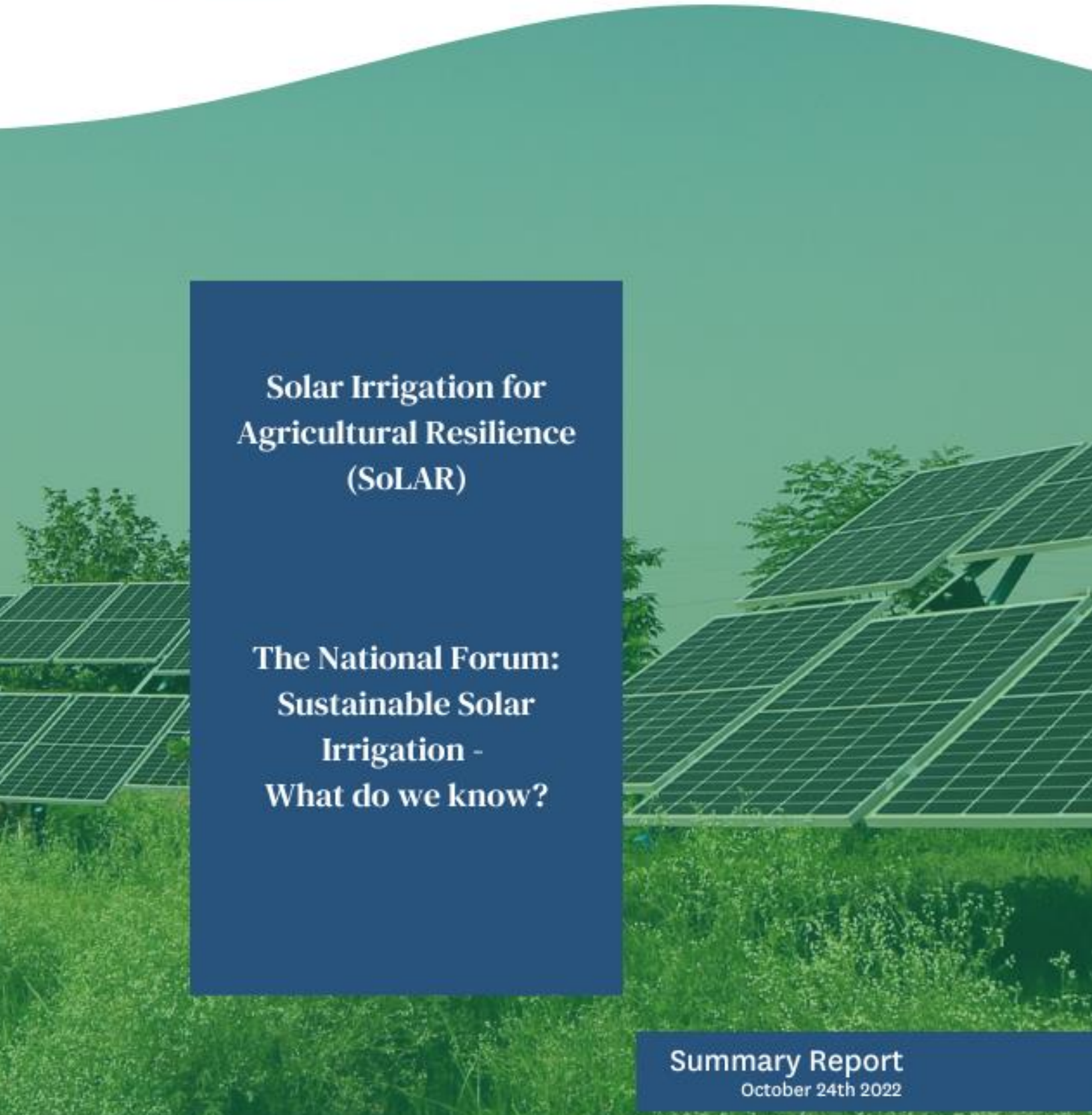
IWMI
International Water Management Institute

SoLAR
Solar Irrigation for Agricultural Resilience

Swiss Agency for Development and Cooperation SDC

Solar Irrigation for Agricultural Resilience (SoLAR)

The National Forum: Sustainable Solar Irrigation - What do we know?



