Farmers Perspective Adoption Hindrances of High Efficiency Irrigation Technologies in Punjab-Pakistan

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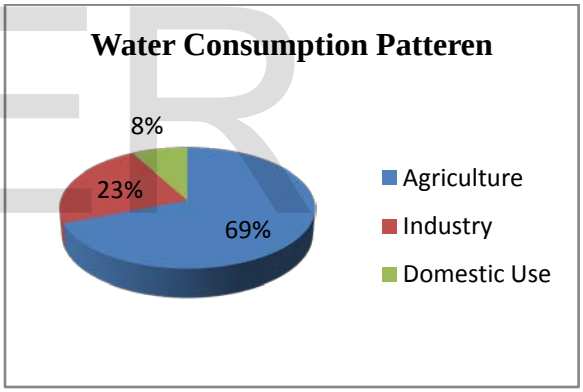
Abstract- Pakistan is an agriculture country and irrigation plays an important role for better agriculture practices, about 90% of total agriculture is dependent on irrigation. Advanced irrigation technologies are a way to use limited water more efficiently. The main purpose of this qualitative study is to investigate the adoption hindrances of advanced irrigation technologies in Pakistan for sustainable agriculture. Punjab province of Pakistan was selected for case study. Data was collected through open ended questions, interviews and additional field notes from 40 farmers. Data was analyzed by descriptive and qualitative analysis. Study findings revealed that adoption of water and energy conserving irrigation technologies highly affected by electricity availability, Technical assistance, Technology cost, Area based subsidy, lack of reliable information, supply and services companies expertise level, project completion time and non availability of technology parts. Study results will be very useful for water management planning unit of Pakistan and many other countries of the world working on high efficiency irrigation systems. This saved water will not only help Pakistan to improve agriculture land and production but also be very imperative for drinking and power generation.

Keywords: Technology adoption, water and energy conservation, water scarcity, Sustainability.

1- INTRODUCTION

AGRICULTURE is one of the most fundamental sectors of the economy of Pakistan. It plays an extremely important role and contributes as a primary pillar in the foundation of economic development growth of Pakistan. Agriculture sector accounts for more than 21 percent to the Gross Domestic Product (GDP) and employees 45 percent of the total labor force of the country. Water plays a vital role for better agricultural productivity because every crop needs a specific amount of water. Rainfall is a natural source of water and during the monsoon season (July-September) 2014, the recorded average rainfall was 140.9mm, while the actual rainfall received to the crops was 106.2 mm which indicates a decrease of 24.6 percent (Economic Survey 2014-15).



Similarly, during the post-monsoon seasons (October-December) 2014, the recorded average rainfall was 26.4 mm, while the actual rainfall received to the crops was 17.8 mm which also indicates a year on year decrease of 32.6 percent (Economic Survey 2014-15). Better water management is a basic restraint to increase agricultural Productivity and job generation. (The World Bank Report, 2005) Water shortage is now becoming a worldwide issue. World Bank predicted that till 2025, 1.8 billion people will face water scarcity problem (United Nations. UN Water, Aug. 2006. Web. Nov. 2009). Because of rapid increase in world population, increase in the area of irrigation land,

and growth in industrial sector, too much attention is being given to adopt water saving techniques.

Lack of water availability issue compelled Pakistan's government to initiate water saving technologies and to manage ground water more efficiently (The World Bank Report, 2005) Provincial, federal government and World Bank all are agree that water management is a main development challenge for Pakistan (The World Bank Report, 2005). To meet this challenge Pakistan signed an agreement with World Bank to finance irrigation projects (The World Bank Report, 2005). With the assistance of World Bank, government of the Punjab, Pakistan started several irrigation projects based on latest technology for better water and land management in the province. Purpose of these projects is to install high efficiency irrigation (Drip, Sprinkler and Bubbler etc) systems in all over the province. In recent years high efficiency irrigation systems such as sprinkler & Drip have been proven successful for increasing water use efficiency (Playan and mateos, 2006).

Pakistan is in dire need to adopt better water management based on the newly introduced water and energy conserving irrigation technologies, experts believe that these technologies can reduce water scarcity by managing its losses. The government has actively sided by policy makers and selected a number of projects to introduce these innovative irrigation methods on larger scale, but unfortunately the rate of technology acceptance is very low. Due to certain reasons, despite allowing subsidies on procurement of equipment, installation and availability of training and after sale services; a large number of farmers are not seen willing to install these new irrigation systems.

