drainage direction Northeast towards Southwest.

The Pishin sub-basin is facing acute shortage of water, and is the most affected sub-basin of PBL as the groundwater level has declined drastically due to prolonged drought, over exploitation and poor management.

Groundwater availability has decreased rapidly, and this is likely to continue with time due to drought spells, climatic changes causing less precipitation coupled with enhanced demands from and increasing population and agriculture. The resources are not keeping pace with the demands and in the absence of functional regulatory framework the degradation of the resource is the common phenomenon. Tod date the focus has been on the development of the groundwater resources, and little attention has been given to ongoing management . There is growing acceptance at the policy level that effective planning requires accurate data regarding availability and use of water resources in the sub-basin area. The analysis of water demand and supply has become crucial for future planning and management of water resources.

Groundwater is the main source of agriculture, domestic and industrial use in the sub-basin and greatest amount of groundwater is extracted through tube well. It is estimated that a large amount of groundwater is extracted annually via more than 3000 tubeswell that are tapping the aquifer of the Pishin sub-basin.

2.3.1.2. Kuchlak Sub-Basin

Kuchlak sub-basin is part of PBL and lies in the northern part of Balochistan (Figure 6).

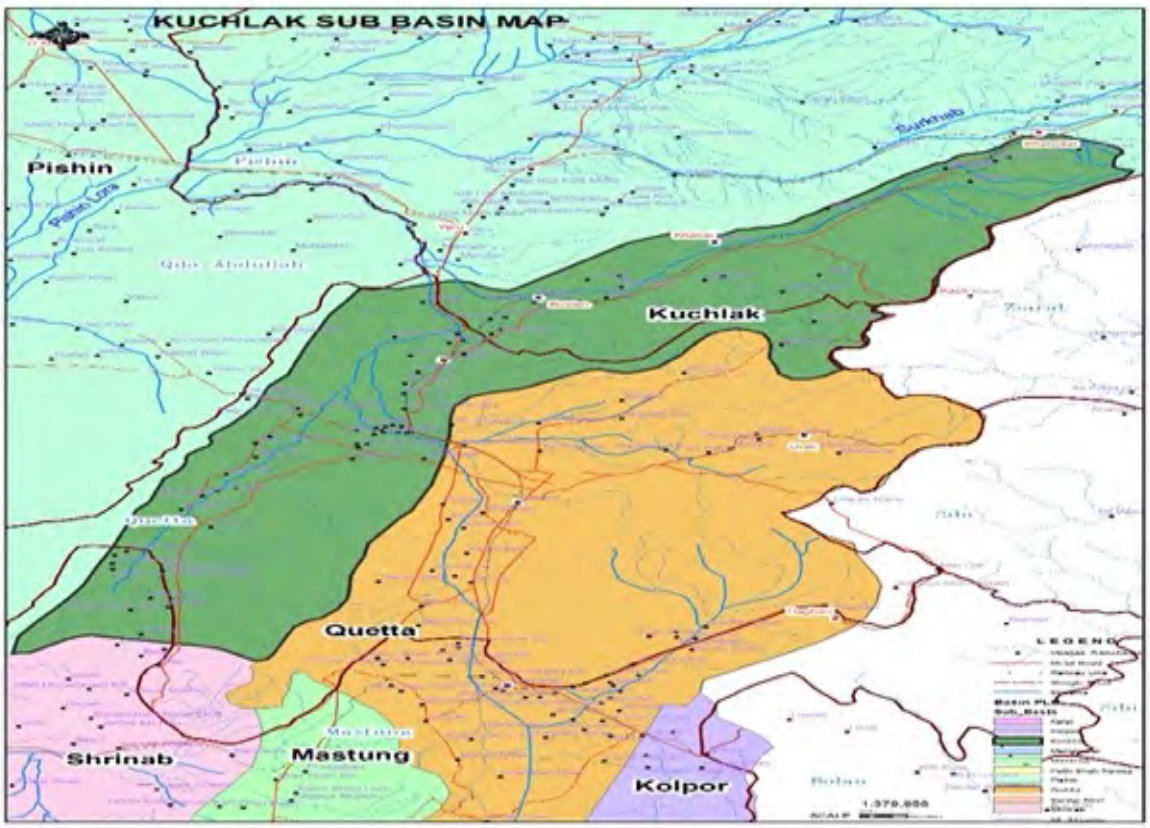

Figure 6 Map illustrates location of Kuchlak sub-basin

Groundwater is the main source of agriculture, domestic and industrial use in the sub-basin and greatest amount of groundwater is extracted through tube well. It is estimated that a large amount of groundwater is extracted annually.

3.4 PRA method

3.4.1 Location

PRA was conducted during 2016-18 in different sites of Kuchlak sub-basin and Pishin sub-basin of PBL (Figure 7 and Table 1).

Figure 7 PRA sites

Table 1: PRAs undertaken in Pishan Lora Basin

Site	Sub-basin	Date of visit
Zarghoon	Kuchlak	December 2016, April 2018
Khushab	Kuchlak	December, 2016
Maghotian	Kuchlak	May 2017
Aghbarg	Kuchlak	May 2017
Malikyar	Pishan	July 2017

3.4.2 General approach

As part of PRA, group interviews (Figure 10), direct observation, transect walks and individual household surveys were held. Primary and secondary data sources are used. Primary data were obtained from group and individual interviews with local communities and related stakeholders. For secondary data various journal articles, technical reports, statistical bulletins etc. were viewed. The reports were obtained from government offices as well as other international institutions and agencies.

Figure 6 Interviews as part of PRA

Transect walks were conducted in all sites to take the vulnerability picture of the community, observation of livelihood and settlement patterns. Group interviews were conducted at all sites with a group of community members comprising of the individuals from diverse backgrounds.

A semi-structured interview schedule was prepared for household level discussions. Semi structured interviews are a wide-ranging category of interview in which the interviewer commences with a set of interview themes but is prepared to vary the order in which questions are asked and to ask new questions in the context of the research situation (Saunders, Lewis, & Thornhill, 2007). The survey team consisted of social scientist, agriculturist, irrigation hydrologist, geologist, and economist:

Dr. S.M.Khair, Associate Professor, BUITEMS, Quetta.

Dr. Maqsood Ahmad, Professor, BUITEMS, Quetta.

Mr. Farooq Ahmad, Executive Engineer, BID, Quetta.

Mr. M. Hanif, Hydrologist, BID. Quetta.

Mr. Zahir Shah, Groundwater Specialist, BID, Quetta.

Mr. Abdul Rashid, Senior Subject Matter Specialist, Agriculture department, Quetta.

Mr. Mujeeb UR Rehman, P & D department, Quetta.

Miss Sadaf Amjad, NGO, Quetta.

Miss Zamina Khan

The data enumerators were properly briefed and trained prior to field work and data collection, on the aims of the project and respectful approach. The household survey consists of five main parts covering:

- Availability of basic amenities
- Agriculture and water management
- current situation in milieu of depleting
- groundwater, and
- potential for improvement

Transect walks were conducted in all sites surveyed in 2016-2017 to take the vulnerability picture of the community, observation of livelihood and settlement patterns.

3.5 Results

3.5.1 Summary

As depicted by Table 2 the five sites selected for consideration for the project are located in the Pishin and Quetta district. These villages are located in the uplands at altitude of more than 5000 feet from the sea level. From hydrological point of view these sites are located in the Kuchlak and Quetta sub-basins of the PBL. The population of these villages varies from some 2,000 to 22,000. The occupation and main livelihood source of the people of the study sites is mainly agriculture where more around 70 percent of people get their livelihood from agriculture, followed by business, mining, government services and laborers. There is no industry near the study sites, however, few industrial units exist in Quetta town which is some 50-70 km away from different sites.

Table 2 General description of the study sites in Pishin Lora

Site name	**Zarghoon**	**Khanozai**	**Aghbarg**	**Maghotian**	**Malikyar**
Nearby town/ distance (km)	Khanozai (15 km)	Khanozai (0 km)	Quetta (20 km)	Kuchlak (5 km)	Pishin (17 km)
Date of visit	31/12/2016 And 2018 (women)	31/12/2016	24/5/2017	24/5/2017	29/7/2017 And 2018 (women)
GPS	N 67.357 E; E 30.649 N	N 67.261 E; E 30.631 N	N 67.004 E; E 30.399 N	N 67.804 E; E 30.11 N	67.057 E; 30.692 N
Group interview respondents	Six farmers	Six farmers, 2 farmers cum government servants	Six farmers, 1 teacher, 1 tenant, 1 tailor	Four farmers, 2 other villagers	Six farmers, 3 other villagers
Altitude from sea level (feet)	5600	5700	5400	5400	5373
Sub-basin	Kuchlak	Kuchlak	Kuchlak	Kuchlak	Pishin
District	Pishin	Pishin	Quetta	Pishin	Pishin

Population of village (000)	13000	15000	2000	4000	22000
Occupation	Agric. 50-60%, business, services & labour 30%, mining 10 %	Agric. 70%, services 5-10%, mining 5%, Business 5%, rest labourer	Agric. 50%, Service 10-15%, Business 15, Other 10%	Agric. 60%, services 5-10%, Business 5-10, labourer	Agric. 80%, service 1-2%, Business 5-10%, rest labourer

Source: Survey 2016-17

Availability of basic amenities in the study sites

All the study sites are connected by metaled (sealed) road to the nearby towns making the accessibility to the area easy. The facilities such as Basic health unit for medical facilities, veterinary centre for animals, agriculture extension facility for farmers do exist at the village/town level or located at a certain distance from the village as shown in Table 3. The other amenities like the schools (primary, middle and high) for boys and girls do exist at the different sites which is an encouraging feature of the area and both boys and girls are taking education in a good number near their door step. Moreover, tap water for drinking purposes was also available either insides homes or at a shorter distance from their homes.

Table 3 Basic amenities availability on the Pishin Lora study sites

Facility/ Site name	Zarghoon	Khanozai	Aghbarg	Maghotian	Malikyar
Metalled road	Yes	Yes	Yes	Yes	Yes
Basic health unit	Yes	Yes	Yes	Yes	Yes
Veterinary centre	Yes	Yes	Yes	Yes (30 km)	Yes
Agric. Extension	Yes (20 km)	Yes	Yes (25 km)	Yes (30 km)	No (17 km)
School boys	Yes (Primary, Middle, High)	Yes (Primary, Middle, High)	Yes (Primary, Middle, High)	Yes (Primary, Middle, High)	Yes (Primary, Middle, High)
Schools girls	Yes (Primary, Middle, High)	Yes (Primary, Middle, High)	Yes (Primary, Middle, High)	Yes (Primary, Middle, High)	Yes (Primary, Middle)
Water supply scheme	Yes	Yes	Yes	Yes	Yes

Source: Survey, 2016-17

Farming system, agriculture related facilities

There are two cropping seasons in the PLB. Kharif crops are sown in summer and harvested in late summer or early winter. Winter crops are sown in winter and harvested in late winter or early summer.

Agriculture extension and research facilities exist at the town level (Table 4), however smaller farm sized and landless farmers are less likely to get these facilities. The larger farmers are influential and financially sound, and are given priority in new technology transfer.

The nearest market for outputs is located some 60-80 km away in Quetta, but the other terminal markets such as Lahore, Karachi, Islamabad are also easily accessible by farmers through well-connected road network. An active farmer's organisation, the Balochistan Zamindar Association is functional in all over Balochistan. This association has been very affective in seeking to prevent the removal of the government subsidy on agricultural tube-wells.

Table 4 Agriculture related facilities availability in Pishin Lora

Facility/ Site name	Zarghoon	Khanozai	Aghbarg	Maghotian	Malikyar
Agric. Extension	No (20 km)	Yes	No (25 km)	N (30 km)	No (17 km)
Agric. Inputs dealer	No (20 km)	Yes	No (18 km)	Yes	No (17 km)
Agric research	No (20 km)	Yes	No (25 km)	Yes	No (17 km)
Output market	No (60 km)	No (80 km)	No (80 km)	No (80 km)	No (80 km)
NGOs/CBOs/FOs	LSO Zarghoon, -FO	-2 NGOs, - FO	- FO	FO exist	FO exist

Source: Survey, 2016-17, FO is Farmers Organization, NGO is Non Government Organization

The soil is fertile and water logging and salinity issues are minimal due to deep water levels. The majority of farms (60-85%) are small (< 2.2 ha) and due to the law of inheritance the farm size is getting further smaller with the passage of time (Table 5). The small farm size also limits the adoption of modern technology due to small and landless farmers limited financial capacity. In contrast, the larger farmers are wealthy and influential and get the new agricultural technology first, while the small and landless farmers get that after months and years.

The cropping pattern is dominated by horticultural crops (fruits and vegetables). Apple being the most profitable crop is dominating the cropping pattern in three out of five sites. Grapes and tomato are replacing apple in the water scarce areas. Wheat, onion, garlic is also being grown in Zarghoon area.

Table 5 Cropping pattern and farm characteristics, Pishin Lora

Facility/ Site name	Zarghoon	Khanozai	Aghbarg	Maghotian	Malikyar
Soil type	Clay	Clay and sandy	Clay	Clay and sandy	Clay and sandy soil

Largest farm (acres)	35-40	>100	150	25	100
Smallest farm (acres)	4	2-3	4	1.5-5	3
Share of small farms	60-65%	60-70%	80%	80-85%	65-70 %
Crops grown	Apple, tomato, wheat, apricot, garlic	Apple-tomato-wheat	Grapes, onion, wheat, barley, tomato	Onion, tomato, garlic, carrot, wheat	Apple-Grapes-Vegetables (Tomato, chillies)
Share of small farms	60-65%	60-70%	80%	80-85%	65-70 %

Source: Survey, 2016-17

Agriculture is the main livelihood sources, due to drying of tube-wells, many farmers have lost their source of livelihood, and remaining farmers are worried about the future of their farming and livelihood. Therefore, people are now looking for alternate livelihood sources in business, mining, government and migration to other rural centres.

As agriculture is the mainstay of the livelihoods of the PRA sites and the alarming drop in agriculture economy of the farmers by several reasons has caused an increase in poverty. During the survey farmer claimed;

> "*We are suffering the worst downturn by inappropriate institutional policies and the turn down support of line departments."*

Besides of the fact that poverty has decreased in a decade at national level but district Pishin witnessed significant incidence such as MPI increased from 0.417 to 0.453, headcount ratio 79.9% to 82.2% and poverty intensity 55.2 to 55.1% during 2004-05 to 2014-15 (Planning Commission of Pakistan, 2015).

Groundwater is the sole source for farming communities of the study sites and an improvement in groundwater management will enhance per capita income of poor farmers that will reduce poverty in the study areas.

During the survey it was found that farmers are growing high delta (high water use) horticultural crops such as apple, peach plum, tomato and onion with traditional or poor irrigation techniques, and the standard rootstock and canopy heights require high water input. The United Nations Development Programme (UNDP), working under the Refugee Affected and Hosting Areas (RAHA) program, is introducing some dwarf varieties of apple in Balochistan that are early bearing, cost effective produce equal size and quality fruit as compared local varieties. Moreover, grapes, pistachio, olive and almond have good production and survival during the current climatic conditions and prolong drought scenario with the same i.e. flood irrigation techniques. These fruits have promising features and are economically viable for sustainable agriculture farming in PLB. Beans have drought resistance characteristics and can easily grow in hot arid summer season can be tested at the place of other Kharif vegetables.

At district level data regarding crops area and production is available in published form. However, at community or sub-basin level data will be obtained by consultation with respective office of agriculture and irrigation departments.

Some women's perspectives

In addition to the above interviews, Miss Sadaf Javed and Miss Zarmina conducted a field visit at Village Zarghoon on April 7, 2018 (Figure 11). Members of the Local Support Organziation (LSO), the Muskan Committee, were invited to participate in the meeting which was organised to

- introduce Project and team members
- seek community cooperation for the implementation of project activities
- obtain information regarding available services in the village

Miss Sadaf Javed shared the objectives of this field visit with the participants where a brief introduction of project regarding water management services was shared with the participants.

Figure 7 Meeting with the members of Muskan Committee at Village Zarghoon

There are 18 community activist members of the LSO-Muskan Committee, six of whom were consulted as part of this PRA. The LSO is very active working for social welfare in the areas of education, health, sanitation, drinking water, sports and other community issues for men, women, youth and children. For example, the LSO-Muskan Committee is working to raise community fund where a sum of Rs.100/- is collected from every household. This community fund is used for individuals in emergency situation and after that fund is returned back to committee when the requirement is fulfilled.

The Balochistan Rural Support Programme (BRSP) organizes capacity building events, such a five day Train the Trainer event focused on nutrition, at which 300 people participated, including some from the village of Zarghoon. Other local capacity building from the BRSP has focused on human health, livestock, and food processing. BRSP also has local water related projects including construction of a tube-well, a pipeline and provision of a solar system. In Malkyar there is one tube well installed in the village, but there have been no training sessions provided in kitchen gardening, home gardening, water supply schemes, health, livelihood and education in this area.

In Zaghoon 70% of the community is educated, with one school each for boys and girls. In Malkyar 60 to 70% boys and 40% of girls are educated. There are both government schools (a Boys, High, a Girls Middle and a Girls primary) and a co-educational English Private School.

Perceptions of Groundwater situation

This section explores farmers' perception about groundwater stress or depletion, and vulnerability of the resources as well as quality of groundwater. It begins by describing the hydrological system, source of irrigation, availability of groundwater data, and concludes by considering successful and socially acceptable tools or interventions.