Summary Report
October 24th 2022

Contents

Solar Irrigation for Agricultural Resilience (SoLAR) project

The IWMI-led Solar Irrigation for Agricultural Resilience (SoLAR) project funded by the Swiss Agency for Development and Cooperation (SDC) organized a series of six webinars during 1-5 February 2021. SoLAR project aims to generate knowledge to sustainably manage water-energy and climate interlinkages through the promotion of solar irrigation pumps (SIPs). The goal of the project is to contribute to climate-resilient, gender-equitable, and socially inclusive agrarian livelihoods in Bangladesh, India, Nepal, and Pakistan by supporting government efforts to promote solar irrigation.

Achieving progress in poverty reduction with minimal carbon emission is at the core of the climate and sustainability challenge. This need is particularly acute in South Asia, where further expansion of irrigation holds the promise of pulling smallholders out of poverty but will also result in large increases in carbon emissions due to overwhelming dependence on fossil fuel-based groundwater pumping. SIPs offer a "climate resilient" solution, yet adoption is slow. Little is also known about the impact of SIPs on groundwater use. In this six-part SDC-IWMI webinar series, we explored some of these larger questions around energy transition and SIPs in four South Asian countries.

Introduction to The National Forum

In the recent past, solar pumping technology has emerged as an alternative to diesel and electric pumps. Water professionals in Pakistan are concerned that converting pumps to solar will result in indiscriminate groundwater abstraction and eventually lead to further groundwater depletion. While Pakistan does not have a specific policy on solar technology for groundwater pumping in agriculture, it does have several policies that have a bearing on it.

The National Water Policy 2018 (NWP-18) makes several references to groundwater pumping, with the goal of regulating groundwater withdrawals to curb over-abstraction and promote aquifer recharge. It also aims to develop hydropower to increase the share of renewable energy. As per the 18th Amendment of the Constitution, governance and management of water resources have devolved to the provinces. Each province has embarked on different paths to deliver on the NWP-18. All the provincial governments have planned and/or have launched subsidized solar irrigation pump plans, mostly coupled with High-Efficiency Irrigation Systems (HEIS), especially in Punjab and Sindh. IWMI has also conducted extensive field surveys to determine whether solar based irrigation is leading to indiscriminate pumping or not. Moreover, an effort has also been made to determine whether there are behavioural changes when people shift from Diesel/Electric pumps to Solar based pumping. This session aims to discuss the current knowledge on solar irrigation in Pakistan to evaluate a sustainable way forward for the agriculture sector in Pakistan.

The National Forum discussed these issues with the sector experts to find out the best possible future course of action for Pakistan in its policy related to solar based irrigation systems. The session was held on Monday, 24th October 2022 which included a keynote presentation along with a panel discussion involving eminent sector professionals followed by questions and answers. A total of 26 participants attended the session. The agenda for the session is included in Appendix A. The list of participants who attended the session is included in Appendix B. The photos from the session are included in Appendix C.

Session 1: Keynote Presentation

Topic: ***Can solar irrigation be a tool for groundwater management? Insights from India and Bangladesh.***

Presenter: Dr. Aditi Mukherji, Principal Researcher, IWMI, India.

Summary of the presentation

Overview of the Solar Irrigation for Agricultural Resilience (SoLAR) project was given. The project has three main components 1) Generating evidence 2) Piloting and testing solutions and 3) Sharing knowledge and strengthening expertise. Project activities are being conducted in four countries Pakistan, India, Nepal, and Bangladesh. In each location different activities are being conducted depending upon the adoption of the solar irrigation pumps in the region. Impact of solar irrigation on different aspects of the adaptation, resilience, mitigation, sustainability, gender, equity, and social inclusion were discussed.

With regards to mitigation, evidence gathered under this project in Nepal shows that annual use of diesel pump for SIP farmers is 275 hours as compared to 770 hours for non-SIP farmers. In Bangladesh study shows that solarizing 3 million hectares of diesel irrigated areas can reduce 1.2 -1.6 million metric tonnes/year.