1.1 Land Utilization Scenario of Pakistan

The total geographical area of Pakistan is 79.6 million hectares (Mha) while cultivated area is 23 million hectares (Mha). Rain fed area is 4(Mha) which is imperative for national economy (Adnan et al., 2009). Asian development bank announced Pakistan is the most water stressed country with an annual rainfall below 240mm.

Land Use	Million Hectares
Total Geographical Area	79.61
Total Reported Area	57.22
Forest	4.19
Not Available for Cultivation	22.7
Cultivable waste	8.33
Cultivated Area	22
Total Cropped Area	23.39

Source: www.pbs.gov.pk/content/land-utilization

1.2 Geographical Scope of Study

This study was conducted in the Punjab province of Pakistan. The Punjab province was selected because it has

It contributes a major share in country's agricultural economy by providing about 83% of cotton, 80% of wheat, 97% fine aromatic rice, 63% of sugarcane and 51% of maize to the national food production. Among fruits, mango 69% of the total cropped area, 29% of the total reported, and 57% of the total cultivated area of Pakistan

accounts for 66%, citrus more than 95%, guava 82% and dates 34% of total national production of these fruits (Agricultural Statistics of Pakistan 2011-12).

Table No. 1

Province wise Land Area Utilization of Pakistan 2013-14

(Area in Million Hectares)

Province	Geographical Area	Cultivation Area	Current Fallow	Net Area Sown	Area Sown more than once	Total Cropped Area
Punjab	20.63	12.52	1.89	10.63	5.89	16.52
Sindh	14.09	5.18	2.80	2.38	0.84	3.22
KPK	10.17	1.88	0.61	1.27	0.56	1.83
Baluchistan	34.72	2.49	1.39	1.10	0.01	1.11
Total	79.61	22.07	6.69	15.38	7.30	22.68

Source: crs.agripunjab.gov.pk/system/files/LUS-**2013-14** hect.pdf · 2016-12-22

2- LITERATURE REVIEW

Adoption of any new irrigation technology needs to be ascertained from its users, users of an irrigation technology may rate it differently according to their experience, level of education, location and land size. Generally farmers with higher level of education are more aggressive to adopt new technologies because they are better able to calculate their profit and loss and have awareness towards relevant innovations. Education enables users to make better adoption decisions at right time (Rahm and Huffman, 1984). This group of educated users being early adopters enjoys more advantages and payback of their investment in new technology (Gardener and Rausser, 2001). Actually it is expected that people with high level of education can be better clued up regarding existence and performance of water and energy conserving technologies (ABDULAI et al., 2011). In Iran, the people with higher level of education are more willing to

adopt water and energy conserving technologies than the people with low level of education (Bagheri & Ghorbani 2011). A similar study conducted in India by Namara et al., (2007), where the farmers who were growing oilseed and leguminous plants and having higher levels of education, has been positively influenced to adopt water and energy saving technologies. There are however instances of empirical studies that show negative relation in this aspect. In some studies higher levels of education have negative influence on technology adoption as farmers with high level of education showed negative attitude to adopt GPS management system for growing cotton (Banerjee, et al., 2008). Similarly in 1989 Gould, et al., studied adoption factors of tillage technology for the Wisconsin farmers and he found that education was negatively correlated. In Iran study showed that farmers with younger ages were more eager to adopt new irrigation technologies (KALANTARI et al., 2010). On the other side in Ghana eldest farmers were more willing to up take new irrigation systems (Abdulai et al. 2011). While in Greece the younger farmers with high level of education demonstrate positive response in irrigation technology adoption (KOUNDOURI et al., 2006). Studies regarding adoption of irrigation technology had also been conducted in Spain where farmers' adoption rate was increasing with the increase of credit availability (ALCON et al., 2011). Similarly in China, credit availability facility increased the adoption rate of irrigation technologies (He et al. 2007). Rossi found that education level, number of varieties of citrus that is grown, the income earned from citrus activities and technical assistance received from specialists, increased the possibility of adopting better irrigation systems (Ribeiro Fabiana et,al 2015). Genius Margarita et,al formulated a theoretical model to empirically identify the important role of Information transmission in adoption and diffusion of new agricultural technologies. The results found that both extension services and social networks are highly significant factors to strongly influence the adoption and diffusion of new irrigation technologies

3- METHODOLOGY

3.1- PRIMARY DATA

This study covers responses of 40 farmers of five districts (Faisalabad, Lahore, Rawalpindi, Attok and Jhelum) of Punjab province Pakistan. Sampling was purposive in type. Research area and sample was selected with specific study purpose in mind. Major crops cultivated in these study area were wheat, maize, vegetables and sugarcane with below mentioned net sown area.