Tube-wells are the main source of irrigation (Table 6). There has been a shift away from the ancient and community managed Karez systems, where groundwater is tunnelled from higher underground storages, to be used by the communities below. A few Karezes still operate, but their flow is very minimal and cannot fulfil irrigation and drinking water needs. In Khanozai area, some five karezes are still active out of some 35-40 karezes. These are Tor Khula, Shakar, Murgha ki, Dilsura. In Maghotian, there were two functional Karezes namely Mughtian/ Heibat and Akhund Zada in the village, but these have been dry for the past 35 years. At the Malikyar site there is a unique Karez called Sahibzada Karez, the shareholders of this karez are four villagers such as Malikyar, Sheikhalzai, Torasha and Kamalzai and it was functional even in the devastating drought period (1998-2002).

The traditional flood irrigation method is used to irrigate the crops. Modern irrigation techniques, such as drip and trickle, are not used in area because the farmers believe that these cannot fulfill the irrigation requirement of their crops and orchards and hard to maintain. Tube-wells are mainly electric but now in few less deep water table areas (up to 100 metres) tube-wells run by solar energy have been introduced. These solar tube-wells are supplementing the electric tube-wells, it is apprehended that the solar pumps may further increase the overuse of groundwater. Electricity supply is 6-8 hours a day, which is not sufficient to meet the water demand. Farmers have sorted out a solution that many have installed more tube-wells to fulfill the water demand or they run their tube-wells by renting a generator at Rs. 1500 per hour.

The respondents from the community of Maghotian noted that the water table depleting seriously in the village, especially in the month of May 2017. The blamed the irrigation, power and agriculture departments for lowering water table in the village. For example, one of the villagers noted that

"By reducing electricity supply; pressure has been increased on groundwater due to the increase of tube-wells in the village".

One farmer suggested that "*Groundwater is declining due to illegal tube-wells*". There are some 33 illegal tube-wells run in the village, apparently with no restriction.

Operating a solar tube-well is expensive as it requires some 4.0 to 4.5 million rupees to extract water from a depth of 150-220 metres, and this is beyond the capacity of the farmers.

Farmers are applying traditional irrigation methods i.e. flood and furrow, while, some irrigate apricots through the water channel. The community people have little access to high efficiency irrigation systems. Few farmers reported that the modern irrigation systems are successful only on new trees/crops, on old deep rooted trees failure and there is a high risk involve with installation of these systems due to high cost.

Table 6 Irrigation sources, method and type of tube-wells, Pishin Lora

Facility/ Site name	Zarghoon	Khanozai	Aghbarg	Maghotian	Malikyar
Water source	Tube-wells	Tube-wells	Tube-wells	Tube-wells	Tube-wells

Irrigation methods	Flood	Flood	Flood	Flood	Flood and furrow
No of tube-wells	147 in UC	> 200	15	75	220
Tube-wells discharge (inch)	3-4”	3-4”	3”	3”	3”
Use of modern irri systems & access of small farmers to it	Very small scale, didn’t succeed	Not suitable with current cropping	No	No match with the needs of crops	Not suitable with current cropping
Type of tube-wells Electric/solar/ Diesel	50 solar, rest electric	95 % electric 5% solar	30 tube-wells, 10 solar systems supplementing elec. Tube-wells	100 electric, electric generator used in summer @ Rs. 1500/hr	Electric, electric generator used in summer @ Rs. 1500/hr
Electricity supply (hrs) from national grid	6 hours	6-8	7-8	4-8	3-6 hrs/day

Source: Survey, 2016-17

Groundwater stress and over extraction

As shown by Table 7, the borewell depth reaches to a maximum of 300 metres, while the water table depth ranges from some 100 to 150 metres. Respondents explained that prolonged spell, mass installation of tube-wells, and poor irrigation techniques have severally affected the agriculture of the area and almost collapsed the agriculture system. Most of the long-standing trees were routed out/dried due to unavailability of water and the remaining are in water stress. In particular, the PRA sites of Pishin have drastically been affected by these drought spells. As one farmer in the noted

“Most of the old tube-wells have gone dry or converted to deep tube-wells.”

The annual decline in water table is alarming i.e., from 3 to 9 metres per year. The electricity supply to tube-wells is subsidized, so that the irrigation cost is only 10 to 20 % of total cost. There was no water treatment reported and the conjunctive water use (tube-well +spring/karez) was found but negligible.

Table 7 Borewell and water table depth, decline of water tables and quality of water, Pishin Lora

Site name	**Zarghoon**	**Khanozai**	**Aghbarg**	**Maghotian**	**Malikyar**
Water table depth (metres)	107	91-122	84	113-146	107-122
Bore well depth (metres	153	207	174	275-305	183

Decline of water table (metres)	6.1	6-9	1.5-3	6-8	9
Irrigation cost % of total	10-20%	10-20%	10-15%	10-20%	10-20%
Treated/untreated water	No	No	No	No	No
Conjunctive water use	Negligible	Negligible	Negligible	No	No
Taste of water	Fine	Ok, generally	Ok	Ok	Ok
Salinity (Yes/No)	No	Deep water brackish	No	No	No

Source: Survey, 2016-17

As shown in Table 7 the quality of groundwater was reasonable at all sites and no surface salinity issues were reported.

As summarised in Table 8, farmers reported that marketing of irrigation water for cash is declining due to water shortage, however, share cropping between the landlord and peasant is still practiced in the area. Farmers of Malikar and Khanozai communities reported that in the past, landlord/farmer were usually growing vegetables and cereal crops through tenants by share cropping system, while the orchard managed itself. But nowadays orchard management requires a very substantial capital for operations by contributing high irrigation and pesticide costs

"*Therefore, we give orchard to the tenant as well on share bases on the prevailing patterns usually ranges from 33-50% tenants' share in output depends upon labour and capital cost share involved*."

Orchards are mostly owner operated however a contract/lease (1-5 year) on different terms and conditions was observed in the survey. In crop and vegetables, share cropping is common. The peasant is paid a share in crop output for his labour contribution, it usually ranges from 33 to 50 percent depend on how much labour and cost sharing is involved.

There are seasonal natural streams and rivers generated in the different sites of the area. These natural streams and rivers help in recharge the groundwater. All of above are temporary streams passes nearby the communities that falls in the PLB. Some of these streams like Tormurgha, Barshore Lora and Ghurkai lora are spatially intermittent streams, while, some other such as Khanan, kazay and Torasha Manda are ephemeral streams, which generally flow after heavy rainfall. Some farmers suggested that construction of dams can recharge ground water like the dams maintain water table in nearby villages (Khanyi and Chuker).

Table 8 Water buying and selling and natural streams/rivers generated, Pishin Lora area

Facility/ Site name	**Zarghoon**	**Khanozai**	**Aghbarg**	**Maghotian**	**Malikyar**
Water buying & selling	Share cropping, small scale	Tenancy and share cropping	Share cropping	Crop sharing	Crop sharing

					(33-50%), Decline with water shortage
Streams generated in area	Khorha, Kazay Manda	Thorgai more active, Ghargai, Nareen, Kandeel (murghazakary a zai area)	In the north and south of village hilly area, streams emerge	A seasonal stream Khanan passes near the village	Main PLB river (Barshor Lora and Tormurgha Nala), Torasha Manda

Source: Survey 2016-17

A temporary stream, Khanan passes nearby the village that originates from Takato Mountain in the south of the community and falls in the north west of the village at the place of Jalwageer in the Pishin Lora Basin. This stream is generally flow after heavy rainfall.

Farmers reported that the rapidly declining water tables and drying tube-wells has been the major problem making their livelihood vulnerable. Farmers reported that extensive pumping of groundwater due to the installation of illegal tube-wells has further aggravated the problem (Table 9). Adding to their miseries is the insufficient electricity supply (6-8 hours a day) that has made it very hard to irrigate their lands. To cope with this; "We have installed illegal tube-wells without the NOC of QESCO, which are running with one legal connection. This has further deteriorated the situation and the national grid is overloaded and hence causes frequent out brakes and low voltage in the electricity supply. They further added; "For the same purpose, we made a committee to maintain voltage especially in summer season. The committee decided that we have to disconnect some tube-wells in our feeder for twenty four hours to minimize burden on electricity supply. In this way, we received 20 days electricity supply in a month by providing 5-8 hours per day. The committee is responsible for collecting PKR 1000 per tube-well-owner per month to paid salaries to the non-electrician local persons that interchanges electricity supply in the village in which some of them lost their lives and some partially damaged in the same job." Low market prices most of the time causes farmers huge financial losses and the prices of agricultural commodities are subject to fluctuations in the markets. Moreover, there is no affective support price mechanism for tomato, onion and other vegetables, making farmers more vulnerable.

Table 9 Pishin Lora Farmers problems ranked in order of importance

Zarghoon	**Khanozai**	**Aghbarg**	**Maghotian**	**Malikyar**
1. Low precipitation, mass tube-well installation caused by rapid decline of water tables. 2. Traditional irrigation techniques decreasing water use efficiency. 3. Improper cropping pattern	1.Water scarcity, unlined channels/water courses, kacha ponds 2.Marketing-Low prices for their produce 3.Inappropriate cropping pattern 4.Post harvest losses of fruits and vegetables	1. Shifting of tube-wells from one site to other sight in the community. 2. Excessive pumping of groundwater due to Installation of tube-wells on solar + electric pumps.	1. Shifting of tube-wells from more rigged area to newly cultivated area of the community. 2. Low voltage and shortage of electricity 3. Poor agronomic	1. Rapid water decline and tube-wells drying due to excessive pumping and lack of rainfall 2. Apple orchard reduction and water stress conditions.

and poor agronomic cultural practices. 4. Apple quality is decreasing due to rising temperature, drought, and water stress condition. 5. An increase of insect and disease pests in horticultural crops	5.Crop diseases 6.Lack of storage of fruits /vegetables 7.Farm to market roads	3. Crops disease and insect pests	practices and irrigation techniques. 4. Low market prices due to poor packaging	3. Poor irrigation techniques 4. improper cropping pattern 5. Post-harvest losses and poor packaging of agric. Commodities 6. Codling moth, borers, powdery and downy mildews,

Source: Survey: 2016-17

In such circumstances farmer coping strategies about groundwater depletion, shortage of electricity supply and crops in water stress condition are reflecting poor and traditional. Examples of what they said include

"We irrigate our apple orchard with the same flood irrigation system as it is high water demanding crop and requires more irrigations in such arid and drought conditions."

"*We are gradually rooting up apple trees and grow vegetables especially garlic having more market value as compare to other vegetables*."

Others discussed growing more cereal crops i.e. wheat and barley, which require less irrigation. However few farmers have been shifting to low water demanding crops and changing their crops according to the current situation.

Hydrological system

The hydrological systems in the study area are open

Availability of groundwater data

Both groundwater and surface water data are available

3.5.2 Main themes

The groundwater situation in the PBL is serious and impacting badly on the livelihoods of farmers in the area. The various issues raised in the PRA discussions are summarised in Table 10.

Table 10 Current situation in the preview of depleting groundwater, Pishin Lora

Facility/ Site name	**Zarghoon**	**Khanozai**	**Aghbarg**	**Maghotian**	**Malikyar**
Problems	Declining water tables Illegal tube-wells	Declining water table	Declining water tables	Declining water tables Low market prices	Rapid decline of water tables
Change in cropping pattern	Orchards being replaced by tomato, garlic	Apple replaced by vegetables and crops	Apples replaced by grapes,	Apple and potato	Yes, Apple orchards being

over the last ten years?	People diverting to business, mining and services		garlic new crop	cultivation omitted	replaced by vegetables and crops.
Livelihood situation	People striving for other livelihood source (mining, business etc.)	Dwindling, water drying, loss of main livelihood source	Comparatively stable, groundwater exist	Dwindling, water drying, loss of main livelihood source	Dwindling, water drying, loss of main livelihood source
Role of women and children in agriculture	Women have no direct role in water management/farming	Women have no direct role in water management/farming	Women have no direct role in water management/farming	Women have no direct role in water management/farming	Women have no direct role in water management/farming
Access to village women for project	Community agree, female social workers can access	Community agree, female social workers can access	Community agree, female social workers can access	Community agree, female social workers can access	Community agree, female social workers can access
Solutions	Construction of dams -Low delta crops -Modern irri methods -Lined channels/ponds -Flood protection	-Construction of dams -Renovation of karezes -Introduction of high efficiency irrigation systems - Introduction of low delta crops	-Construction of dams -introduction of high efficiency irrigation techniques -Training on Improved irrigation practices/methods	-improve electricity duration and voltage -ban on new tube-wells -Pakka/ Concrete channels and ponds	-Construction of dams -Change of irrigation methods -migration

Source: Survey, 2016-17

3.6 Balochistan case study site selection

As shown in the following Table 11, a five category scale was used to see the suitability of different study sites for the project intervention. The Zarghoon and Malikyar sites were suitable on all three suitability criteria respectively and marked very suitable. While the other three sites rate less important as per criteria.

Table 11: Summary of case study selection , Balochistan

BALOCHISTAN	Unsuitable	Not very suitable	Has both suitable & unsuitable features	Suitable	Very suitable
For each criterion, please indicate each site's suitability using the following legend:	(0)	(1)	(2)	(3)	(4)
Case Study Site	**Zarghoon**	**Khanozai**	**Aghbarg**	**Maghotian**	**Malikyar**
Groundwater situation					
ESSENTIAL: Availability of groundwater data (e.g. what is known, what is available?)	Don't know	Don't know	Don't know	Don't know	Don't know
KEY: The situation regarding groundwater (e.g. how much stress or exploitation? Are the resources vulnerable or degraded? Is there salinity or waterlogging?	Not clear	Not clear	Not clear	Not clear	Not clear
DESIRED: Features of this site that will make it useful for exploring multiple key issues associated with groundwater management	4	2	3	2	4
What sort of tools or interventions are likely to be accepted/ successful? Could these be easily replicated elsewhere?	4	3	4	3	4
The hydrological system (e.g., is it a closed system?)	Open	Open	Open	Open	Open
Sources of water for irrigation and their use	Not clear	Not clear	Not clear	Not clear	Not clear
Socioeconomic situation					
KEY: The social, cultural, and economic situation – e.g. Are there farming families, communities and partners who can facilitate change? Is it a place where we can work towards achieving behavioural change, with the presence of a well-organised community willing to participate with us?	4	2	3	2	3

Table 11: Continued

BALOCHISTAN	Unsuitable	Not very suitable	Has both suitable & unsuitable features	Suitable	Very suitable
Case Study Site	**Zarghoon**	**Khanozai**	**Aghbarg**	**Maghotian**	**Malikyar**
Prevalence of poverty where potential for livelihood impacts are measureable and achievable, and where capacity of stakeholders is low with high prospects for enhancing their capacity	3	2	3	2	3
Potential for high value crops of high economic return/ viability of economic options, and proximity to input (finance) and output market	4	4	4	4	4
Availability of data related to social and economic aspects, or good prospects to acquire/ create such data	4	3	3	3	3
The extent lessons from this village could be applicable in other places	4	3	4	3	4
Features of this site that will make it useful for exploring multiple groundwater-related issues for improving livelihoods	3	2	3	2	3
Logistics					
ESSENTIAL: Accessibility, safety and security	3	3	4	3	3
DESIRED: Features that make this site feasible or not as a place where tools can be tested	4	2	3	2	3
Potential to connect with/ build on the irrigation efficiency improvement Farmer Field Schools established by the ACIAR project LWR/2014/074	4	3	3	4	4
Features that make this site feasible or not to finalise case study activities within the life of the project	4	3	3	3	3

3.7 Recommendations

On the basis of PRA and available literature it was found that there is there is supply and demand imbalances in the study sites. Therefore, there is needed such interventions, which has both supply/recharge and demand/discharge side features. For groundwater recharge the following interventions may be suggested:

- Construction of check dams for soil conservation and water recharge.
- Artificial recharge of aquifers with the help of inject wells by applying seasonal surplus surface water.
- Construction of delay action dams

While for demand side interventions the following tools/techniques may be recommended:

- Presently high delta crops with water wasting irrigation techniques are growing in the drought prone/ water scarce districts of Balochistan. Therefore, less water demanding crops like pistachio, olive, almond, grapes and pomegranate could be considered.
- High efficiency irrigation systems such as drip, bubbler or sprinkler may be installed as per requirement of the crop.
- Raise bed technology, ridge planting may be applied for wheat and vegetables.
- Application of an appropriate mulching for vegetables cultivation

4 Punjab report

4.1 Authors

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4.2 Introduction

PRAs were conducted at fourteen locations in the Lower Bari Doab Canal (LBDC) in two district, Okara and Sahiwal. PRAs were undertaken with men in each location, and eight PRAs with women were undertaken within the same locations.