With regards to adaptation and reduce vulnerability to climate risk, studies from Nepal and Bangladesh shows that SIPs provide assured irrigation in case of rainfall variability, and SIPs provide supplementary irrigation in monsoon season when there is a gap between two rainfall events. In Bangladesh, farmers receiving irrigation from SIP and electric pumps tend to grow more summer Paddy, while high-cost diesel farmers diversify their crops to low water consuming crops. 21% of SIP owners in Nepal introduced new crops, including mostly vegetables, and diversified farming. SIPs result in enhanced income from agriculture due to cultivation due to cultivation of high value crops, e.g orchards (Pakistan), vegetables (Nepal), and by lower lowering diesel costs leading to lower cost of cultivation. In India SKY beneficiary farmers sell electricity back to grid; selling electricity contributes to ~15% of total income of a household on average.

Due to zero marginal costs, it is expected that SIPs lead to more pumping. Evidence from Bangladesh shows that there is no substantial difference in groundwater application for summer paddy between solar and diesel pumps. In India, preliminary data shows no significant difference in volume of groundwater pumped by grid connected SIP and electric pump owners. In Pakistan, in terms of average HP hours per acre, usage of SIP is lower than electric and diesel. This can be attributed to three factor 1) high hp of diesel pumps 2) SIP use is limited by sunlight hours 3) HP of SIPs is less than diesel/electric pumps.

Grid connection of SIPs with feed-in-tariff can be a possible way to further incentivize less groundwater, use by SIP. Possible way forward in this regard can be different models already at work in India i.e., Suryashakti Kisan Yojana (SKY), India- Grid connected solar.

Session 2: Keynote Presentation

Topic: ***Sustainable Solar Irrigation in Punjab: Issues and Options.***

Presenter: Dr Mohsin Hafeez, Country Representative, IWMI, Pakistan.

Summary of the presentation

Presentation began by listing few facts regarding groundwater use in Pakistan. Pakistan is a 4th largest user after India, USA and China. Average annual groundwater potential is about 55 MAF whereas actual annual abstraction is 50 MAF. Groundwater budget on overall basis is negative. Before the use of pumps, Persian wells/water wheels were used. During that time, groundwater table was around 3-12 meter deep. As more than 1.3 million tube wells are being used, groundwater at many places has gone down to 100-300 meters deep. In the past few decades, there has been exponential growth of tube wells.

Salient feature of pumping practice in Punjab were mentioned. Irrigated area in Punjab is 7.4 Mha and allocation of surface water to Punjab as per 1991 Water Accord is 55.94 MAF per annum. Punjab has low canal water allowance compared to other provinces at ~ 3 cfs/1000 acres. Thus, canal water supplies in Punjab can only meet 40 % of the crop water requirements. On the other hand, groundwater use in Punjab is around 85% of the total groundwater use in Pakistan. Conjunctive use of surface and GW in more than 50% of irrigated land in Punjab. More than 1.1 million private tube wells in Punjab are leading to severe groundwater depletion and 2.5 million farmers depend on tube wells water for irrigated agriculture. More than 80 percent of these tube wells are diesel powered and these diesel pumps contribute 5.025 million metric tons of CO2 emissions annually. The province has 23% of the area which has poor groundwater quality. Policies regarding groundwater management in Punjab include Punjab Water Act 2019, Groundwater rights ordinance, Irrigation and Drainage Act 2021, and Punjab Climate Change Policy.

Under Solar Irrigation for Agricultural Resilience (SoLAR) project in Pakistan, surveys have been conducted in three districts of Punjab province, namely Chakwal, Jhang, and Rahim Yar Khan. Under a World Bank project, stakeholder consultation workshops have been conducted in the same provinces. Moreover, as a part of same project groundwater vulnerability index of Punjab have been developed. Key messages from all these research activities are non-agriculture use of SIP should be promoted, SIP with HEIS should be promoted for high value crops/orchards, areas with low groundwater vulnerability zones should be targeted for SIP, standardization of SIP should be prioritized, and rainwater harvesting will be pivotal to create positive balance at Indus Basin level.