Table No. 2
Land Utilization statistics by Districts

District	Reported Area (Thousands hectares)	Cultivated Area (Thousands hectares)		
		Total	Net sown	Current Fallow
Faisalabad	584	474	473	1
Lahore	177	109	88	21
Rawalpindi	526	273	210	63
Attock	693	318	234	84
Jhelum	359	126	88	38

Source: Punjab development statistics 2015

Respondents were searched, selected and contacted through Punjab government water management department. Data collection time was three months. In first month exploratory visits to agriculture farm houses, Pakistan water management departments and water user associations were made. The field visits were arranged by a government officials working in the area as a water management officer (WMO). It was great help from Pakistan government to facilitate this research for completion of field survey. Visited sites had some government advanced irrigation technologies projects and farm houses of private farmers which could not be approached directly without water management officials' support.

3.2 RESPONDENTS DEMOGRAPHICS

Table No. 3

Demographic Factor	No.	Percent	Cumulative Percent
Age Level			
1 to 30 years	5	12.5	12.5
30 to 60 years	28	70.0	82.5
60 years or above	7	17.5	100.0
Education Level			
Primary School or Below	23	57.5	57.5
Secondary School	16	40.0	97.5
Bachelor Degree or Above	1	2.5	100.0
Land Size (Acres)			
1 to 10 acres	27	67.5	67.5
10 to 20 acres	9	22.5	90.0
20 acres or above	4	10.0	100.0
Farming Experience			
1 to 10 years	12	30.0	30.0
10 to 20 years	24	60.0	90.0
20 years or above	4	10.0	100.0
Income/acre (Annual)			
less or equal to 150000	10	25.0	25.0
200000	26	65.0	90.0
250000 or above	4	10.0	100.0

3.3 FARMERS INTERVIEWS

For convenience data collection, respondents were invited to government water management offices situated in every district of Punjab Pakistan. Face to face interviews were conducted in government regional offices. Due to cultural limitation observer was unable to conduct interview with females so only male farmers were called for interview. In Pakistan usually land is owned and managed by male

members of a family. Keeping in mind the study scope and literature review a semi structured questionnaire was developed in English language but because Most of the farmers in Pakistan cannot speak English so the questions were translated into local language "Urdu" with the help from linguistic experts. After completion of the survey interviews, the transcripts of the interview responses were translated into English with the help of language experts

3.4 INTERVIEWS FINDINGS

Table No. 4

Respondents' Interview Feedback

Interviewee	Farmer's Responses
How often did you find problem to have an adequate electricity power to operate this technology?	• Usually we have electricity but for very short time. This short time availability of electricity is not sufficient for our crops irrigation. Because of non-availability of electricity, Irrigation schedule given by agriculture experts cannot be followed. When we have electricity, we run the advanced irrigation system but right after field half irrigation, power cut by government make our crops water deficit and low productive. This technology is good but lack of electricity ruined our fields and money invested in this project…(Farmer#5) • No we don't have enough electricity to operate this technology but I am still using this technology and getting better results. Timely irrigation is very important for better crop production so I have alternate setup based on mechanical power from farm tractor to operate this technology. This alternate mechanism is comparatively costly for me because cost of fuel is much higher than electricity. During advanced irrigation system operation I cannot utilize my tractor for cultivation of my soil and other tractor work because tractor remains busy with irrigation system… (Farmer#9) • I had installed this system but due to electricity shortage problems I am unable to get real advantage of this technology. I think I had wasted my money because without adequate electricity supply this technology cannot be used efficiently. This system need to be used on daily basis which is impossible in such electricity availability situation…..(Farmer#13) • Electricity shortage is a big problem for this technology operations but I am still using this technology. I had bought 25hp diesel engine mechanism. When I don't have electricity, I attach diesel engine mechanism as a power source. It increased my operational cost but I can afford it and I am happy with this technology….(Farmer#16) • Often we don't have electricity. This sudden load shedding destroyed my electric motor twice. Now I had bought electric control panel to resolve this issue. I had also hired a labor person every time available in my field. When electricity come he "ON" the system when no electricity he "OFF" the system. I am a poor farmer; I cannot afford tractor or diesel engine…(Farmer#20) • Non availability of electricity is one of a basic restraint to up take this technology. We are famers, we have to do many activities in our fields so cannot monitor this system for 24 hours. Frequent load shedding demand human resources in field all the time which is not possible for a small farmer…(Farmer#25) • Load shedding is a big challenge for all farmers but I had hired a labor person