4.3 Description of project area

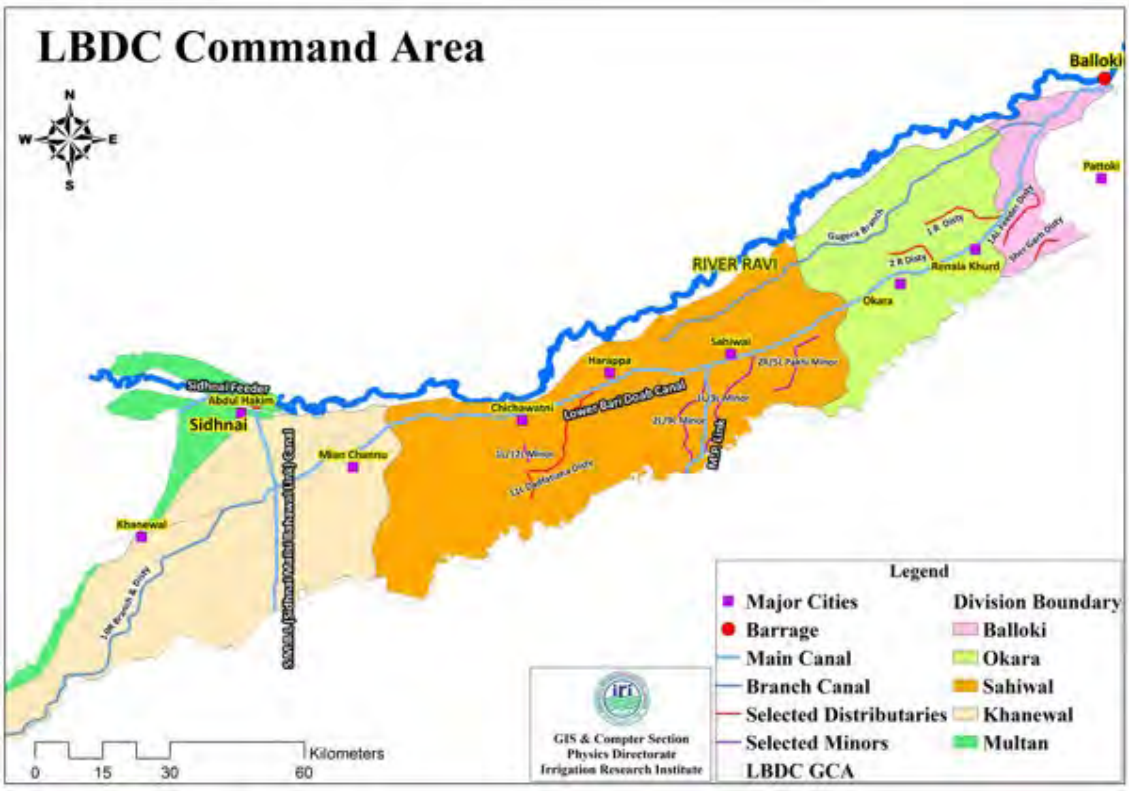

Figure 8 Lower Bari Doab Canal Command Area, Punjab

4.4 PRA method

The interviews involved economists and sociologists from academia, hydro-engineers from PID and PCRWR, PIDA and NGOs representatives meeting in the selected villages to discuss groundwater and related issues with the men. PRA discussions were held separately with women in thirteen of these selected locations, facilitated by female researchers, and recorded using the selection criteria template. The details from the pairs of discussions are included, party to show the areas of overlap and disparity, and to capture as much detail as possible. Photos are provided for each of the male PRAS, but fewer photos are available of the female focused sessions due to cultural expectations.

4.5 Results

4.5.1 Summary

A summary of the information from all the male PRA meetings is presented in Table 12, showing the locations and key data about each of the 14 PRA sites. This summary shows the variation across the 14 sites, with village populations varying from 4000 to 12000 people, the percentage of households with no land varying from 30-80%. While the number of canal outlets (moggas) was between 2 and 6, the number of tube-wells per village was highly variable, ranging from 0-250.

Table 12 Summary of the PRA sites and some descriptive information from the sessions with held with men

Variables	PRA-1	PRA-2	PRA-3	PRA-4	PRA-5	PRA-6	PRA-7	PRA-8	PRA-9	PRA 10	PRA-11	PRA-12	PRA-13	PRA-14
Date	July 14, 2017	July 14, 2017	July 14, 2017	July 15,2017	July 15, 2017	July 29, 2017	July 29, 2017	August 04, 2017	August 04, 2017	Sept 26, 2017	Sept 26, 2017	Sept 26, 2017	Sept 26, 2017	Sept 26, 2017
No. in session	30	20	25	30	40	35	60	20	40	15	20	15	25	15
District	Okara	Okara	Okara	Sahiwal	Sahiwal	Sahiwal	Sahiwal	Sahiwal	Sahiwal	Okara	Okara	Sahiwal	Sahiwal	Sahiwal
Distributary	1/L	1-R	2-R	6-R	11-L	9-L	5-L	9-L	12-L	1-R	2-R	2-L/9-L Minor	2-L/9-L Minor	11-L
Location in Distributary	Tail	Middle	Middle	Head	Tail	Middle	Tail	Head	Tail	Tail	Tail	Head	Tail	Tail
Village Name	16-1/L	8/1-R	25/2-R	96/6-R	7/11-L	130/9-L	73-A/5-L	97/9-L	32/12-L	17/1-R	32/2-R	103/9-	124/9-	30/11-L
Total Population	10000	4000	12000	9000	10000	4000	5000	10000	10000	5000	20000	9500	5500	4000
Household have no land %	30	40	15	40	60	50	66	50	33	80	50	50	60	75
Average years of school	8	8	10	10	8	8	10	10	14	10	10	10	8	Less than 8
% of poor families	40%	50%	30%	20%	60%		15%	20%	Very low	40%	50%	50%	60%	70%
Outlets / Moggas	3	3	6	3	5	2	3	3	4	5	2	4	3	2
Bore depth (metres)	76	61	46-61	107-150	90-137	93	52	24	46	69	69	137	37	61
Tube-wells	2-3	30	250	100	80	11	0	6	30	180	135	30	35	14
GW quality	Brackish/ salty	Brackish / salty	variable	variable	variable	Brackish/ salty	Good	Brackish	variable	good	good	good	salty	salty

Tehsil Ranella Khurd, District Okara

This first PRA was conducted at 16/1-L, Tehsil Ranella Khurd, District Okara on July 14, 2017. It was conducted along 1-L distributary which linked with Lower Bari Doab Canal (LBDC). This village is located at tail command area of 1-L distributary. Thirty respondents participated in this group discussion (Figure 13).

The total land of this village is 900 acres and the majority of farmers have small land holdings. The soil is naturally fertile but deteriorating because of poor groundwater quality.

The average land rent is Rs. 35000 per acre. Groundwater quality of this village is brackish to salty. Bore depth for installation of tube well is around 76 metres and the groundwater table is around 16 metres. This village has three tube wells, operated by tractor and electricity, and three canal outlets. The major cash crops of this village are wheat, sugarcane and cotton, with groundwater contributing around 10%. Groundwater cost to irrigate one acre for one cropping period is PKR 5000. Farmers of this village are not using any high efficiency irrigation system. Around 50 % of young people, and 50% of women provide their services in farming. Young women are interested in education and do not participate in agricultural activities. The Farmers Organization (FO) is very active along this distributary and has solved most of the problems the farmers.

Figure 9 PRA with Male Farmers, Tehsil Ranella Khurd, District Okara

The discussion with women undertaken at this site, led by female researchers, provided the confirmatory or additional information below.

The people farm in the traditional way, and women are active in agricultural activities. The major crops comprise wheat, sugarcane, maize, cotton, and nirma (kind of cotton). There is a pond in the village where the people wash their cattle.

The ground water is not stressed here as due to the degraded quality there is little extraction, the water creates soil salinity and hardens it, so they just rely upon the insufficient canal water, rain or sometimes they use waste water for their crops. There is a FO, managing water disputes and collecting the water charges; the people are satisfied by the FO role, but there is no representation of women there.

Overall, from a groundwater perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

The people, including women here are educated, have an average of 8 years of schooling. The village has 50% poverty, and agriculture is declining. Women take part actively in the agricultural activities, but the girls' participation is not much, especially educated girls do not take part in agriculture.

When the people were asked to define a poor person they identified it as a person who is unable to send their children to a good school, who finds it difficult to earn daily bread for his family and who is unable to spend on recreation.

The people here are quite cooperative, which is a good sign towards achieving change. People are willing to participate in any community or agricultural development program, but it is not recommended to work here on this project because ground water is not used for agriculture.

The village women are taking active part in agriculture especially in livestock management. They are willing to participate in some developmental work that increases agriculture there. They are more concerned about water because non availability of surface water and unfit or marginal fit groundwater makes it difficult to get it at all. Women are mostly aware of irrigation, and in some cases they supervise the process. At home, the women are using domestic water pumps for various purposes including clothes washing, cattle quenching, livestock, and bathing but not for drinking or food preparation.

Overall, from a socio-economic perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

The site is easily accessible as it has asphalt road and is situated near to the main road. Working here is very safe as government has its firm writ here, also people are very friendly and are willing to bring about the change.

Young people are leaving farming so it would be difficult to generalize the outcomes for the longer run. Young women having very little participation in agriculture, which is pushing people towards selling or lending their land to the tenants.

Overall, from a logistics perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Tehsil Ranella Khurd, District Okara

PRA # 2 was conducted on July 14, 2017 at 8/1-R, Tehsil Ranella Khurd, District Okara (Figure 14.) The population of this village is 4000 and 40% of families have no land to undertaken any agricultural activity, and 50% of families are poor. The people of this village average eight years of schooling. This village is 6 KM away from the main road and 6 KM from main grain market. The hand pump water quality is unfit for consumption. The land of this village is 725 acres and majority farmers have small land holding. The soil of this village is fertile but is deteriorating due to poor groundwater quality.

Land rent which charge to the other tenant farmers is Rs. 35000 per acre. This village is located at middle command area of 1-R distributary. Groundwater quality of this village is brackish to salty. The bore depth for installation of tube well is 61m and groundwater table at 33m. The village has

is 30 tube wells operated by peter engine and electricity. There are three canal outlets of this village, and the major cash crops are wheat, sugarcane, canola and cotton. Mostly farmers of this village practice conjunctive use of water, with groundwater contributing 30%. Groundwater cost to irrigate one acre for one cropping period is PKR 5000. Farmers of this village were not used any high efficiency irrigation system. Around 10 % of young people, and 50% of women, including young women, provide their services to farming. The Farmer's organization is very active along this distributary and addresss most of the problems of the farmers.

Figure 10 8/1-R, Tehsil Ranella Khurd, District Okara

The discussion with women undertaken at this site, led by female researchers, provided the confirmatory or additional information below.

8/1-R, Jandwala is a small village of city Renala Khurd, district Sahiwal, it has a population size of about 4,000 people, and situated at about 6km from the main road, a broken, narrow charcoal road is the only way from the main road to the village. The women are active in agricultural activities. The people, especially women, are farming in the traditional way. The average education level of the village is 8 years of schooling, although young women average only 5 years of schooling. The major crops of the village are Cotton, Sugarcane (as fodder), Wheat, and Canola. 50% families are poor and the labour is scarce in village and wages demand is high. Young people focus on jobs rather than agriculture, with young men prefer going abroad specially to Gulf countries, but there are also hurdles financially for that.

Groundwater situation

There are 30 tube-wells in the village, but the water is brackish and not good for the soil. The FO manages water disputes and collects the water charges, the people are satisfied by the FO role, but there is no representation of women there in the FO set up.

Overall, from a groundwater perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

The men and women here are not much educated, and 50% families are poor. Women and female youth take part in the agricultural activities but there is not much left to do because of the water shortage and low groundwater quality. People are willing to participate in community or agricultural development programs, but they are not willing to have experiments, due to the financial conditions. The major crops are wheat, sugarcane and cotton. The women are not aware of irrigation; they irrigate when it is needed but the agriculture is crumbling in the area. The women are using domestic water pumps for various household purposes, including for livestock.T hey use groundwater for clothes washing, cattle quenching and bathing, but not for drinking and food making. Laboratory and other experts have advised them to have a 150m deep bore in order to have quality drinking water. The pump wasn't yet activated the day we visited the site.

Overall, from a socioeconomic perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Villagers are cooperative and the share of groundwater in agriculture is about 40 %, The site is not easily accessible though it is situated near to the main road, but the way is totally broken and it takes 30 minutes or more to reach the village from the main city. Working here is very safe as government has its firm writ here, also people are very friendly. But the young men are more concerned with getting jobs. and are not much involved in farming. Young women have nearly no participation in agriculture. People are not willing to have experiments, but are willing to adopt the innovation at promising outcomes.

Overall, from a logistics perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

25/2-R, Tehsil and District Okara

PRA # 3 was conducted on July 14, 2017 at 25/2-R, Tehsil and District Okara (Figure 15). 25 respondents participated in this group discussion. The population of this village is 12000 and 15 % of its families have no land to do any agricultural activity, and about 30% are poor. The people of this village have average ten years of schooling. This village is 4 KM away from the main road and 12 KM away from main grain market. The hand pump water quality is marginally fit. The total land of this village is 1250 acres, with fertile soil. The majority of have small land holdings. Land rent which charge to the other tenant farmers is Rs. 40000 per acre.

This village is located at middle command area of 2-R distributary. Bore depth for installation of tube wells is 200 ft. and groundwater table at 15 ft. There are 250 tube-wells, operated by peter engine, tractor and electricity. The village has six canal outlets and the major cash crops are wheat, sugarcane, maize, rice and cotton. Mostly farmers of this village use conjunctive use of water. Share of groundwater to irrigate the crops is 60 %. Groundwater cost to irrigate one acre for one cropping period is PKR 3000. Farmers of this village were not used any high efficiency irrigation system. Around 50% of young men in the village their services to farming. Women of this village also take part in agricultural activities, but young women have not showed interest/.Farmer's organization is very active along this distributary and solved most of the problems on time of the farmers.

Figure 11 25/2-R, Tehsil and District Okara

The discussion with women undertaken at this site, led by female researchers, provided the confirmatory or additional information below.

General description of area/site

The study was accomplished in 25/2R – Sangokay, of District Okara, it has a population size

of about 12,000-15,000 people, and is situated about 4km from the main road; a charcoal road in satisfactory condition is the only way from the main road to the village. Farming is traditional, and women are active in agricultural activities, even in irrigation. Major crops of the village comprise wheat, rice, sugarcane, maize, and cotton. 30% families are poor and the labour is scarce in village and wages demand is high. There had been a lake since 1947, which gradually has been dried up, it was a great recreational for the people even from other areas. There had been seasonal fowls, and people of all over Punjab and Sindh loved to come here for hunting.

Groundwater situation

The ground water stress and extraction can be visualized by the number of tube wells working here, there are about 250 tube wells in the village. The water creates salinity and hardens the soil, so conjunctive use is practiced. Waste water is not in use. FO manages water disputes and collects the water charges, the people are satisfied by the FO role, but there is no representation of women there.

Overall, from a groundwater perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Socioeconomic situation

The people, including women, have an average of 10 years of schooling and 30% families are poverty struck. Women and female youth take active part in the agricultural activities, but agriculture is declining. The people of the village are willing to participate in any community or agricultural development program. Of the major crops wheat is a staple, and Maize and sugarcane the cash crops. We can see that the yield has a mixed trend, average good yield is observed.

Women supervise and even sometimes themselves irrigate the fields. The women are using domestic water pumps hey use groundwater for cattle quenching, bathing and all the washing. They identified that they had a well also in the village of which drinking water was excellent, but later on that well was used for drainage dump and at last that was closed.

Overall, from a socio-economic perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

The site is easily accessible as it has asphalt road and is situated near to the main road, and working here is very safe and the peopl are very friendly and are willing to bring about change. Especially the youth is more concerned about education. A 15-year-old school girl told us that she is intended to not only be educated herself but also wants to educate every child of the village and had firm resolutions. The youth is involved very much in farming so it would be helpful to get the longer term outcomes. Female youth is also having very active participation in agriculture.

Overall, from a logistics perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

96/6-R, Tehsil and District Sahiwal

PRA # 4 was conducted on July 15,2017 at 96/6-R, Tehsil and District Sahiwal, along 6-R distributary which linked with the LBDC. 30 respondents were participated in this group discussion. The village population is 9000, around 30% of families are poor, and 40 % of families have no land for agricultural activity. The people of this village have average ten years of schooling. This village is 1 KM away from the main road and 6 KM away from main grain market. The hand pump water quality is marginal. The village has 1500 acres of fertile land, and the majority of farmers have small land holdings. Land rent which charge to the other tenant farmers is Rs. 40000 per acre.

This village is located at head command area of 6-R distributary. The groundwater is marginal quality. Bore depth for installation of tube well is 450 ft. and groundwater table at 60 ft. The 100 tube wells are operated by peter engine and electricity. There are three canal outlets, and major cash crops are wheat, maize, rice and potato. Mostly farmers of this village use conjunctive use of water. Share of groundwater to irrigate the crops is 60 %. Groundwater cost to irrigate one acre for one cropping period is PKR 4500. Farmers of this village used sprinkler irrigation system at only seven acres. Women of this village also take part in agricultural activities, but youth are less interested. The Farmer's organization is very active along this distributary and solved most of the problems on time of the farmers.

Figure 12 96/6-R, Tehsil and District Sahiwal

The discussion with women undertaken at this site, led by female researchers, provided the confirmatory or additional information below.

General description of area/site

96/6R is the village of district Sahiwal, with a population of about 9,000, and situated about 1 km from the main road, a charcoal road the way from the main road to the village. 20% families are poor and the labour is scarce in village and wages demand is high. The youth focuses on jobs rather than agriculture, people prefer going abroad.

Groundwater situation

There are about 100 tube wells in the village, with good quality water. Groundwater is used conjunctively, and waste water is not used. The FO manages water disputes and collects the water charges, the people are satisfied by the FO role, but there is no representation of women there in the FO set up.

Overall, from a socio-economic perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Socioeconomic situation

The people here are educated, women also are educated and the average education in women is higher than the boys, and 20% families are poverty struck. Women and female youth take some part in the agricultural activities. The people of the village are willing to participate in any community or agricultural development program, but the village is close to the city, and people are losing interest in agriculture, and are selling their land for future commercialisation. Wheat is a staple crop, and Rice and Maize are cash crops. We can see that the yield has a mixed trend, average good yield is observed. Women are aware of irrigation, but in most of the cases they don't go to the field for the irrigation. Women are using domestic water pumps for various household purposes, including for livestock, cattle quenching, bathing and all the washing, and also drinking and food preparation.