Questions from Panelists

Distinguished panel included following participants.

- **Mr. Hafiz Qaisar (HQ), Director Headquarter, On Farm Water Management (OFWM)**
- **Engr. Kifayat Zaman (KZ), DG, Federal Water Management Cell, MNFS&R Islamabad**
- **Ms. Sadiya Qayyum (SQ), The World Bank**
- **Mr. Muhammad Israr (MI), Secretary Agriculture, Govt. of KPK**
- **Dr. Muhammad Bashir Ahmed (BA), Director CAEWRI, PARC Islamabad**

Question to HQ: How transition is taking place in Punjab from diesel to solar water pump and what is the plan of to oversee this transition?

Response:

In Punjab, policy doesn't not support blanket solarization of tube wells. In year 2012, after long debate and discussions among stakeholders, consensus developed that coupling of High Efficiency Irrigation system with solar irrigation system can be sustainable option for adoption of solar pumps in Punjab.

Initially in 2016, government of Punjab has converted 20,000 acres of land into high efficiency irrigation system and received promising results afterwards. In 2018, more area of 40,000 acres was also converted through a mega initiative by coupling highly efficient irrigation with solar irrigation.

Question to KZ: How incentivise solar pumps for farmers across the country or different areas?

Response:

Currently, govt is focusing in solarization of tube wells. There are 2.1 million diesel pumps and 0.3 million electric tube wells operating. Diesel operated tube wells produce carbon emissions, 2.6 L of diesel produces 8.6 million of annual CO_2 emissions. Farmers are switching to solar irrigation and government wants to subsidize solar pumps but due to high-cost government is negotiating with State Bank of Pakistan to lower the mark up rate. Preliminary finding from IWMI on solar irrigation water pumps would be helpful in devising future strategies

Question to SQ: How financial institutions play role in promoting solar irrigation**?**

Response:

Government has given 100 billion subsidies to electric tube wells, 50% to Punjab and 48% to Baluchistan**.** Considerable number of farmers are moving towards solar but switching to solar is not sustainable in long-run. Solar system should be net metered by connecting them to grid. Financial institutions are supporting this technology but still quality of solar panels and local capacity is a problem.

Question to MI: How do you see support of Government of KPK for solar pumps and what is the future of Solar Water Pumps in Pakistan?

Response:

We have surface water irrigation system, but few areas don't get much surface water and they are extracting ground water more than the optimal abstraction levels. Most important thing is to know the recharge of aquifer.

Cropping patterns need to be changed. Farmers are growing high water requirement crops like sugar cane, capacity building of farmers on growing low water requirement crops is important. From geographical point of view, we have ample potential of solarization of tube wells, but we need to develop capacity of farmers. In addition to this, training and technical skills of extension workers and departments are required

Question to BA: How farmers could be sensitized to shift on solar irrigation?

Response:

Farmers are converting to solar irrigation system; we cannot stop farmers to adopt any technology, but we can develop mechanisms for sustainable solar water pumping. For that, strong governance system is required and inter coordination among departments is required. Farmers alone cannot be blamed, evidence-based policy making, and regulation is also important.

Panel Discussion

After individual questions, moderator and audience participated in the discussion.

Q: How do you see the future of sustainable solar based irrigation in Pakistan?

HQ replied: All stakeholders in agriculture, irrigation, energy, and farming sector have to work together to come up with sustainable solutions for solar irrigations

Q: Held back of 30000 SIPs in Baluchistan, what is the plan of government now?

KZ replied: Government in negotiations with other provinces. First phase, 25,000 pumps will be solarized. Through water accounting exercise areas need to be identified for solarization of pumps. Farmers will grow water efficient crops and adopt efficient practices if there is market for crops they are growing, and efficient technology is resulting in increase in production and profits. All provinces have different context in terms of water availability and cropping patterns, therefore, solutions need to be tailored accordingly.

Q: Which type of crops are grown with solarized drip system on 40,000 acres?

HQ replied: Adoption is with orchards and vegetables. It is demand driven, mostly adoption is in water scarce areas.