	which only looks after this system. This labor person is trained as he got training from installation team. During load shedding periods this labor man is responsible for timely "ON" and "OFF" the system. Not only this but in case of any defect in the system has he repaired it. This labor man increased my operational cost but saved burn out the electric parts of the advanced irrigation systems caused by frequent load shedding…(Farmer#31) • No we don't have electricity. Government should not launch this project until they manage electricity crises. I had installed this system 1 year ago but I am not using this technology because of regular electric load shedding. ..(Farmer#36) • It is big problem for me to operate this system in such electricity load shedding situation. At three feet elevation, I had constructed a big reservoir and installed a small solar pump. Water in reservoir is filled solar pump and then this water is used in drip irrigation by gravity flow….(Farmer#40)
What do you think training of this technology can enhance the adoption rate?	• Yes training of this newly introduced technology can enhance the adoption rate. This technology is new for us. This technology consists on many complicated pressure valves and electric mechanism that we don't know how to operate it. Initially Supply and Services Company provide us training but that training was not sufficient. Not only this but also Because of new technology we are unable to find technician for after sales and services…(Farmer#1) • Yes adoption rate can be better after proper technology knowledge. Initially I was afraid to use this technology because i don't even know to start it. If government provides farmers proper training to use this technology then they can adopt it. For our community this system is very high tech. Our traditional way of irrigation comparatively very simple. Many farmers come to see my advanced irrigation system but just because of operational complications they are scared to adopt it…(Farmer#4) • During my sowing season, I face a problem in my rain gun rotation mechanism. I visit the market to repair it but can't find even a single mechanic to repair it. I also called to supply and services company their response was very bad. Until they come, my sowing time disturbed. No doubt technology is good but government should arrange training session in every district for smooth technology operations…(Farmer#11) • May be but I have no issue regarding technology training. I hired a special technician. Every month I pay him 18000rupees. I have no problem in technology operations until face a major defect. I think instead of training government should develop big parts store of this technology….(Farmer#17) • Yes because training of this technology can save a big amount which I pay for technology operations. Generally very small problem but technician charge more just because of non availability of mechanics. Once I called supply and services company technician. He just cleaned the filter and claimed repairing fees, travelling and daily allowance. I saw him, Cleaning the filter was not a difficult job. I don't know for adoption but for sustainable technology use government should arrange training seminars….(Farmer#19) • I think training is very imperative. I am small farmer; I can't afford high salaried technicians for land irrigation. As I already had installed the system but I will not suggest other farmers to up take this technology without proper usage training…(Farmer#26)
What do you think Is technology cost main restraint in adoption?	• Technology cost is very high. Average farmer in Pakistan is a small farmer. No doubt government is providing us subsidy but still for me it was very difficult to pay my share. Technology is good if government provide me more subsidy I am willing to install advanced irrigation system on my remaining land. (Farmer#1) • Yes. Initial high cost is a big challenge in adoption. At the start newly

	introduced technologies should be installed totally free…(Farmer#15) - I can afford the cost of this technology but this technology is very difficult to manage. At the end of season too much labor is required to fold and spread the lateral lines….(Farmer#19) - Of course low cost will increase adoption rate. Not only cost should be low but government should also provide us quality of material. As per charged price material quality is poor…(Farmer#27) - Technology low opening cost can increase adoption rate. For me main hurdle for further adoption is project cost….(Farmer#37)
What do you think how can government improve the adoption of water and energy conserving irrigation technologies?	- I had installed this project three year ago. As per my observations, there are many factors which government should consider in enhancing the adoption rate of advanced irrigation technologies Government should: • Provide fully subsidized advanced irrigation projects to poor farmers. Small share can be taken from rich farmers • Timely Completion of project (Before sowing season) • Timely subsidy for Pond Construction • Availability of electricity for agricultural land irrigation….(Farmer#1) - I recently installed this project. I think first government and supply & services companies should improve their expertise level of project designing and installation. Due to lack in execution expertise my project installation take too much time, leading to destruction my one season crop….(Farmer#4) - Provision of solar pump with irrigation system can enhance the adoption rate. I had installed the system but due to electric crises can't use it properly….(Farmer#9) - 17% tax charged on project cost should be exempted. Already technology cost is out of range. If government want to make this project successful then tax should be removed from water and energy saving irrigation technologies…(Farmer#11) - After technology installation, we also need spare parts and technical assistance. Government should arrange awareness, training seminars and easily availability of technology spare parts…(Farmer#17) - My friend is working in water management department. He told me about this technology. As I have seen this technology in Dubai so I decided to install it. Many farmers don't know about this technology. Government should promote this project on national TV, Radio, newspapers, and village level awareness seminars about the technology benefits and usage…(Farmer#23) - Lack of clear and reliable information….(Farmer#33)