Overall, from a logistics perspective, this site is (circle one)

(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Logistics

Villagers are friendly and cooperative and the site is easily accessible as it is situated near to the main road. Working here is very safe. But the youth is more concerned about getting jobs. They go abroad and lend their land to someone. Female youth nearly no participation in agriculture.

Overall, from a groundwater perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

11-L Loharian Wala, Tehsil Chichawatni

PRA # 5 was conducted on July 15,2017 at 7/11-L Loharian Wala, Tehsil Chichawatni, District Sahiwal, at the head area of 11-L distributary which linked with LBDC with 40 respondents participating in the male group discussion. The village population is 10000, with around 60% of families in poverty, 60 % of families have no land for agriculture. Villager average eight years of schooling. This village is 1.5 KM away from the main road and 15 KM away from main grain market. The hand pump water quality is unfit for drinking. There is 2604 acres of fertile land, and the majority farmers have small land holdings. Land rent which charge to the other tenant farmers is Rs. 35000 per acre.

Groundwater quality of this village is marginal, bore depth for installation of tube well is 450 ft. and groundwater table at 250 ft. There are 80 tube wells operated by tractor and electricity. There are five canal outlets, and the major crops are wheat, maize, cotton and potato. Mostly farmers of this village use conjunctive use of water. Share of groundwater to irrigate the crops is 50 %. Groundwater cost to irrigate one acre for one cropping period is PKR 7000. Farmers of this village were not using any high efficiency irrigation system. There is some interest in agriculture by male youth, and women women of this village also take part in agricultural activities and share their services about 50 %. Female youth have not showed their interest to take part in agricultural activities and they prefer to get more education. The Farmer's organization is very active along this distributary and address most of the problems.

Figure 13 7/11-L Loharian Wala, Tehsil Chichawatni, District Sahiwal.

The discussion with women undertaken at this site (Figure 17), led by female researchers, provided the confirmatory or additional information below.

General description of area/site

7/11-L Loharian Wala, in Chichawatni, city of District Sahiwal has a population of about 10,000 people, and situated at about 1.5KM from the main road. Traditional farming is used, but farmers are also tending to mechanise their farming. The average education level of the village is 8 years of schooling, majority of the female youth is educated and they have average 10 years of schooling. The major crops are wheat, maize, cotton, and potato. 60% families are poor and the labour is scarce in village demanding high wages. The youth focuses job rather than agriculture.

Groundwater situation

There are about 80 tube wells in the village. The groundwater is marginally, used conjunctively and waste water is not used. Potash is applied to treat soil hardening. FO manages water disputes and collects the water charges, the people are satisfied by the FO role, but there is no representation of women in the FO set up.

Overall, from a groundwater perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Socioeconomic situation

60% of families are poverty struck. There are clearly two classes in the village, the elite and the labourers. The elite class people have businesses other than agriculture, and are lending the land to the tenants or hiring some labour to do work at fields in their absence and care for their livestock. The other segment of the village were those tenants or labourers who worked for the elite, or they were the people going to the city or jobs or business. The women from the elite, or just have stepped into elite, were hesitant to share their knowledge and experiences they had in agriculture but it was seen that only the women from labour class were going to the fields, or who had own land and cultivating themselves. The people of the village are cooperative, and some are well off, and are ready to try something new, they are risk takers and also gradually mechanising their fields. People are willing to participate in any community or agricultural development program.

Women are aware of irrigation, in most of the cases they don't go to the field for irrigation

purpose, but women of labour class sometimes supervise the process and direct their sons or the labourers working there. The women are using domestic water pumps for bathing and all the washing but the groundwater is is not used for drinking or food preparation. There is some water vendor, who delivers drinkable water at Rs. 20 per 20ltr can.

Overall, from a socio-economic perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Logistics

The villagers are cooperative and have experimental mindset, and are ready to take risks, and may be classified as the early adopters. Working here is very safe. People are having other occupations, but the majority also have agriculture side by side. The young men are reluctant to be involved in agriculture, and young women have nearly have no participation in agriculture.

Overall, from a logistics perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

130/9-L, Tehsil and District Sahiwal

PRA # 6 was conducted on July 29, 2017 at 130/9-L, Tehsil and District Sahiwal, along 9-L distributary which linked with LBDC. 35 respondents participated in this group discussion. The village population is 4000, 10% of families are poor, and 50 % of families have no land for agricultural activity. The people of this village have an average of eight years of schooling. This village is 6 KM away from the main road and 26 KM away from main grain market. Hand pump water quality is unfit for drinking. The land area is 1125 acres of fertile soil. Land rent which charge to the other tenant farmers is Rs. 32000 per acre.

The groundwater quality of this village is brackish to salty. Bore depth for installation of tube well is 305 ft. and groundwater table at 50 ft. There are 11 tube wells, operated by tractor and electricity. There are 2 canal outlets, with the major cash crops of this village being wheat, maize, cotton and potato. Mostly farmers of this village use conjunctive use of water. The share of groundwater to irrigate the crops is 30 %. Groundwater costs to irrigate one acre for one cropping period is PKR 2800. Farmers of this village were not using any high efficiency irrigation systems. The young men of the village prefer to education over agriculture, as do most of the young women. Some older women are engaged in agricultural activities. The Farmer's organization is very active along this distributary.

Figure 14 130/9-L, Tehsil and District Sahiwal

The discussion with women undertaken at this site, led by female researchers, provided the confirmatory or additional information below.

General description of area/site

130/9L – Dera Raheem is located in district Sahiwal, having about 4,000 people, and situated at about 6km from the main road. Traditional farming is in practice. The women there are active in

agricultural activities, even in irrigation, average education level of the village is 8 years of schooling. The majority of young women are educated, averaging 12 years of schooling. Major crops of the village Wheat, Maize, Potato, and Cotton people prefer agriculture and the poverty is very low because people are very much cooperative and help each other open heartedly. We can see that the yield has a mixed trend, average yield is observed just satisfactory. The labour is scarce in village and wages demand is high. The young men are interested in agriculture, and alongside the jobs, they also take part in agricultural activities.

Groundwater situation

There are 11 tube wells in the village. The water is salty, so conjunctive use is practiced, and some vegetable growers use waste water. FO manages water disputes and collects the water charges, the people are satisfied by the FO role, but there is no representation of women there in the FO set up.

Overall, from a groundwater perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Socioeconomic situation

The people here are educated, the average education in women is higher than the men. Women and female youth take part in the agricultural activities, but young women rarely go to the fields. The people of the village are highly cooperative and organised, there are two women organisations in the village working actively for development. Women are mostly aware of irrigation,, but when they have to irrigate, they hire labourers and supervise them. One or two women of the village sometimes irrigate the fields themselves. They use domestic groundwater for cattle quenching, bathing and all the washing but not for for drinking and food preparation.

Overall, from a socio-economic perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Logistics

Cooperation among people here is exemplary but the share of groundwater in agriculture is very low as only 11 tube wells are there in the village, the women are using domestic water pumps for various household purposes, including for livestock. The site is easily accessible as it is situated near to the main road at only 6km distance and asphalt road makes the journey easier. Working here is very safe as government has its firm writ here, also people are very friendly and the youth is also interested in agriculture.

Overall, from a logistics perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

73-A/5-L Tehsil and District Sahiwal

PRA # 7 was conducted on July 29, 2017 at 73-A/5-L Tehsil and District Sahiwal, at the tail of 5-L distributary which linked with the LBDC. 60 respondents participated in this group discussion. The village population is 5000, 15% of families are poor, and 66% of families have no land for agricultural activity. The people of this village have average ten years of schooling. This village is 0.75 KM away from the main road and 26 KM away from main grain market. Hand pump water is of marginal quality. The village land is 1500 acres and majority farmers have small land holding. The soil was fertile, but is deteriorating. The land rent which charge to the other tenant farmers is Rs. 18000 per acre.

The groundwater quality of this village is unfit for drinking due to nearby location of of the Bias river. Bore depth for installation of tube well is 170 ft. and groundwater table at 50 ft. There are no tube wells to fulfill the needs of groundwater. There are three canal outlets, and the major cash crops are wheat, cotton and sugarcane. Farmers of this village do not use high efficiency irrigation systems. Young men of the village prefer education to agriculture. Women take part in agricultural activities , but young women are less interested, also preferring education. PIDA and FOs do not perform very well and there is no proper system of outlets

Figure 15 73-A/5-L Tehsil and District Sahiwal

The discussion with women undertaken at this site, led by female researchers, provided the confirmatory or additional information below.

General description of area/site

73a/5L is situated in district Sahiwal, having about 5,000 people population size, and situated about 1km from the main road and 26km from the main city. The village is from before partition and traditional farming is practiced. The women are active in agricultural activities, even in irrigation. The average education level is 10 years of schooling, but most of the young women average 12 years of schooling. Highly educated people are also residing the village. Major crops of the village are wheat, maize, potato, and cotton, and highly dependent on rainfall. People are leaving agriculture and claim that the poverty is increasing, however the researchers found no such claims compatible with the villagers' lifestyle. The labour is scarce in village and the youth is also not interested in agriculture, but prefer other jobs.

Groundwater situation

There are no tube wells in the village. The water is unfit for the soil, it hardens and creates salinity in the soil. Some vegetable growers use waste water. The canal water is not sufficient, yet FO

manages water disputes and collects the water charges. People are satisfied by the FO role, but there is no representation of women there in the FO set up.

Overall, from a groundwater perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Socioeconomic situation

The people here are highly educated, the average education in women is higher than the men. Livestock is an essential part of each household, managed mostly by the women, or sometimes by men, rather than by young people. The people of the village are cooperative and organised, there is a women's organisation in the village working actively for development, also men have different organisations and are active in developmental process, with the help of a member of provincial assembly. Women are mostly aware of irrigation and if they irrigate, they hire labourers and supervise them. They use domestic groundwater for cattle quenching, bathing and all the washing, and also for drinking and food making. There is a water filtration plant in the village which has been recently installed and not started working yet.

Overall, from a socio-economic perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Logistics

Cooperation among people here can be seen by the organisations they have, they are well organised people, but the share of groundwater in agriculture nil as no tube wells are there in the village, the women are using domestic water pumps for various household purposes, including for livestock. The site is easily accessible as it is situated near to the main road at only about 1km distance and asphalt road in efficient makes it easier to go. Working here is very safe as government has its firm writ here, also people are very friendly.

Male and female youth involvement in agriculture is at minimum level, which is alarming sign, working here will not produce long term outcomes.

Overall, from a logistics perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

97/9-L Tehsil and District Sahiwal

PRA # 8 was conducted on August 04, 2017 at 97/9-L Tehsil and District Sahiwal. This village is located at head command area of 9-L distributary, and 20 respondents participated in the group discussion. The population is 10000, with 20% poor families, and 50 % of families have no land for agriculture. The people of this village have average ten years of schooling. The village is located on the main road and 10 KM away from main grain market. The hand pump water quality is unfit for human consumption. The land area is 1250 acres, with fertile soil, and the majority of farmers have small land holdings. Land rent which charge to the other tenant farmers is Rs. 30000 per acre.

The groundwater quality is brackish. Bore depth for installation of tube well is 80 ft. and groundwater table at 27 ft. There are 6 tube wells for this village, mostly operated by tractor operated. There are 3 canal outlets, and the major cash crops are maize, cotton, sugarcane, potato and wheat. Mostly farmers of this village use conjunctive use of water. Share of groundwater to irrigate the crops is 30 %. Groundwater cost to irrigate one acre for one cropping period is PKR 3500. Farmers of this village were not using high efficiency irrigation systems. Women of this village also take part in agricultural activities, but the young people, both male and female, prefer education to agriculture. The farmer's organization is very active along this distributary.

Source: Survey, 2017.

Figure 16 97/9-L Tehsil and District Sahiwal

The discussion with women undertaken at this site, led by female researchers, provided the confirmatory or additional information below.

General description of area/site

97/9-L, a village of district Sahiwal, has a population size of about 10,000 people, situated at about 10km from the main city. The people farm in the traditional way, and women are active in agricultural activities. The average education level of the village is 10 years of schooling, including girls and young women. Labour is scarce in village and wages demand is high.

Groundwater situation

There are only 6 tube wells in the village. The water is brackish and not good for the soil, conjunctive use is practiced but waste water is not in use. FO manages water disputes and

collects the water charges, the people are satisfied by the FO role, but there is no representation of women there in the FO set up.

Overall, from a groundwater perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Socioeconomic situation

Women andtake part in the agricultural activities but not much there is left to do because of the water shortage and low groundwater quality. People are not willing to participate in any community or agricultural development program. Women use groundwater for cattle quenching, bathing and washing but not for drinking and food preparation.

Overall, from a socio-economic perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Logistics

The site is easily accessible, as it is situated very near to the city. Young people are not much in farming so it would be restriction in getting the longer term outcomes. Female youth nearly has no participation in agriculture.

Overall, from a logistics perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

32/12-L Tehsil Chichawatni, District Sahiwal

PRA # 9 was conducted on August 04, 2017 at 32/12-L Tehsil Chichawatni, District Sahiwal. This village is located at tail command area of 12-L distributary, and 40 respondents participated in this group discussion. The village population is 10000, 5% of families are poor, and 33 % of families have no land for agricultural activity. The people of this village have average fourteen years of schooling. This village is 8 KM away from the main road and 10 KM away from main grain market. The hand pump water quality is not fit for human consumption The village as 1500 acres of fertile land, with the majority of farmers having small land holdings. Land rent which charge to the other tenant farmers is Rs. 30000 per acre.

The quality of the groundwater is marginal. The bore depth for installation of a tube well is 150 ft. and groundwater table at 50 ft. There are 30 tube wells operated by tractor and electricity. There are four canal outlets, and the major crops are wheat, rice, sugarcane, potato, cotton and maize. Mostly farmers of this village undertake conjunctive use of water. The share of groundwater to irrigate the crops is 60 %. Groundwater cost to irrigate one acre for one cropping period is PKR

3350. Farmers were not using high efficiency irrigation systems. Women of this village also take part in agricultural activities, but the young people, both male and female, prefer education to agriculture. The farmer's organization is very active along this distributary.

Figure 17 32/12-L Tehsil Chichawatni, District Sahiwal

The discussion with women undertaken at this site, led by female researchers, provided the confirmatory or additional information below.

General description of area/site

32/12-L of Tehsil Chichawatni, District Sahiwal, it has a population of about 10,000 people, and is situated at about 8 km from the main road, a charcoal road in good condition is the only way from the main road to the village. The people ,especially women are, farming in traditional way though machines are also in use of some farmers. The women

there are active in agricultural activities, even in irrigation, and average education level of the village is 14 years of schooling. Most of the young women are educated, and the poverty rate is very low.

Groundwater situation

There are about 30 tube wells in the village. The groundwater is fair, especially when

conjunctive use is practiced, and waste water is not in use. There is a great share in of groundwater in agriculture because of its good quality. FO manages water disputes and collects the water chargers , the people are satisfied by the FO role, but there is no representative of women there.

Overall, from a groundwater perspective, this site is				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable	(3) Suitable	(4) Very suitable

		and unsuitable features		

Socioeconomic situation

The villagers, men and women, are highly educated, with an average of 14 years of schooling, and highest educational degree is Ph.D. There are few families in poverty, and agriculture is sustaining in the village as the yield of the major crops is very good. Women, including young women, take active part in the agricultural activities. The people of the village are willing to participate in any community or agricultural development program. They

Are interested in improving their agriculture. Women are aware of irrigation, in most of the cases they supervise and even sometimes themselves irrigate the fields. They use groundwater for different purposes including cattle quenching, bathing and all the washing. They noted that the domestic pumps have mixed quality of water at different places of the village, so for drinking and food making, people use the water from those areas.

There also were examples of ladies working in fields. A lady of the respondents, who was also a teacher at a government school was a widow. She was managing her farm with her brother in law, she was supervising all the farm activities actively, and she had sent her children to reputed institutes of Lahore, getting higher education.

Overall, from a socioeconomic perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Logistics

The site is easily accessible as it has asphalt road and is situated near to the main road.

Working here is very safe and the people are very friendly and willing to bring about change. Especially the youth is more concerned about education. Young people here are interested in education, but also agriculture. The people are much interested and also the education has made the people organised and they are keen on innovations, and willing to take risks.

Overall, from a logistics perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

17/1-R, Tehsil Ranella Khurd, District Okara.

PRA # 10 was conducted on September 26, 2017 at 17/1-R, Tehsil Ranella Khurd, District Okara, at the tail command area of 1-R distributary, and 15 respondents participated in this group discussion. The village population is 5000 , around 40% of families are poor, and 80 % families have no land for agriculture. The people of this village have average ten years of schooling. This village is 2 KM from the main road and 15 KM away from main grain market. The quality of the hand pump water is marginal. The village has 1900 acres of fertile land, and of those that have land the majority are small holdings. Land rent which charge to the other tenant farmers is 30000.

The groundwater quality of this village is marginal, bore depth for installation of tube well is 225 ft. and groundwater table at 30 ft. There are 180 tube wells mostly operated by tractor and electricity. There are 5 canal outlets major cash crops of this village are sugarcane, rice, maize, wheat, and potato. Conjunctive use of water is common, and the share of groundwater to irrigate the crops is 60 %. Groundwater cost to irrigate one acre for one cropping period is PKR 6000. No high efficiency irrigation systems are used. Women take part in agriculture, but the young men prefer education over agriculture. Female youth have sometimes showed their interest to take part in agricultural activities, but they too prefer more education. Farmers of that area are totally disappointed the role of PIDA and FOs. They do not transfer the proper property rights.