Q: Is there any study conducted to access effects on groundwater in downstream areas to areas where solarized drip systems have been adopted?

HQ replied: In Punjab, there 39 million acres of cropped area. Up till now SIP with HEIS have been installed on 40,000 acres only. I do not think adoption at this small scale as compared to the total cropped area will influence groundwater to surrounding areas. Government is aiming to install these systems on 1 million acres as a threshold beyond which market forces will take it further for subsequent adoption.

Q: Financial benefits outweigh the cost of SIP, what is total economic costs i.e., reduction carbon emissions but have we done any analysis on effects of groundwater aquifer if 2.5 million SIPs are installed in future?

HQ replied: Punjab government is concerned about the groundwater abstraction. Punjab government will regulate every pump for groundwater abstraction to combat climate change.

KZ replied: SIPs are limited by sunlight intensity and duration. In future, if there is subsidy on electricity, there can be more abstraction with electric pumps.

Q: Farmers grow crops of their choice, what is scope of leasing farm with corporate sector? Then corporate sector can ensure good practices.

BA replied: Areas where land holding is small near cities, corporate farming can be a good option and can generate employment. But then it will require a lot of consultations for implementations.

Key takeaways

Following were the key takeaways of the National Forum 2022.

- Ground water abstraction is increasing at exponential rate especially at the tails end of canals. It is important thing is to create positive water balance at Indus Basin level
- Solar system should be connected to the grid through net metering
- Financial institutions are supporting this technology but still quality of solar panels and the local capacity is a problem
- Cropping patterns need to be changed, capacity building of farmers on growing low water requirement crops are important
- Strong governance system is required and inter coordination among departments is required
- Need to work on water accounting and agronomic crop production technologies

Closing remarks from Rachael Mcdonnell, DDG, IWMI

For WEFE nexus solarized irrigation is a critical area. By reducing carbon emissions solar pumps not only provides solution to climate resilience and climate mitigation they also increase farmer incomes. It is very evident from the discussion we had that climatic and geographic conditions differ with in the region and with the country. Thus, one solution cannot fit all and it is a complicated subject.

I would also want to shed light on other possible areas of research. What will be the fate of solar panels at end-of-life cycle? This is a pertinent question as millions of panels are operating. Similar problem we are facing currently is windmills that are approaching expiry date, what will happen to the blades of wind energy? Obviously, we cannot just bury them.

Lastly, one possibility that should be discussed more is that solar panels can provide off grid energy solutions to remote villages with no power supply. For example, without being connected to a grid solar panel can directly provide power to school and hospital in the village.

Appendix A: National Forum Agenda

Agenda		
	Moderator: Dr. Azeem Ali Shah, IWMI	**Rapporteur:** Ms. Kanwal Waqar, IWMI Pakistan
16:00 - 16:05	Setting the Scene: Dr. Azeem Ali Shah, IWMI	
16:05 - 16:10	Opening Remarks: Mr. Zafar Hassan, Secretary MNFS&R	
16:10 - 16:30	Keynote Speaker: Dr. Aditi Mukherji, Principal Researcher, IWMI: ***Can solar irrigation be a tool for groundwater management? Insights from India and Bangladesh.***	
16:25 - 16:40	Keynote Speaker: Dr. Mohsin Hafeez, Country Representative, IWMI: ***Sustainable Solar Irrigation in Punjab: Issues and Options.***	
16:30 - 17:15	Questions from Panelists	
17:15 - 17:25	Questions and Answers from Audience	
17:25 - 17:30	Closing Remarks	
1. Each session is 1.5 hrs		
2. Session to be mixed and lively, gender balance in panel		
3. Sessions to comprise: panelist perspectives on a topic, or presentation and panel feedback and Q&A, or intersperse with video to break up		
4. Use Menti polls (online system logging with mobile phone) to take audience poll, seek feedback		
5. Option of roundtable discussion as a different type of session with presenters and active debate		
6. Prepare thematic paper outlining each theme and the topics to be covered		