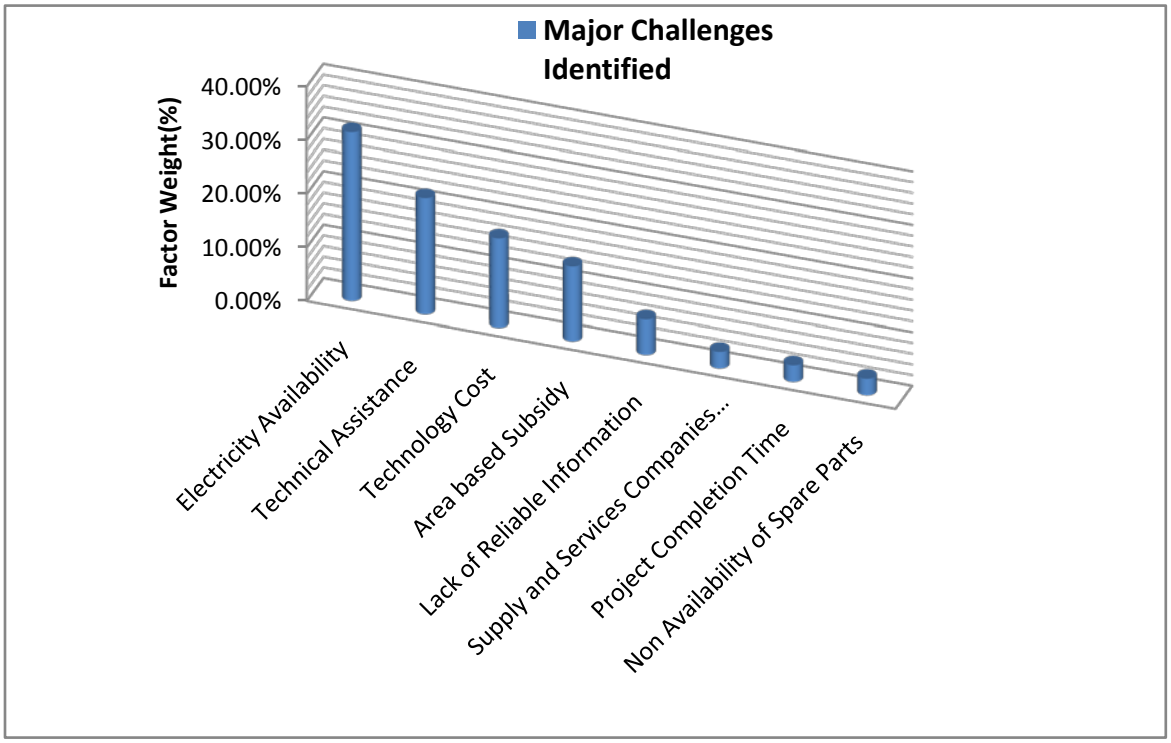
3.5 - SECONDARY DATA

Literature from different journals relating to agricultural water management, adoption of different advanced technologies and land use statistics have been used. Online information about Punjab province regarding cropped area, net sown area, fallow area, irrigated area and percentage contribution of different crops in national GDP also has been taken from different regional offices and online sources. World Bank reports on water scarcity and other

useful additional material from websites has also been used.

Major Challenges Identified			
Factors	**Factor Weight age**	**Percentage**	**Cumulative Percentage**
Electricity Availability	20.25	31.51	31.51
Technical Assistance	14	21.78	53.29
Technology Cost	10.75	16.73	70.02
Area/Farmer based subsidy	9	14.00	84.02
Lack of Reliable Information	4.25	6.61	90.63
Supply & Services Companies Expertise Level	2	3.11	93.74
Project Completion Time	2	3.11	96.85
Non availability of Spare Parts	2	3.11	100

STUDY RESULTS AND DISCUSSION



4.1

ELECTRICITY AVAILABILITY (EA)

Study analysis showed high influence (31.51%) of this factor. Pakistan is facing severe electric power crises (National Transmission and Dispatch Company). Available and affordable power is basic need to operate this technology. During survey, adopters of this technology explained that they had installed the system but unfortunately, due to lack of electric power they were unable to operate it. They further pointed out that other power sources like diesel engine and tractors etc. cannot be used because of their high operational cost. If government offers proportional electricity price to farmers then adoption of high efficiency irrigation system can be enhanced (Kumar, 2005).