Figure 18 17/1-R, Tehsil Ranella Khurd, District Okara

The discussion with women undertaken at this site, led by female researchers, provided the confirmatory or additional information below.

General description of area/site

The village 17/1-R of Tehsil Renala Khurd, District Okara consists of 2100 acres at the tail end of the canal. A charcoal road is a way from the main road to village. The people are farming mostly in traditional way. The women of village are active in agriculture activities, including irrigation of their fields and harvesting the crops. Labour is scarce in the village, while 1900 acres is the declared area for cultivation. Average education of the village is 5 years of schooling; the most young women are uneducated.

Groundwater situation

There are 150-200 tube wells in this village. The groundwater of this village is good and people also use the canal water. Recently, they had test for their groundwater, and found it was not good for drinking. Previously, just 10-20 years back, the water table was 40 feet which has gone down to 100 feet. Bore depth for tube wells is now 300 feet. Conjunctive use of canal water is in practiced, but mostly they depend upon tube wells. A water market exists at the rate of Rs. 200/hour. Women of this area know that how to run tube wells. Electrical, peter-engine tube wells and turbine system

is also in the use. People felt decline in the aquifer by one foot yearly. 30% water courses are lined, and no HEIS is in practice, bio-gas or solar energy tube wells do not exist at the site.

Overall, from a groundwater perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Socioeconomic situation

Most of the people are small farmers. The men here are educated, but the women are mostly uneducated. Women and female youth have mixed trend in taking part in the agriculture activities. Male youth also takes active part in agriculture, as they have not much else to do Previously drip irrigation was introduced to the farmers here with a subsidy of 80%, but they have not adopted because , it is costly, skilled labour is not available, and above all, people are not willing to do the experiments. Women use groundwater for cattle quenching, bathing all the washing, drinking and food preparation.

Overall, from a socio-economic perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Logistics

People are cooperative, there is no murder for decades, and they are not divided into political parties. This site is easily accessible and people are contented and totally dependent on their income from agriculture, and youth have a great interest in farming. The villagers are organized but they are say that PIDA and the FOs are not performing well.

Overall, from a logistics perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

32/2-R Tehsil and District Okara

PRA # 11 was conducted on September 26, 2017 at 32/2-R Tehsil and District Okara, located at tail command area of 2-R distributary, and 20 respondents participated in this group discussion. The village population of is 20000, 50 % families are poor, and 50% have no land for agricultural activity. The people of this village have average ten years of schooling. This village is 1 KM away from the main road and 6 KM away from main grain market. The hand pump water quality is marginal. There are 1000 acres of fertile land, and most farmers have small land holdings. Land rent which charge to the other tenant farmers is Rs. 40000 per acre.

The groundwater quality is marginal, bore depth for installation of tube well is 225 ft. and groundwater table at 40 ft. There are 135 tube wells, mostly operated by tractor and electricity. There are two canal outlets, and the major crops are sugarcane, rice, maize, wheat, and potato. Mostly farmers of this village use water conjunctively, and the share of groundwater to irrigate crops is 60 %. Groundwater cost to irrigate one acre for one cropping period is PKR 5000. Farmers of this village were not using high efficiency irrigation system. Women of this village also take part

in agricultural activities, but the young people, both male and female, prefer education to agriculture. PIDA and FOs are not actively performed in this area. Farmers have many complaints to PIDA and FOs.

Figure 19 32/2-R Tehsil and District Okara

The discussion with women undertaken at this site, led by female researchers, provided the confirmatory or additional information below.

General description of area/site

The village 32/2-R of District Okara, consists of 1050 acres, the sugar and rice mills are located near the village. Total population of the village is nearly 20,000 individuals, living in around 3,000 houses. A broken, one kilometre road is the only way from the main road to the village. The people farming in traditional way, and women are active in agriculture activities, they irrigate their fields and also drive the carts in some of the cases. The major crops village are wheat, rice, potato, maize, and sugarcane.

Groundwater situation

There are about 100 tube wells in this village. The groundwater is drinkable according to the people, but they noted that its quality is being degraded gradually. Canal water is extremely scarce, so they use tube wells for irrigation, which also hardens the soil when used regularly. A domestic bore is 90 feet deep and 100 feet for good quality water. 200-225 feet deep bore is dug for tube wells. A water market exists, but usually very low number of people need water from others, the rate is Rs. 300/hour. The villagers explained that every year they feel that they have to go 4-5 feet deeper for the water; 10 years ago the water table was only 40 feet.

Overall, from a groundwater perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Socioeconomic situation

Almost every household of the village is involved in farming in a way or other, although 50% of the farmers are landless and a few have gone abroad. The people here are well educated, especially the women with an average of 10 years of schooling. Most young women are educated and they also are job holders, having an average of 12 years of schooling. Some of the girls work at the only private school of the village getting a salary of Rs. 1500 to Rs. 2000. Women also take a part in agriculture activities. People of this village are cooperative exemplified by their their successful

struggle to get a filter system for drinking water. Women use groundwater for clothes washing, bathing , drinking and food making, and for the livestock.

Overall, from a socio-economic perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Logistics

The site is not easily accessible as the road is totally broken. Working here is very safe as government firm writ here. Sugar and rice mills are an add-on near the village. Many young men want to leave the agriculture as the concept of modernity among them is not related to agriculture. Young women have little participation in agriculture, they concentrate on their education, but women have interests in the working of fields. People are also not willing to have experiments and while a drip irrigation campaign team reached the village but the people never adopted it.

Overall, from a logistics perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

103/9-L Tehsil and District Sahiwal

PRA # 12 was conducted on September 27, 2017 at 103/9-L Tehsil and District Sahiwal, at the head command area of 9-L distributary, and 15 respondents were participated in this group discussion. The village population is 9500, 50% of families are poor, 50 % have no land for agriculture, and they average ten years of schooling. This village is 4 KM away from the main road and 11 KM away from main grain market. The hand pump water is of marginal quality. There is 1675 of fertile acres and the majority of farmers have small land holding. Land rent which charge to the other tenant farmers is Rs. 42000 per acre

The groundwater quality is marginal, bore depth for installation of tube well is 450 ft. and groundwater table at 45 ft. There are 30 tube wells, mostly operated by tractor or electricity. There are four canal outlets, and the major cash crops maize, potato and wheat. Most farmers use water conjunctively with the share of groundwater to irrigate the crops 25 %. Groundwater cost to irrigate one acre for one cropping period is PKR 5500. Farmers of this village were not using high efficiency irrigation systems. Women of this village also take part in agricultural activities. The young men and women of the village are interested in agriculture, although the young women are more interested in education. PIDA and FOs do not play their role actively. Farmers are totally disappointed of that area

Figure 20 103/9-L Tehsil and District Sahiwal

124/9-L Tehsil and District Sahiwal

PRA #13 was conducted on September 27, 2017 at 124/9-L Tehsil and District Sahiwal, at the tail command area of 9-L distributary, and 25 respondents participated in this group discussion. The population is 5500, 60% of families are poor, and 60 % of families have no land for agriculture. The people of this village have average eight years of schooling. This village is 2 KM away from the main road and 23 KM away from main grain market. The hand pump water quality is marginal and brackish. The village has 1875 acres of fertile land, and most farmers have small holdings. Land rent which charge to the other tenant farmers is Rs. 28000 per acre.

The groundwater quality is marginal, bore depth for installation of tube well is 120 ft. and groundwater table at 40 ft. There are 35 tube wells, mostly operated by tractor or electricity. There are three canal outlets and the major cash crops are wheat, sugarcane, maize, potato and rice. Most farmers use water conjunctively, with the share of groundwater to irrigate crops is 60 %. Groundwater cost to irrigate one acre for one cropping period is PKR 5000. Farmers of this village were not using high efficiency irrigation systems. Women of this village also take part in agricultural activities , and young men have some interest in agriculture. Young women sometimes show interest, but are more interested in being educated. Farmers are satisfied about the role of PIDA and FOs.

Figure 21 124/9-L Tehsil and District Sahiwal

The discussion with women undertaken at this site, led by female researchers, provided the confirmatory or additional information below.

General description of area/site

24/09-L is a village of District Sahiwal; it has a population size of about 6,000 people and

situated at about 10km from the main road, a broken, narrow charcoal road is the only way from the main road to the village. The people especially women are farming in traditional way. In this village women are active in agriculture activities, participating in irrigating the land with tube well and canal waters. Some farmers are also using the machines for the cultivation of their crops. There are two major families in this village, Kharal and Madhar. The villagers saying that there is lack of trees here. The major crops of this village are potato, maize, wheat, and sugarcane. People are interested in agriculture and they are very cooperative.

Groundwater situation

Canal water is scarce and there are 35 tube wells. The groundwater is is used conjunctively, and waste water is not used. The groundwater is also bad for drinking; they use water from the pumps alongside the water channel or canals. The tube well rent is around 400 PKR per hour. They have been using tube wells for about 50 years, and over that the period, water has gone 100 feet down. According to the women the low level of is due to over extracting water. The women were worried about groundwater quality creating problems for village.

Overall, from a groundwater perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Socioeconomic situation

The Average land holding size here is 5-7 acres. The villagers average only 5 years of years of schooling, although young women average 12 years of schooling. Young women takes part in in agriculture activities but there is little left to ft to do because of water shortage and low groundwater quality. the women are using domestic water pumps and hand pumps for various household purpose, including for livestock. People are willing to participate in any agriculture development program but not experiments due to financial conditions.

Overall, from a socio economic perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Logistics

This village is easily accessible and working here is very safe and very friendly. But young people prefer other jobs to agriculture.

Overall, from a logistics perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

30/11-LTehsil Chichawatni, District Sahiwal.

PRA #14 was conducted on September 27, 2017 at 30/11-LTehsil Chichawatni, District Sahiwal, at the tail command area of 11-L distributary, with 15 men participating in the discussion. The population of this village is 4000, 70 % of families are poor, and 75 % families have no land for agriculture. The people of this village average eight years of schooling. This village is 10 KM away from the main road and 20 KM away from main grain market. The hand pump water quality is marginal and brackish. There are 1500 acres of fertile land, and most farmers have small landholdings. Land rent which charge to the other tenant farmers is 26000.

The groundwater quality is marginal, bore depth for installation of tube well is 200 ft. and groundwater table at 20 ft. There are 14 tube wells , operated by tractor or electricity. There are two canal outlets and the major crops are maize, wheat and rice. Most farmers use water conjunctively, with the share of groundwater to irrigate the crops 60 %. Groundwater cost to irrigate one acre for one cropping period is PKR 6000. Farmers of this village were not using high efficiency irrigation system. Women of this village also take part in agricultural activities , but young people prefer to get more education. PIDA and FOs do not play their role actively. Farmers are totally disappointed of that area.

Figure 22 30/11-LTehsil Chichawatni, District Sahiwal

The discussion with women undertaken at this site, led by female researchers, provided the confirmatory or additional information below.

General description of area/site

The village 30/11-L of tehsil Chichawatni, District Sahiwal, situated at about 40 km from the city Sahiwal, a broken, narrow, charcoal road is the only way from the main road to village which is 10km long. The village area is about 1500 acres. The people are farming in traditional way, and the women are active in agriculture activities. The average education for male and female is 5 years schooling. There are different types of people live in this village and are divided into parties and sects and also religiously, including Sunni-Shia and Sunni-Qadiyani. The poverty ratio of this village is 70%, as the women say conflicts are not letting the village grow. There is a pond in this village for the use of waste water.

Groundwater situation

There are 50-70 tube wells in this village. The groundwater of this village is of mixed quality, somewhere very good, and somewhere marginal. People use 60% canal water for their crops. Women are also involved in irrigation. The water table is 60 feet and average domestic bore depth is 90 feet, while average tube well bore depth is 170 feet. After testing, the drinking water is also good for health, people of this village are healthy and active in their activities related to their agriculture system and others.

Overall, from a groundwater perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Socioeconomic situation

The people of this village are poorly educated and poverty is high because the majority of the people belonging to poor families and village is a long way from city, therefore, people do avoid sending their children this far.

Overall, from a socio-economic perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

Logistics

This site is not easily accessible as it is situated 10 km from the main road, but the road us full of pits and broken and it takes one hour or more to reach the village from the main city. Working here is not safe as because of conflicts, and people are not willing to experiment, but are willing to adopt the innovation at promising outcomes.

Overall, from a logistics perspective, this site is (circle one)				
(0) Unsuitable	(1) Not very suitable	(2) Has both suitable and unsuitable features	(3) Suitable	(4) Very suitable

4.5.2 Main themes

A major feature apparent from these PRAs is the diversity across the sites. Access to groundwater varies depending on position in the distributary, and the use of groundwater also varies widely. Some villages are prosperous, others are clearly impoverished and struggling. In some areas agriculture is thriving, and young people are interested in working the land, and improving outcomes. In other villages agriculture is declining, and young men are moving away for work, sometimes internationally. The usefulness of the Farmer Organizations is also highly variable across the potential sites.

A clear theme common to all villages is the potential for improved water use.

4.6 Punjab Case study site selection

Table 13: Case study site selection Punjab

PUNJAB – 1	Unsuitable		Not very suitable		Has both suitable & unsuitable features	Suitable		Very suitable
For each criterion, please indicate each site's suitability using the following legend:	(0)		(1)		(2)	(3)		(4)
Minor/ Distributary No.	**11-L**		**2-R**		**9-L**			
Case Study Site	**7/11-L (Site 5) Head**	**30/11-L (Site 14) Tail**	**32/2-R (Site 11) Tail**	**25/2-R (Site 3) Middle**	**130/2L-9L (Site 6) Middle**	**97/9-L (Site 8) Head**	**124/9-L (Site 13) Tail**	**103/9-L* (Site 12) Head**
Groundwater situation								
ESSENTIAL: Availability of groundwater data (e.g. what is known, what is available?)								
KEY: The groundwater situation – e.g. how much stress or exploitation? Are the resources vulnerable or degraded? Is there salinity or waterlogging?								
DESIRED: Features of this site that will make it useful for exploring multiple key issues associated with groundwater management								
What sort of tools or interventions are likely to be accepted/ successful? Could these be easily replicated elsewhere?								
The hydrological system (e.g., is it a closed system?)								
Sources of water for irrigation and their use								

Table 13: Continued

Minor/ Distributary No.	11-L		2-R		9-L			
Case Study Site	**7/11-L (Site 5) Head**	**30/11-L (Site 14) Tail**	**32/2-R (Site 11) Tail**	**25/2-R (Site 3) Middle**	**130/2L-9L (Site 6) Middle**	**97/9-L (Site 8) Head**	**124/9-L (Site 13) Tail**	**103/9-L* (Site 12) Head**
Socio-economic situation								
KEY: The social, cultural, and economic situation – e.g. Are there farming families, communities and partners who can facilitate change? Is it a place where we can work towards achieving behavioural change, with the presence of a well-organised community willing to participate with us?								
Prevalence of poverty where potential for livelihood impacts are measureable and achievable, and where capacity of stakeholders is low with high prospects for enhancing their capacity								
Potential for high value crops of high economic return/ viability of economic options, and proximity to input (finance) and output market								
Availability of data related to social and economic aspects, or good prospects to acquire/ create such data								
The extent lessons from this village could be applicable in other places								
Features of this site that will make it useful for exploring multiple groundwater-related issues for improving livelihoods								
Logistics								
ESSENTIAL: Accessibility, safety and security								
DESIRED: Features that make this site feasible or not as a place where tools can be tested								
Potential to connect with/ build on the irrigation efficiency improvement Farmer Field Schools established by the ACIAR project LWR/2014/074								
Features that make this site feasible or not to finalise case study activities within the life of the project								

Table 13: Continued

PUNJAB – 2	Unsuitable	Not very suitable	Has both suitable & unsuitable features	Suitable	Very suitable
For each criterion, please indicate each site's suitability using the following legend:	(0)	(1)	(2)	(3)	(4)

Minor/ Distributary No.	**1-R**		**1-L**	**12-L**	**5-L**	**6-R**
Case Study Site	**8/1-R (Site 2) Middle**	**17/1-R (Site 10) Tail**	**16/1-L (Site 1) Tail**	**33/12-L (Site 9) Tail**	**73-A/5-L (Site 7) Tail**	**96/6-R (Site 4) Head**
Groundwater situation						
ESSENTIAL: Availability of groundwater data (e.g. what is known, what is available?)						
KEY: The groundwater situation – e.g. how much stress or exploitation? Are the resources vulnerable or degraded? Is there salinity or waterlogging?						
DESIRED: Features of this site that will make it useful for exploring multiple key issues associated with groundwater management						
What sort of tools or interventions are likely to be accepted/ successful? Could these be easily replicated elsewhere?						
The hydrological system (e.g., is it a closed system?)						
Sources of water for irrigation and their use						

Table 13: Continued

Socio-economic situation						
KEY: The social, cultural, and economic situation – e.g. Are there farming families, communities and partners who can facilitate change? Is it a place where we can work towards achieving behavioural change, with the presence of a well-organised community willing to participate with us?						
Prevalence of poverty where potential for livelihood impacts are measurable and achievable, and where capacity of stakeholders is low with high prospects for enhancing their capacity						
Potential for high value crops of high economic return/ viability of economic options, and proximity to input (finance) and output market						
Availability of data related to social and economic aspects, or good prospects to acquire/ create such data						
The extent lessons from this village could be applicable in other places						
Features of this site that will make it useful for exploring multiple groundwater-related issues for improving livelihoods						
Logistics						
ESSENTIAL: Accessibility, safety and security						
DESIRED: Features that make this site feasible or not as a place where tools can be tested						
Potential to connect with/ build on the irrigation efficiency improvement Farmer Field Schools established by the ACIAR project LWR/2014/074						
Features that make this site feasible or not to finalise case study activities within the life of the project						

Notes 31 Jan 2018: Rationale for deciding to select 1R over 2R.

