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Pakistan's Final Report to DfID

Reaping the Benefits: Assessing the Impact and Facilitating the Uptake of Resource Conserving Technologies in the Rice-Wheat Systems of the Indo-Gangetic Plain

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Executive Summary

1. The goal of this DfID-funded project was to improve rural livelihoods through accelerated adoption of resource-conserving technologies (RCTs).
2. Farmers in 2 villages in Sheikhupura district and 2 villages in Sialkot district were assigned to one of four socio-economic groups, i.e. landless, marginal, subsistence or food surplus/cash cropping, depending on their ability to take the risks involved in adopting new technologies.
3. Data collected under Output 1 indicated that all socio-economic groups have benefited from using new varieties of rice (*Basmati Super* and *Basmati 2000*) and wheat (*Pak 81, Lailpur 33* and *Auquab)* in terms of improved yields and economic return.
4. Many farmers were confused regarding the benefits of using the DfID/New Zealand/Asian Development Bank-sponsored zero-till drill for wheat production, due to the fact that the two main government departments responsible for promoting its use (On Farm Water Management and Agricultural Extension) are in disagreement over its effectiveness.
5. Project farmers who had experienced using the zero-till drill complained of soil compaction, increased pest problems in the following rice crop and lack of back-up support from the Department of Agricultural Extension.
6. On investigating ways in which farmers access information, for Output 2, it was found that women depend on their husbands for all new information, while marginal and landless farmers are rarely contacted by extension workers. All socio-economic groups have access to TV and radio.
7. Despite the wide range of institutions concerned with the promotion of RCTs they are not well co-ordinated and seem remote from poor farmers.
8. Researchers recommended that more emphasis is put on disseminating information concerning RCTs at gatherings such as *Haweli* that involve marginal farmers. These farmers could also be organised into Citizen Community Boards so that they can access government funding for agricultural equipment, including zero-till drills. This equipment would be shared by marginal and subsistence farmers.
9. 80% of women belong landless and marginal farming families. These women demanded information on vegetable production and food processing.
10. CABI scientists collaborated with CARITAS Pakistan to create an enabling environment by developing a curriculum for disseminating information on zero-tillage to 100 subsistence and marginal farmers through Farmer Field Schools (FFSs).
11. Wheat yields at three farmer practise (non zero-till plots) were 10–20% higher than wheat yields in FFS zero-till plots. However, cost benefit ratios (per acre) were higher in zero-tilled compared to non-zero-tilled plots, due to reduced labour costs.
12. 118 subsistence and marginal farmers were convinced of the benefits of using zero tillage following visits to two large-scale commercial farmers who had been using zero-tillage for wheat production for the past five years. Both farmers stressed the savings they make in terms of time and labour costs, but admitted that extra deep ploughing is needed to break up the plough pan that develops and that a 20% increase in pests should be expected in the following rice crop.
13. Farmers who attended the FFS were motivated to register as Citizen Community Boards and submit proposals for government funding to establish agricultural machinery pools.
14. CABI scientists provided additional support through the production of training resources, including posters, pamphlets and a zero-tillage training manual in *urdu* and by building farmer capacity in repair and maintenance of zero-till machines.

Acronyms

AO = Agricultural Officer
ARF = Adaptive Research Farm
ARO = Assistant Research Officer
CABI = CAB International
CCB = Citizen Community Board
CIMMYT = International Centre for Wheat and Maize Improvement
CTG = Community Tubewell Groups
DBG = Drainage Beneficiary Groups
DCO = District Coordination Officer
DDA = Deputy Director Agriculture
DDC = Deputy District Officer
DDOA = Deputy District Officer Agriculture
DFID = Department for Overseas Development, UK
DG = Director General
DGA = Director General of Agriculture
DO = District Officer
DOA = District Officer Agriculture
EDO = Executive District Officer
FA (UC) = Field Assistant (Union Council)
FAO = Food and Agriculture Organization of the United Nations
FFS = Farmer Field School
FMI = Farm Machinery Institute, NARC
FP = Farmers' Practice
HSO = Higher Scientific Officer
IATI = In-service Agriculture Training Institute
ICM = Integrated Crop Management
IPM = Integrated Pest Management
NARC = National Agricultural Research Centre
NARS = National Agricultural Research System
NGO = Non Governmental Organization
OFWM = On Farm Water Management
PARC = Pakistan Agricultural Research Council
RBC = Regional Bioscience Centre (CABI)
RCT = Resource Conserving Technology
RO = Research Officer
RRI = Rice Research Institute
RWC = Rice-Wheat Consortium
SARC = South Asia Regional Centre (CABI)
SSMS = Senior Subject Matter Specialist
TOT = Training of Trainers
WESA = Wheat Ecosystem Analysis
WM = Water Management
WUA = Water Users Associations
WWF = Worldwide Fund for Nature
ZT = Zero Tillage
ZTBL = Zarai Taraqiati Bank Ltd (formerly ADBP = Agricultural development Bank of Pakistan)