4.2- TECHNICAL ASSISTANCE

Training facilitates farmers to use technology more efficiently, training of water conserving technology operations can work smoothly. Further farmers enlightened that due to these factors they are unable to grow crops timely leading to low crop production.

Irrigation positively associated with adoption (Ribeiro Fabiana et,al 2015). Field survey showed that respondents were disappointed due to lack of technical knowledge which is very important to operate a newly introduced technology. Technology users also claimed that right after the project installation government and supply & services companies should provide adequate training so that

4.3-TECHNOLOGY COST

Average land holding in Pakistan is 6.4 acres (Economic Survey of Pakistan). Average farmers have very small land size and limited financial resources. Farmers with larger land holdings do not have financial issues so they can easily adopt high efficiency irrigation system (Putler and Zilberman 1984). Due to high initial cost many small

farmers are powerless to afford such kind of projects. During survey, farmers showed up this factor with 16.73% effect. Farmers also suggested that government should provide full subsidy to small farmers on sustainable irrigation projects as it will not only improve irrigation area but will also contribute in national GDP.

4.4-Area/Farm Based Subsidy

Subsidy is financial support to any economic sector (department/institutions/individual) to promote policies (Myers, N.; Kent, J. (2001). During study data collection farmers communicated that government should provide area/farm size based subsidy. If one farmer had 25 acres of agriculture land then he should given low subsidy as compared to a farmer owned 5 acre land because of small farmers' low financial resources.

4.5-Lack of Reliable information

During the survey at district level, author came to know that many farmers don't know about this technology. Newly introduced technology adoption depends on farmer's specific time information towards this technology (Besley and Case 1993; Foster and Rosenzweig 1995; Conley and Udry 2010). No doubt, government of Pakistan is contributing in cost of project in form of subsidy but there is a huge need to market this project.

Conclusion

This paper concludes that adoption of water and energy conserving irrigation technologies in Pakistan can be enhanced by putting special focus on electric power availability, Training of advanced irrigation technology to users, technology cost, Area/Farm based subsidy, diffusion of reliable information, project team technical expertise and technology parts availability in local markets. Steps should be taken at government level to overcome all above mentioned adoption indicators. Adoption of such kind of projects will not only lead towards sustainable agriculture but also contribute in country economy.

Agriculture is a back bone of Pakistan. For adequate electric power availability in agriculture sector, government should design a separate policy. District level separate power grid station can be designed for agricultural water management.

Training is very important factor for technology adoption. If technology user/farmer doesn't know about the usage of technology than he will remain reluctant to adopt the same. In every district subdivision, there is water management office; this office can also be used as a technology

4.6-In competencies of Supply & Services Companies

Farmers and other technology adopters also claimed that project execution team needs to improve their technology designing and installation expertise as farmers faced problems just after the installation of project. Not only is this but mostly project team members were unable to troubleshoot the problem. Timely irrigation to crops is very important for better production but due to late/delay in technology installation crop sowing time is greatly affected, ultimately leads to low production.

4.7- Project Completion Time

During interviews farmers also explained that Timely project completion is very important for crop sowing period. Due to late/delay in technology installation crop sowing time was affected, ultimately leading to low agricultural production.

4.8- Non availability of Spare Parts

Farmers highlighted that advanced irrigation system consisted of many small parts. In case of a little fault/change of drippers they are unable to buy these parts because of their non availability in local markets. This leads to delay in field irrigation.

awareness/training institution. It will increase interaction between farmers and water management officials. This social learning will put positive impact on technology adoption.

Village level technology awareness seminars, social media, TV and newspapers advertisements can be arranged by local government to promote the technology recognition.

Technical expertise of technology execution cell is very important for adoption, in fact, the lack of technology has been found to put negative impact on adoption. During interviews, many farmers claimed that at first, the government should properly train their own officials and supply & services companies' engineers for better results. Government should arrange national/international level trainings for project execution team to make this project successful.

As average farmers in Pakistan is a poor and lack financial resources, having less than 6.4 acre land (Economic survey of Pakistan), cost is also a major issue in the adoption of newly launched technologies. Exemption of 17% tax charged on every project can bring positive impact in technology adoption.

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