According to my conversation with Prof Ashfaq today, PID expressed concerns about the selection for 2R for 3 reasons: (1) the distributary is too short; (2) there are no major significant groundwater issues; and (3) the distributary has recently been lined, which means there is unlikely to be much difference across the distributary. 1R, on the other hand is longer, with much greater likelihood of diversity from head to tail along the distributary – the distributary was lined a long time ago

The counter concerns about 1R have since been raised by Khalid Mian Kisan Board Okara, who rang today to speak with Prof Ashfaq. The concerns raised were: (1) the farmer organisations in 1R are not very active; and are weak [from preferred Village 17 PRA "People are organized but they are crying that PIDA and the FOs are not performing well" but in Village 8 not preferred "the people are satisfied by the FO role"]; (2) the contribution of GW to irrigation is low [from less preferred village "The groundwater usage is 40% of total irrigation, which also is not a good indicator for the selection of the site for the further experiment of the project"; (3) the dependence on agriculture is low [from less preferred Village 8 "The site is not recommended because people are losing interest in agriculture"; and (4) the farmers are currently growing crops that use a lot of water, with little focus on changing cropping patterns [in Village 8: "Major crops of the village are cotton, sugarcane (as fodder), wheat, and canola" and in Village 17: "Major crops of the village are comprising wheat, rice, and sugarcane"].

Re concern 1 (weak FO), this may actually make it a useful site. One of the criteria for the project overall is to select a site that is different to others in terms of outside support. Results from the PRA analysis suggest that in preferred Village 17 the people are organised and are crying out for support. This may actually make it a good reason for selection. Also, re less preferred Village 8, the PRA analysis notes that "people are not willing to have experiments, but are willing to adopt the innovation at promising outcomes" so if Village 17 is willing to try new things, and all goes well, then maybe Village 8 (as well as other villages along 1R) will be keen to adopt! Our intervention might even help revitalise FO activity in the area.

However, re concern 2 (contribution of GW is low), according to the PRA results, this is not actually correct, with half GW share or more – as in village 17 "The share of groundwater in agriculture is also very much"; the number of tuebwells at tail is 180 (preferred 1R village 17) and at middle is 30 (less preferred village 8) – also 40% share is not insignificant

And re concern 3 (low dependence on ag), re preferred village 17: "They are contented and totally dependent on their income from agriculture, and youth have a great interest in farming"

5 Sindh report

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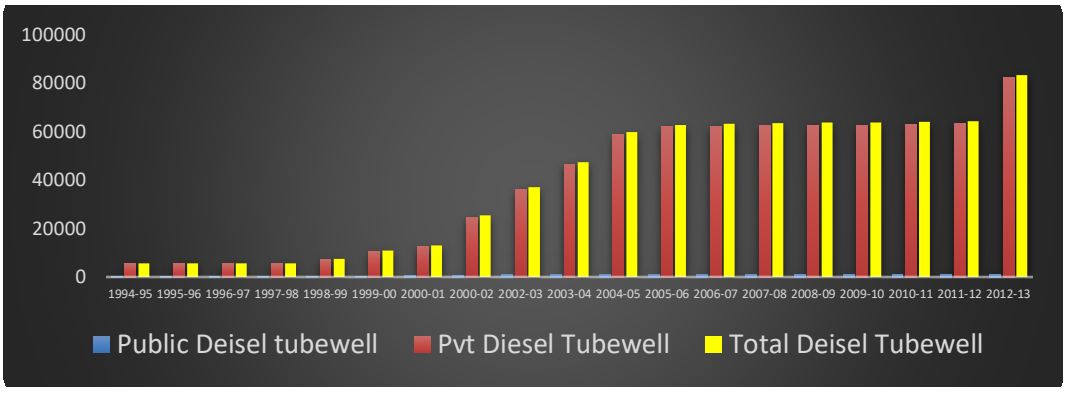
Local SDOs (Sindh Irrigation Department)

5.2 Introduction

In Sindh province of Pakistan reduction in canal water supply leads to increase in demand of freshwater and competition among municipal, industrial and agriculture sector. This intensifies water crises in the province. In Sindh due to high pressure on food supply side and inability of canal irrigation systems to fulfill irrigation requirements, majority of farmers depend on groundwater as sole or additional source of irrigation and tube well irrigation become an important characteristic of agriculture economy of Sindh (Gaur, et al. 2008; Qureshi et al. 2003).



(Source: Agricultural Statistics of Pakistan, 2012-13)

Figure 23 Number of diesel tube wells installed in Sindh

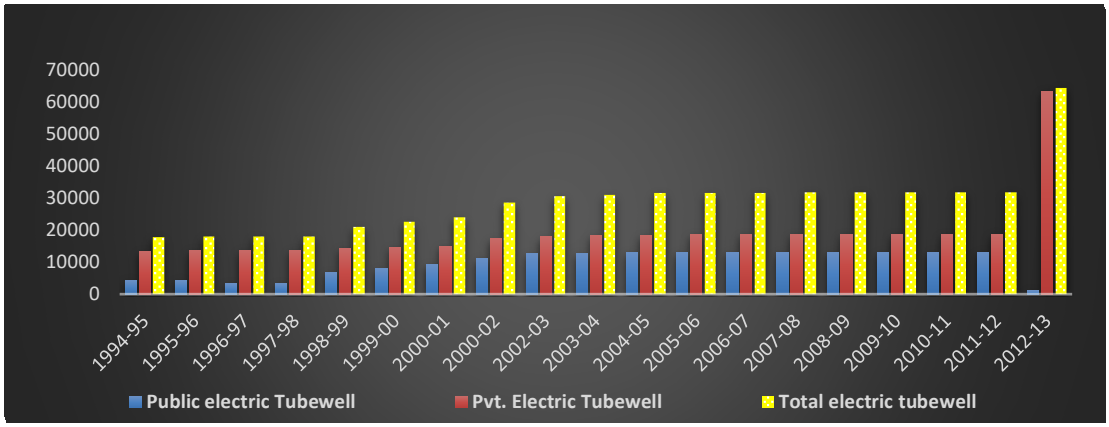


Figure 24 Number of electric (public and Private) tube-wells installed in Sindh (Source: Agricultural Statistics of Pakistan, 2012-13)

The complexity and size of the challenge of fresh water scarcity, underground water degradation and over extraction requires an integrated approach towards sustainable management of groundwater to enhance productivity and thereby farmers livelihoods. Integrated management also requires more participatory governance arrangements to enable groundwater users and other relevant stakeholder communities to more effectively engage in the knowledge gathering and decision-making processes determining sustainable and fair use of groundwater (Mitchell, Curtis, Sharp, & Mendham, 2012).

The aim of this project is to build the capacity of researchers, farmers, farming communities and relevant government and non-government agencies to improve groundwater management in ways that enhance farming family livelihoods in Pakistan. Building capacity means building skills, knowledge and confidence, and the provision of tools and processes. Enhancing farming livelihoods includes ensuring long-term sustainability of agriculture and fairness of consideration across the political spectrum

This PRA was undertaken to gain information to identify the research sites for the project.

5.3 Description of project area

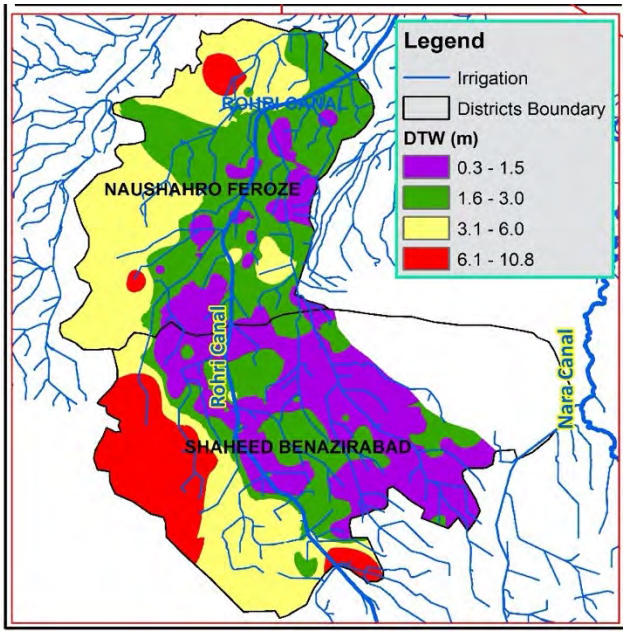


Figure 25 Map of Sindh Study Area

Project site selection began with considering those minors that were suggested in the workshop at Mehran University of Engineering and Technology (MUET). In that workshop 5 minors in Naushahro Feroze and 4 minors in Nawabshah (Shaheed Benazirabad) were proposed based, on the following general criteria:

Groundwater and Surface water uses in selected area

- Surface water availability and allowances
- Water requirement of crops
- Cropping pattern
- Groundwater level and quality
- Soil salinity
- Easy access and approach Road
- Prior knowledge/work/data availability

Table 14 Summary of PRAs, Sindh

Sr #	Name of site/minor	District	Selection Criteria	Features
1	Gul Minor	Naushero Feroz	Conjunctive use of surface and groundwater, usable groundwater	DTW = 3-6 meter GWQ= Useable (0-1500 ppm)
2	Nather Detha	Naushero Feroz	Conjunctive use, having shallow with marginal quality of groundwater	DTW = 1.5-3.0 meter GWQ= 0-1500 ppm & 1500-3000 ppm
3	Chiho Minor (preferred)	Naushero Feroz	Utilizing lot of groundwater in conjunction with surface water with usable quality of groundwater, MDF-NGO has done already some work in this area, easy data availability	DTW = 1.5-3.0 meter GWQ= 0-1500 ppm Wheat, sugarcane, cotton, maize. The farmers of Chiho village in coordination with SID are managing Chiho minor.
4	Tetri Minor (optional)	Naushero Feroz	Utilizing lot of groundwater in conjunction with surface water with marginal quality of	DTW = 3.0-6.0 meter GWQ= 1500-3000 ppm

			groundwater, MDF-NGO has done already some work in this area, data availability	Wheat, sugarcane, cotton, maize. The farmers in coordination with SID are managing Tetri minor.
5	Chanari (optional)	Naushero Feroz	Utilizing lot of groundwater in conjunction with surface water with marginal quality of groundwater, MDF-NGO has done already some work in this area, data availability	DTW = 1.5-3.0 meter GWQ= 1500-3000 ppm Wheat, sugarcane, cotton, maize. The farmers in coordination with SID are managing Chanari minor.
6	Sarkand	Nawabshah	Useable quality of groundwater with easy access from National Highway. MUET is going to start some research work in this area by Master's student	DTW = 3-6 Meter GWQ = 0-1500 ppm Design discharge 63 Cusecs Off-taking from Rain Distry (RD40). GCA=3,261 Acres CCA=11,612
7	Village = Allah Bux Purely on solar based groundwate r pumping	Nawabshah	Area with Useable groundwater quality, purely on groundwater using solar pumping, along the Rohri Canal, not having sufficient surface water availability due to tail-end	Already visited during previous field visit to Nawabshah. Farmers are growing sugarcane, wheat, etc Lift irrigation system
8	Malwa Minor or any other minor from Malwa Distry covering tail-end	Nawabshah	Deep water table with marginal groundwater quality	DTW = 6-10.8 Meter GWQ = Marginal (1500-3000 ppm)
9	Manhoro Minor	Nawabshah	Left side of Rohri Canal Mainly waterlogged area with useable quality of groundwater	DTW = 0-3.0 Meter GWQ = Useable (0-1500 ppm) It is at the border of Nausheroferoz and Nawabshah (Benazirabad)

5.4 PRA method

Various tools of PRA were used to get the required information such as, (1) Diagramming (transect walk), (2) interviewing (group interviews, key informant interviews, focus group discussions) (3) mapping (including social maps, consists of household information such as population density, social classes, land use etc.) and (4) resource maps (that shows resources of the area like soil, water, minerals etc.). During the PRAs the research team took efforts to ensure participation of male, female, youth and small, medium and large farmers to seek information in detail from communities.

After a few sites were visited it was identified that availability and quality of water and other situations were different head, middle and tail villages. It was therefor decided to conduct separate PRAs at the potential case study sites listed above. At each site PRAs were conducted at head, middle and tail to get more in-depth knowledge. For PRAs a list of indicators/ determinants was

made, relating to the project needs such as general description of sites, underground water and its quality, crops and technologies and drinking water.

In Nawabshah PRAs were conducted on the distributaries/sites: Malwa, Sakrand, Manahro and Daleel Minors. At head, middle and tail PRAs were conducted in following villages.

NOTE: As Noor Bhoora was a big village therefore it is covering both head and middle.

Table 15 Summary of PRAs

Distributary	**Head**	**Middle**	**Tail**
Manahro	Ali Muhammad Bindhar	Sultan Lashari	Sher Purian
Sakrand	Noor Bhoora	Noor Bhoora	Muhammad Bachal Deho
Malwa		Wahid Dino Lakho	Deran
Daleel			Allah Bux Magsi

5.5 Results

5.5.1 General description of sites on head

Shaheed Benazirabad division comprise of Benazirabad, Naushahro Feroz and Sanghar district. District Shaheed Benazirabad is in the centre of the Sindh Province surrounding by the Indus on West, by District Sanghar and District Khairpur on East, by District Hyderabad on South and by District Naushahro Feroze on North. It covers an area of 4239 square kilometres with a population of 593200 in Taluka Nawabshah, 282507 in Taluka Sakrand and 259424 in Taluka Kazi Ahmed. There are 51 Union councils having a population from 20000 to 30000 305 Dehs and 327 large villages. District Shaheed Benazirabad is connected with the rest of province and country by airport, main railway and roads. It has a one Peoples Medical College (for girls) Hospital and one Engineering University. The main crops of this District are sugarcane, wheat, cotton, and there are three sugar mills.

The PRA information of two sites selected at head of Sakrand and Manharo distributaries of Benazirabad reveals the number of households is higher at these sites and they also share significant length of distributary with shorter distance from city and minor.

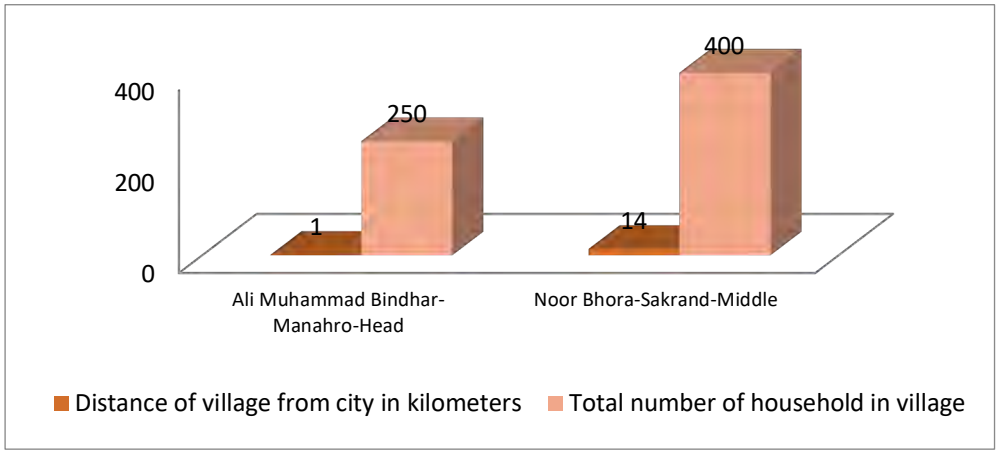


Figure 26 General description of sites on head, Shaheed Benazirabad

There are a significant number of small farmers at these sites with 230 at Manharo and 40 at Sakrand. While the number of medium and larger farmers were same at Manharo head site village Ali Muhammad Bindhar. At Sakrand site Noor Bhoora village, the number of medium farmers was slightly higher than larger farmers.

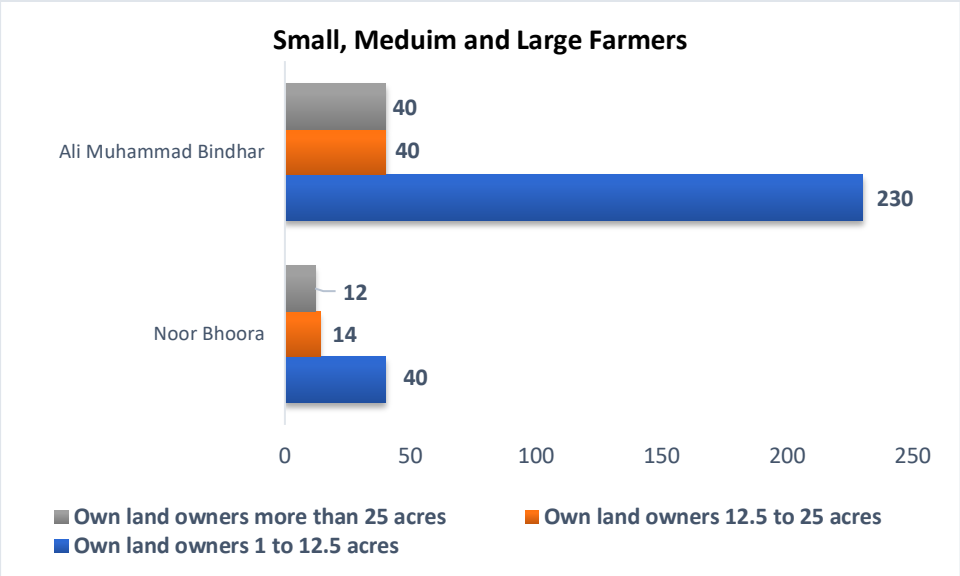


Figure 27 Farm Size Shaheed Benazirabad

Both canal and groundwater are sources of irrigation in head sites canal, but while there is some tube well use the farmers mainly rely on canal water for irrigation (Figure 31).