Appendix B: Attendance Sheet

Sr. No.	Full Name	Affilated Organization	E-mail	Mobile
1	Dr. Muhammad Bashir Ahmad	PARC, Plot No. 20, G-5/1, Islamabad	dr.bashir70@gmail.com	0333-5487506
2	Hafiz Muhammmad Qaiser	Government of Punjab	malikakramkhokhar@gmail.com, pipipwm@gmail.com	+92-42-99200724
3	Kashif Hussain	IWMI - Pakistan	k.hussain@cgiar.org	
4	Imran Nadeem	IWMI - Pakistan	I.nadeem@cgiar.org	
5	Muhammad Tahir Ali	IWMI - Pakistan	m.ali@cgiar.org	
6	Ms. Rachael McDonnell	International Water Management Institute (IWMI)	r.mcdonnell@cgiar.org	
7	Engr. Kifayat Zaman	MNFSR	info@mnfsr.gov.pk	051-9210088
8	Azeem Ali Shah	IWMI - Pakistan	a.shah@cgiar.org	
9	Kanwal Waqar	IWMI - Pakistan	k.waqar@cgiar.org	
10	Dr. Muhammad Israr	Secretary Agriculture - Government of Khyber Pakhtunkhwa	misrar04@gmail.com	0312-9425477
11	Mohammad Mohsin Hafeez	Country Representative - IWMI - Pakistan	M.Hafeez@cgiar.org	
12	Zain Bin Akbar	Researcher - Policy and Water Goverance - IWMI - Pakistan	m.akbar@cgiar.org	0322-4440758
13	Engr. Mushtaq Ahmad Gill	South Asian Conservation Agriculture Network- SACAN Services Pakistan	mushtaqgill@gmail.com	0300-4206225
14	Dr. Ghulam Mohammad Ali	PARC	chairman@parc.gov.pk / drgmali5@gmail.com	051-9203966
15	Engr. Sarab	UCP Lahore	sarab.riaz@gmail.com	0335 8574714
16	Engr. Zubair	Agriculture Department Government of Khyber Pakhtunkhwa Dera Ismail Khan	pd.gzd.cadp@gmail.com	0300-8586875
17	Prof. Zubair Ahmed	University of Agriculture Peshawar	zubair@aup.edu.pk	33339198222
18	Zeb-u-Nisa	Development Alternative		0303 5271330
19	Adnan Majeed	MNFSR	adnanolx@gmail.com	0335 0596460
20	Farah Naz	PCRWR	farahqau@hotmail.com	0336 5137405
21	Mr Abdul Wahab Kakar	Director General, Agriculture Extension and On Farm Water Management (ONFWM)	dgwmbalochistan@gmail.com, abdulwahadkakar@yahoo.com	3138399939
22	Mr. Umaid Ali Khokar	Secretary, Agriculture and Cooperatives	agbuzdar@yahoo.com	
23	Ahsan Tayyab	Agriculture Economist	ahsantayyab1958@gmail.com	
24	Irfan Ali	PARC	irfanali61@hotmail.com	0333 6456544
25	Qurban Ali	WWF	qali@wwf.org.pk	0333 7022626
26	Ahsan Fayyaz	Refined ADB staff	ahsan-fayyaz1958@gmail.com	0304 4087033

Appendix C: Photo

Figure 1: Panellists

IWMI is a CGIAR Research Center

The International Water Management Institute (IWMI) is an international, research-for-development organization that works with governments, civil society and the private sector to solve water problems in developing countries and scale up solutions. Through partnership, IWMI combines research on the sustainable use of water and land resources, knowledge services and products with capacity strengthening, dialogue and policy analysis to support implementation of water management solutions for agriculture, ecosystems, climate change and inclusive economic growth. Headquartered in Colombo, Sri Lanka, IWMI is a CGIAR Research Center with offices in 14 countries and a global network of scientists operating in more than 30 countries.

International Water Management Institute (IWMI)
Headquarters
127 Sunil Mawatha, Pelawatta
Battaramulla, Sri Lanka

Mailing address:
P. O. Box 2075
Colombo, Sri Lanka
Tel: +94 11 2880000
Fax: +94 11 2786854
Email: iwmi@cgiar.org
www.iwmi.org