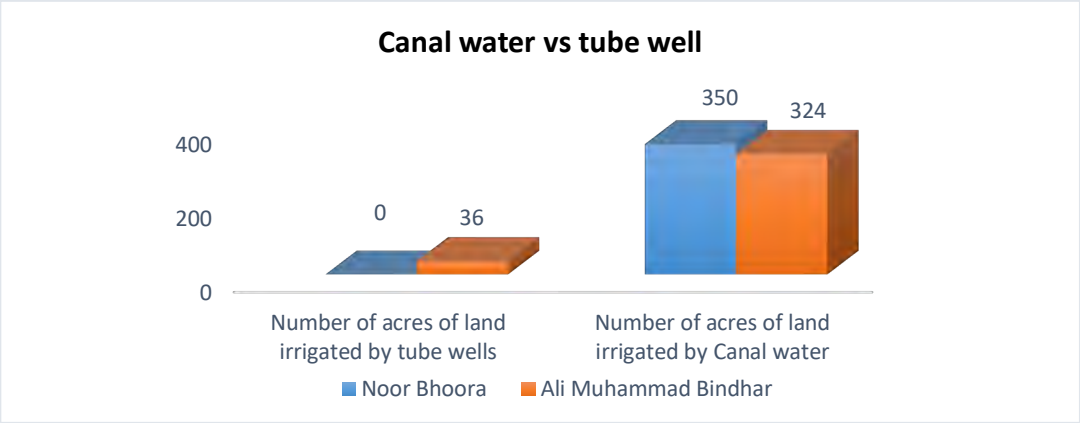


Figure 28: Source of water Shaheed Benazirabad

The number of fallow land acres was also reported higher at the head sites.

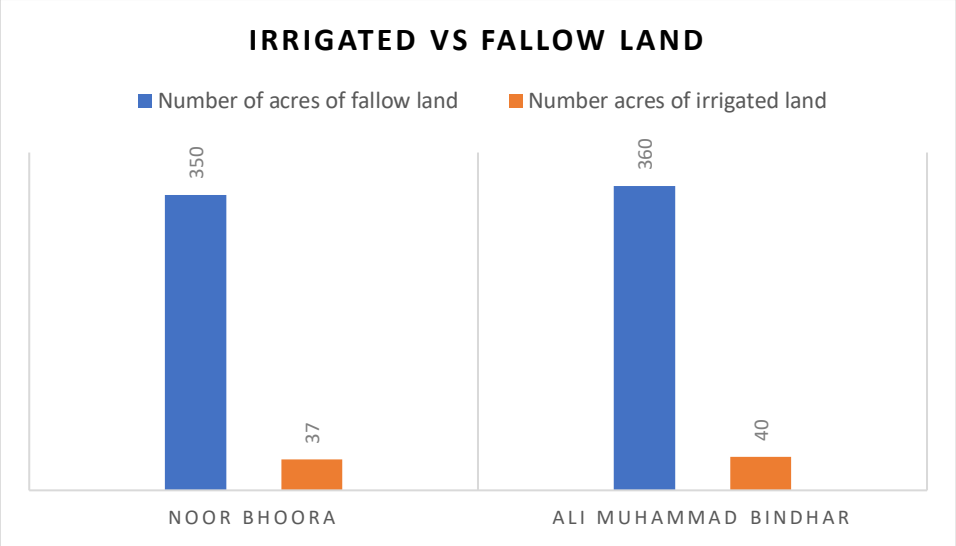


Figure 29 Irrigated vs Fallow land, Shaheed Benazirabad

Currently no tube wells were reported at the head of Manharo and Sakrand distributary sites; though at Sakrand minor village Noor Bhoora 3 tube wells were working in last ten years and the depth for tube well bore was shared as being about 100 feet.

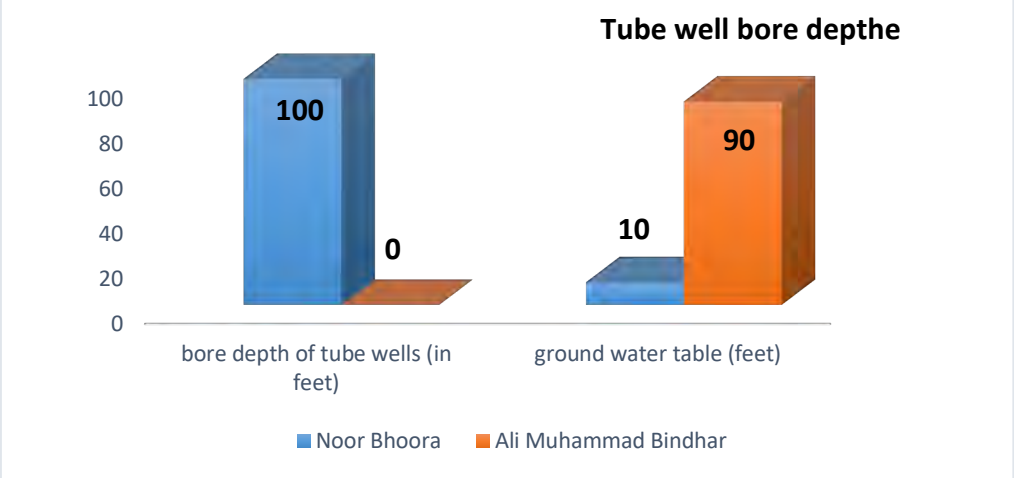


Figure 30 Tube well bore depth, Shaheed Benazirabad

Sugarcane, banana, wheat, cotton, are the major crops of the sites at head. On average over the last five years the annual yield of crop has been increased in these villages. The major reason reported for this was use of machinery, better fertilizers and quality of water. The average time required to irrigate one acre from canal water was reported 30 to 45 minutes at these sites and flood irrigation was mentioned as the common method of irrigation. The use of laser levelling was reported at Sakrand distributary head site village Noor Bhoora.

The annual per acre rent at these sites was reported thirty-two thousand to thirty-five thousand and per acre Abiana (water fees) was reported 400 at Noor Bhoora site of Sakrand distributary.

Ground water is the major source of drinking at the sites on the head of the distributaries. At Sakrand distributary head site it was reported that the quality of ground water for drinking is not good, however it was reported as is good at Manharo distributary head site. At Sakrand distributary there are 200 hand pumps, and at Manahro 150 hand pumps.

Soil quality was reported as good at both sites. There is no ground water and cultivation water treatment in these villages.

The overall law and order situation was found good in the villages at head sites. Relations within communities and with surrounding communities were observed well during PRA.

5.5.2 General Description of Sites on Middle

The PRA sites on middle of the distributaries share significant length of distributaries except Wahid Dino Lakho site at Malwa. These sites are at shorter distance from minors but the distance from city is higher from 1.5 km to 14 km.

We found the highest number of small farmers at middle sites of the distributaries followed by medium farmers. On average all these sites have farmers holding land from one acre to more than 25 in significant number (Figure 36).

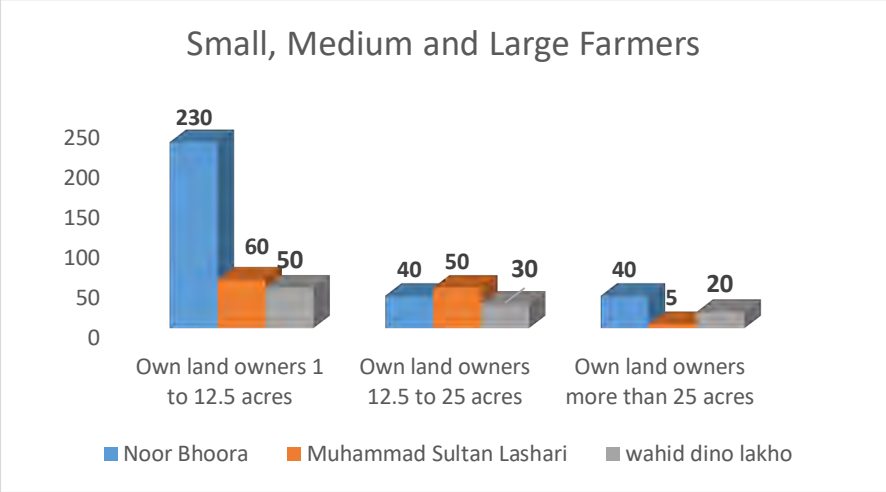


Figure 31 Farm size

There are 500 acres of irrigated land and 80 acres of fallow land on the site of Manharo.

Table 16 Summary of irrigated vs fallow land

	Irrigated land	Fallow land
Manharo	500 acres	80 acres
Noor Bhoora	360 acres	40 acres
Wahid Dino Lakho	70%	30%
Sultan Lashari	1500 acres	80 acres

Middle sites had water available from both canal and tube wells, with canal water the major source of irrigation at these sites. Wahid Dino Lakho site of Malwa also reported both source of irrigation (Figure)

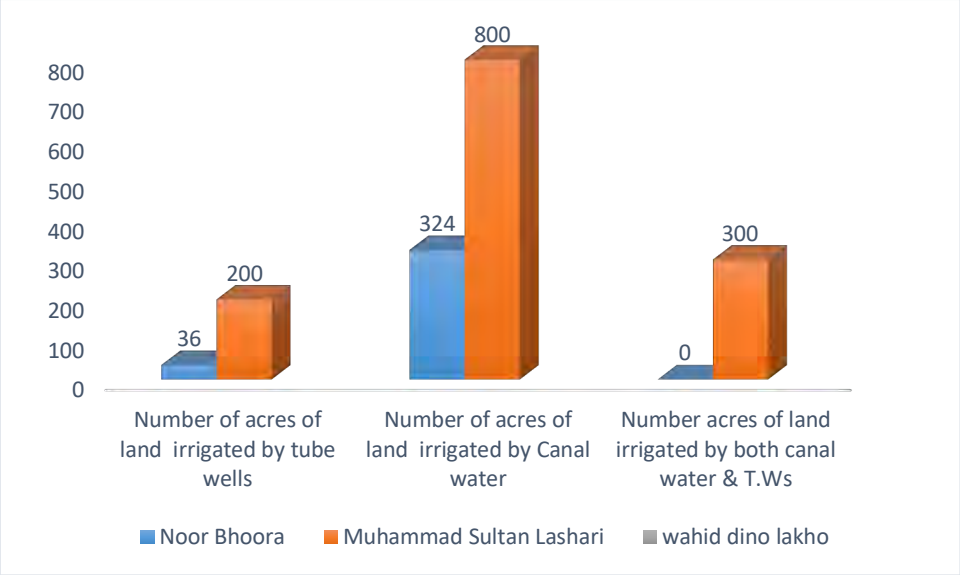


Figure 32 Sources of water

At the middle site of Sakrand distributary 6 private tube wells were reported all operated by diesel. While at Manharo site 4 private tube wells were reported working on diesel. The highest number of tube wells is indicated at Malwa Site Wahid Dino Lakho. At Malwa middle site 100 tube wells were reported including 90 private and 10 government. Out of these 90 tube wells were operated on diesel, 3 on solar and 7 on electricity (Figure).

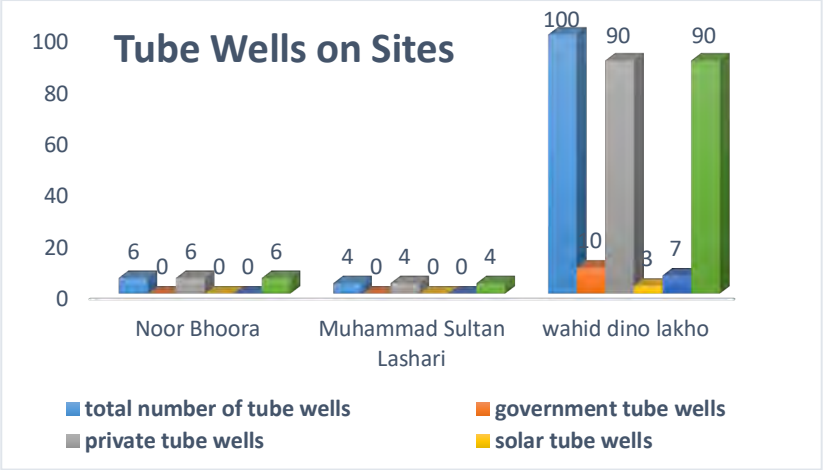


Figure 33 Number of tube-wells

The groundwater table was reported 120 feet at Sakrand distributary site and 6 feet at Manharo site. The depth for tube well bore is from 90 feet to 120 feet at the middle sites.

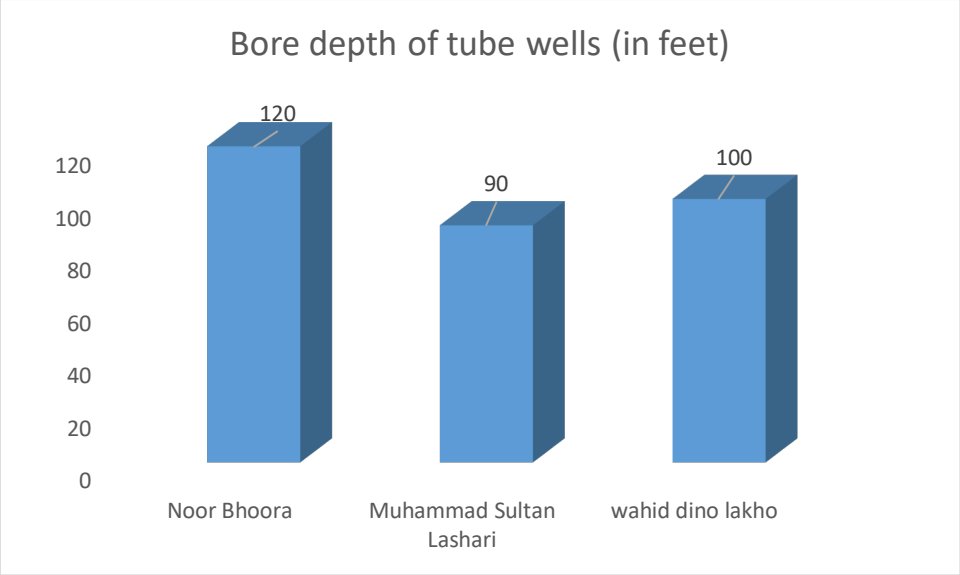


Figure 34 Bore depth of tube-wells

Participants in Sakrand and Malwa distributaries reported a change in water quality from sweet to saline after the 2003 earth quake.

Sugarcane, banana wheat, rice and cotton are the major crops of the sites at middle. It was reported in last five years the annual yield of crop has been decreased at these villages and the major reason given was shortage of water fertilizers and pesticides. There was some increase at the Malwa middle site reported, due to hard work and use of technology. The use for laser leveling was also reported at these sites, except Manharo site due to unavailability. The number of laser levelled sites at Noor Bhoora was 30 while it was 5 at Malwa. Furrow and flood are the common methods of irrigation at these sites. The annual land rent per acre was reported 25000 to 45000 at these sites.

The source of drinking water at the sites on middle of distributaries was ground water. Water quality was good except at Malwa & Sakrand distributary site where it was reported as salty. Salinity was reported as soil issue at Malwa distributary while it is not common at other two sites. PRA data indicates the number of hand pumps (around 380) in middle sites is adequate for the population, except at Malwa which has less than half of what the population requires.

There is no groundwater and cultivation water treatment in these villages except at Malwa. While the average time required to irrigate one acre with canal water 30 to 60 minutes and 120 to 240 minutes with tube well water.

The overall law and order situation is good at these sites. Communities have good relation within and with other surrounding communities.

4.5.3 General description of sites on Tail

The sites at the tail hold significant length of distributary. The distance between nearer city and distributary ranges from 4 km to 15km and distance from minor to village from 0.5 km to 2 km.

The bigger number of small farmers was found at tail site of Sakrand distributary Muhammad Bachal Deho followed by medium farmer at same site while there was no any large farmer. Overall information depicts the number of large farmer is less at tail site. The share of small farmers is higher at tail site followed by medium size farmers holding 12.5 to 25 acres of land.

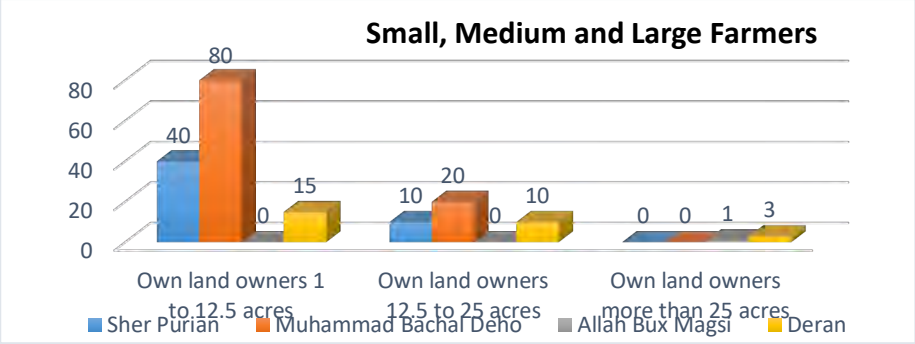


Figure 35 Small medium and large farmers

Both sources of irrigation are used on tail sites canal as well as tube wells but Deran site of Malwa mainly rely on tube wells and Sakrand distributary tail site mainly relies on canal water for irrigation. Daleel (Allah Bux Magsi site) and Manharo (Sher Purian site) distributaries tail site use both sources.

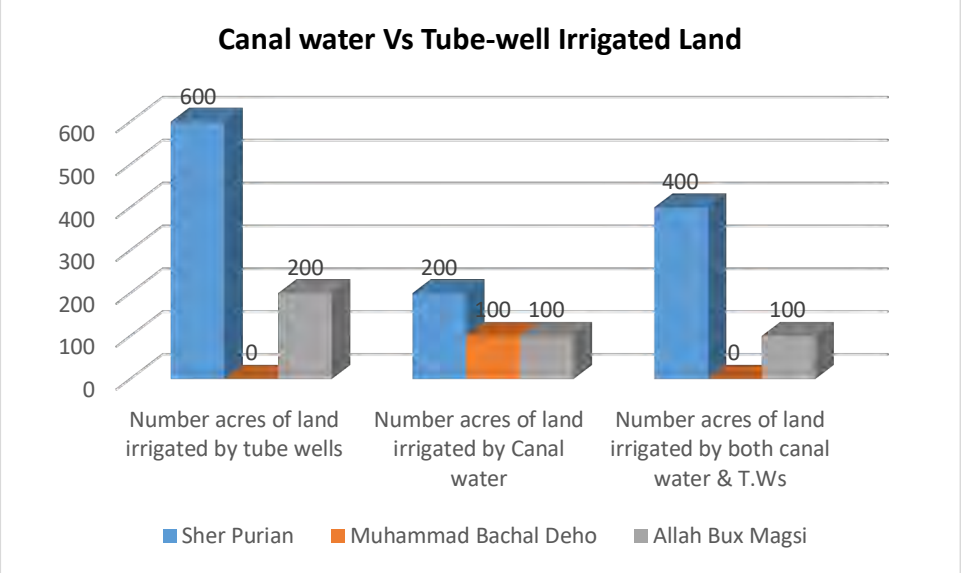


Figure 36 Canal water vs Tube-well irrigated land

100 acres irrigated and 400 fallow land was reported on the site of Sakrand distributary and 800 irrigated and 1200 fallow land on Manharo distributary site. While 300 irrigated and 20 acres are fallow land as reported at Daleel distributary site.

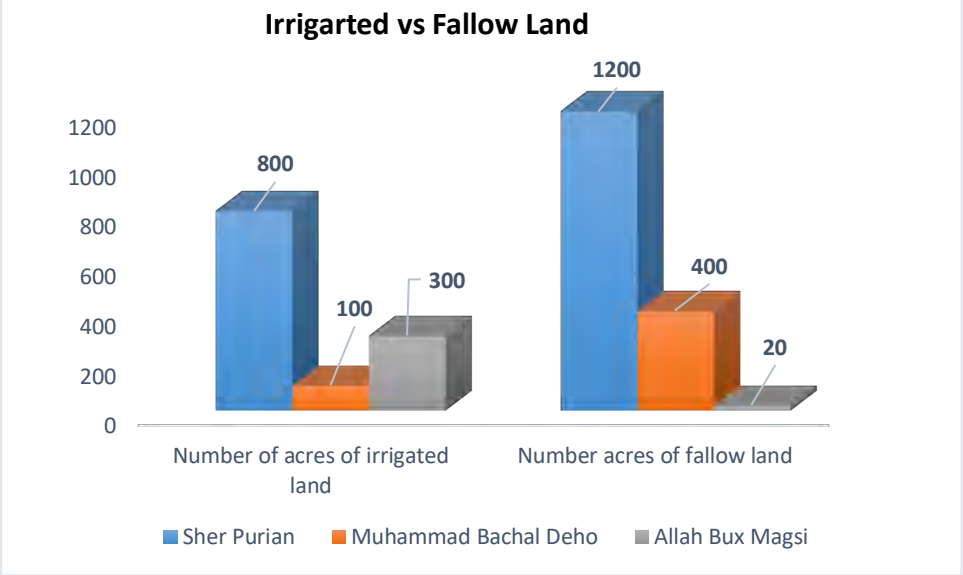


Figure 37 Irrigated vs fallow land

The number of tube wells is highest at Deran site of Malwa distributary, with 60 private with 40 running on diesel and 20 electrics followed by Sher Purian site of Manharo distributary 20 private tube well working on diesel. No tube well use was reported at tail site of Sakrand distributary. Similarly, at Allah Bux Magsi site of Daleel 4 tube wells were reported 2 government and 2 private. Two of them were working on diesel and two were on electricity.

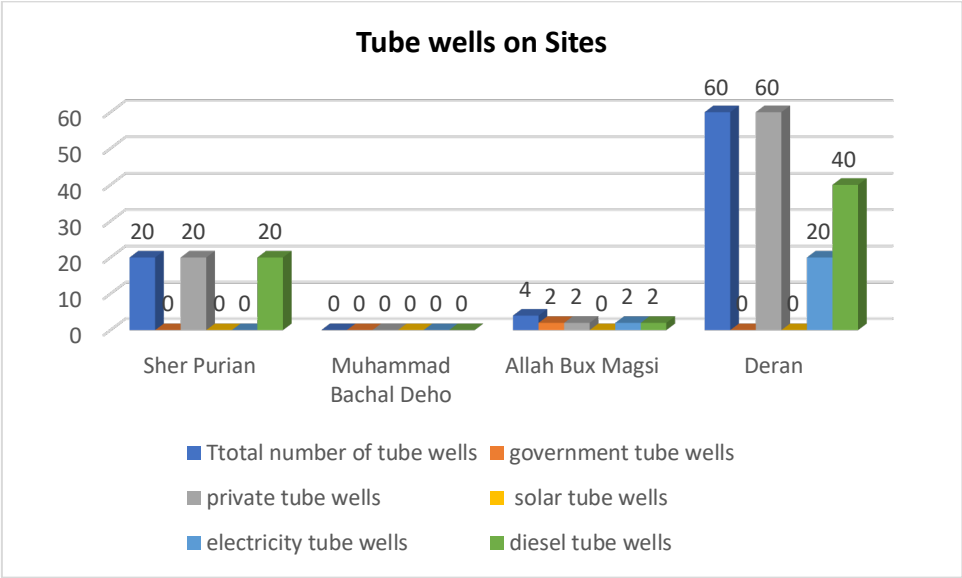


Figure 38 Tube-well numbers

The depth for tube well bore is between 100 feet to 250 feet while the ground water table start from 15 feet to 25 feet.

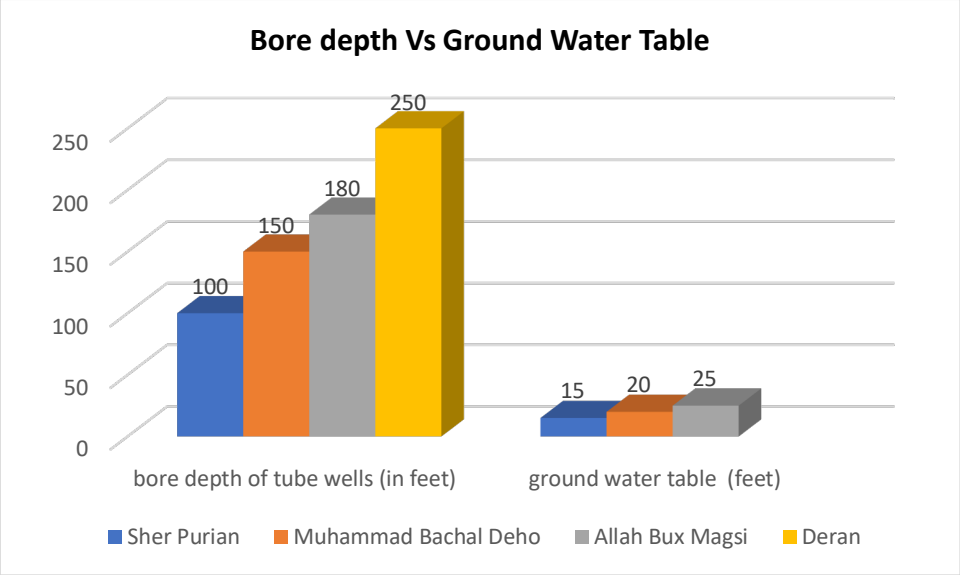


Figure 39 Bore depth and water tables

Sugarcane, banana, wheat, cotton are common crops at the tail sites. It appears that, excluding Daleel distributary site Allah bux Magsi, the tail three sites have seen the annual yield of crop has decreased over the last five years the. Water shortage was reported as the cause, while it was reported that yield increased at Allah bux Magsi due to better use of seeds, fertilizers and machinery. Laser levelling was not common except at Manharo where 50 household use it and one household at Allah Bux Magsi site use it. All the sites use flood method for irrigation except Allah bux Magsi where both flood and furrow methods of irrigation. The average time required to irrigate one acre with canal water was reported from 60 minutes to 150, while with tube wells 100 minutes to 240 minutes.

The average rent of one acre per year was shared 15000 to 35000 at the sites on tail.

Sites on tail avail groundwater is used for drinking purpose and its quality is different at all sites. At Sakrand and Manharo distributary sites it was reported salty while it was better at Daleel and Malwa Site. However, the water quality testing is not done at any site.

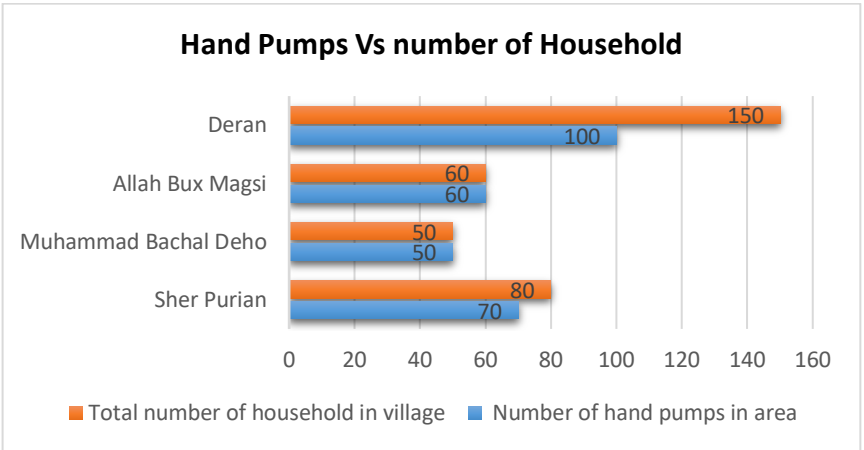


Figure 40 Hand pumps

Twenty percent of soil at The Malwa tail site experience salinity while at the other two sites the soil quality is better.

The overall law and order situation on tail sites was reported good. Communities have good relation within and with other communities in surrounding villages.

5.6 Case study Site Selection

Based on information collected in PRA Malwa and Manahro are proposed as research sites based on following:

1. More fallow land due to unavailability of water and degradation of soils due to poor quality irrigation water
2. Large number of small farmers including large and medium farming community
3. Use of both Tube well and canal water
4. More positive and collaborative communities as compared to Sakrand and Daleel minor (village Allah Bux Magsi)

Table 17 Case study site selection, Sindh

SINDH – 4 sites preferred						Unsuitable	Not very suitable	Has both suitable & unsuitable features	Suitable	Very suitable
For each criterion, please indicate each site's suitability using the following legend: Note: the completion of the matrix for Sindh is still a work in progress						(0)	(1)	(2)	(3)	(4)
	Naushero Feroz					**Nawabshah**				
Case Study Site	**Gul Minor**	**Nather Detha**	**Chiho Minor**	**Tetri Minor**	**Chanari**	**Sarkand**	**Daleel Allah Bux**	**Malwa**	**Manhoro Minor**	
PRAs conducted – head (H); middle(M); tail (T) Green colour indicates sites that were determined as preferred. Details below have been taken from the presentation by the Sindh co-inquiry team to the Nov 6-7 meeting	H: Allah Bux Tanwri	M: Md Faize T: Golo Potho	H: Bahram Mari M: Cheeho T: Md Ibrahim Brohi	H: Haji Jawayo Sial M:Md Ibrahim Khoso T: Ahmed Khan Lashari	H: Haji Laiq Khaskheli M: Jalal Lashari T: Maserji Wai	H&M: Noor Bhoora T: Md Bachal Deho	T: Allah Bux Magsi (solar)	M: Wahid Dino Lakho T: Deran	H: Ali Md Bindhar M: Sultan Lashari T: Sher Purian	
Groundwater situation										
ESSENTIAL: Availability of groundwater data (e.g. what is known, what is available?	Limited									
KEY: The groundwater situation – e.g. how much stress or exploitation? Are the resources vulnerable or degraded? Is there salinity or water logging?	Soils are degraded	Water logging, soil salinity at tail	Over exploit-ation of GW at tail; less water more TWs	Some areas face shortage of water, some water logging	Shortage of water at tail	GW sources are highly vulnerable and degraded		Exploit-ation of GW, high TW use, water soils are degraded	Water logging due to excess water	
DESIRED: Features of this site that will make it useful for exploring multiple key issues associated with groundwater management	Both shortage of water and salinity in some areas	Don't know because issues are at tail only	Only tail has issues due to water shortage	Tail & middle have issues due to water logging	Sufficient GW; only tail areas have issues due to water shortage	Below 50 feet water is poisoned & not useable for drinking		Acute shortage of water, highly affected soils, fallow land, good community	Sufficient GW	

Table 17: Continued

What sort of tools or interventions are likely to be accepted/ successful? Could these be easily replicated elsewhere?	Capacity building	Don't know	Capacity building for increasing yields	Don't know	Don't know	Capacity building for better use of GW & fallow land		Tools to measure quality and quantity of water	Don't know
The hydrological system (e.g., is it a closed system?)	Open Irrigation system (furrow & flood irrigation)								
Sources of water for irrigation and their use	Both	Canal	Both	Mostly canal	Canal at head and middle; tail has significant no. of TWs	Both		Mostly TWs	Canal
Socio-economic situation									
KEY: The social, cultural, and economic situation – e.g. Are there farming families, communities and partners who can facilitate change? Is it a place where we can work towards achieving behavioural change, with the presence of a well-organised community willing to participate with us?	Positive and organised; high willingness to adopt change	Comm-unity less educated, seemed less co-operative & positive	Better communities	Less positive community	Better community	Com-paratively educated, willingness to adopt change		Very positive and organised; can facilitate change; Active role of women in decision making	Very positive and organized communities that can facilitate
Prevalence of poverty where potential for livelihood impacts are measureable and achievable, and where capacity of stakeholders is low with high prospects for enhancing their capacity	Higher level of poverty, lower level of capacity	Higher level of poverty, lower level of capacity	Com-paratively low poverty as compared to other areas	Higher poverty, low yields, water logging	Less poverty	Higher poverty, low yields, water		High poverty, low capacity & potential to improve livelihoods by various inter-ventions including GW mgmt	Less poverty, high education

Table 17: Continued

Potential for high value crops of high economic return/ viability of economic options, and proximity to input (finance) and output market	Very high potential for high value crops, high willingness to adopt new tech-nologies	Good potential	Better potential	Potential for high value crops willingness to adopt new tech-nologies	Don't know	value crops willingness to adopt new technologi es		High willingness to increase yields by improving water & soil conditions	High willingness among to increase yields
Availability of data related to social and economic aspects, or good prospects to acquire/ create such data	Limited secondary data is available								
The extent lessons from this village could be applicable in other places	Applicable due to similar socioeconomic conditions								
Logistics									
ESSENTIAL: Accessibility, safety and security	Secure								
Potential to connect with/ build on the irrigation efficiency improvement Farmer Field Schools established by the ACIAR project LWR/2014/074	High potential because there is willingness in community to adopt change	Less potential due to behavior of community	Good potential	Com-munity willing to adopt techn-ologies	Good potential	High potential		Better potential	High potential

6 Discussion

6.1 Case study site selection

Following reflection on what was learned during the PRAs, and some further investigations the following case study areas were selected for the remaining focus of the project:

Balochistan: Malikyar and Zarghoon in the severely groundwater depleted Pishin Lora Basin, near Quetta, Balochistan.

Punjab: The 1R and 11L distributaries of the Lower Bari Doab Command area, near Okara and Sahiwal respectively.

Sindh: The Cheeho distributary in NaushahroFeroze district and Malwa distributary in Shaheed Benazirabad (formerly Nawabshah) district

6.2 Reflection on process and its role in this project

PRA takes time and resources, and can seem to hold back immediate action in a project. But the benefits of taking time to understand the geo-social landscape and its implications for the project have been shown many times. In this project the PRA process achieved three major outcomes, each associated with multi disciplinary research.

One outcome is the rigorous and defensible selection of case study areas based on multi-disciplinary criteria. The project needed sites that met certain groundwater and socio-economic parameters, as well as being logistically possible in a short term project. We note, however, that there is great variation across all of the rapidly appraised areas, which has implications for scaling out findings and ideas from this project. Through this designed process sites with the most promise for research and change were selected, and other areas may be more resistant to positive change.

The second outcome was the involvement of a range of researchers and practitioners in 'social' research. Many project partners visited villagers, and listened to stories in ways they had not had the opportunity for before. This is a small step to reducing the silos in which all of us live our lives.

The third outcome was team building- travelling together, sharing stories and reflecting on what was told, and what it could mean, helped to create empathy and professional linkages among the project partners, building a good foundation for the remainder of the project.

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