Introduction

Project Goal

Improved rural livelihoods through accelerated adoption of productive, appropriate and sustainable agricultural practises:

- Increased incomes and social benefits
- Increased productivity and food needs met
- Sustainable agro-ecosystems

Project Purpose

To maximise opportunities and options for livelihood improvement by ensuring the relevance, impact and sustainability of new production mechanisms to optimise uptake of beneficial practises to all social strata involved in agriculture.

Project Implementation

This project was implemented by scientists from CABI-Europe and CIMMYT South Asia, in collaboration with NARS scientists and local NGOs at five sites with rice-wheat farmers inhabiting villages across the Indo-Gangetic Plain: Dinajpur, Bangladesh (Wheat Research Centre + DIPSHIKA)

- Basti, Faizabad, India (Narendra Deva University of Agriculture and Technology)
- Varanasi, India (Institute of Agricultural Services, Banaras Hindu University)
- Belwa and Benauli, Terai Region, Nepal (Nepal Agricultural Research Council + CIMMYT Nepal)
- Sheikhupura and Sialkot districts, Pakistan (CABI Pakistan)

The Pakistan Team

In Pakistan, the Principle Investigator was Dr Tahseen Jafry, CABI Associate and specialist in Sustainable Development and the Regional co-ordinator was Dr Etienne Duveiller, Cereal Pathologist with CIMMYT South Asia. The Site Manager was Dr Ashraf Poswal, Director of CABI South Asia (based in Islamabad) and the research scientists were led by Mrs Bushra Raza Ahmad, assisted by Gulam Ali, also of CABI South Asia and field workers from CARITAS (International) Pakistan led by Raymond Rizzario.

Bushra Raza Ahmad and Gulam Ali at the Dhaka workshop

In depth studies on information pathways for Output 2 were conducted by Muhammad Azam Niazi, Akhtar Ali, Sajida Taj, Nadeem Akmal and Umar Farooq of the National Agricultural Research Centre, Islamabad.

The Rice-Wheat System in Pakistan

Rice and wheat are grown sequentially in a mainly irrigated, double cropping pattern in the Indo-Gangetic plains of South Asia on about 13.5 million hectares of land in Bangladesh, India, Nepal and Pakistan (Ladha, 2000). It is major cropping system for sustaining food security in the region and there are millions of farmers and agricultural workers dependent on this system for employment and livelihoods. Similarly the rice-wheat system of Pakistan is spread over 2.1 million hectares and represents nearly 9% of the global rice-wheat system. Nearly three-fifths of Pakistan's rice-wheat area lies in the Punjab province where about 10 million people are directly involved (Population Census, 1998). In Punjab, rice-wheat cropping sequence is practiced in Kalat tract, mainly covering Gujranwala, Sheikhupura and Sialkot districts. Rice-wheat is also practiced in the periphery districts (i.e. Lahore, Gujrat and Mandi Baha-ud-din) of these three main districts. From a national perspective, rice is Pakistan's export crop while wheat bears food security concerns, as wheat is the main staple food of Pakistani population.

The productivity of this important system has declined or stagnated during the last decades or so (Randhawa, et al, 1981; Aslam et al, 1993 and Aslam et al, 1991). Decline in productivity of this important cropping system shows sustainability problems (Sheikh et al, 2000). To keep pace with the changing requirements of the ever growing population under the free trade era of globalization there are demands for the rapid adoption of new technologies and methods. The system diagnostic studies conducted by Byerlee et al, (1984) and Sheikh et al, (2000) estimated big yield gaps between the potential and actual wheat yields realized by the farmers. Land preparation practices peculiar to the rice crop along with its planting time conflicts with the following wheat crop and are determined as major yield limiting factors. Flooded and puddle soil required by rice as compared to well drained conditions necessary for wheat (Hobbs, 1985) is one such example of these system conflicts. Late rice harvest, soil structure and plant residues creates difficulties for the preparation of a good seedbed for wheat crop (Byerlee et al., 1984). This results into late planting of wheat and farmers usually use broadcast methods for wheat sowing. Rainfall at the time of land preparation further delays planting of wheat by 2-3 weeks in the area (Aslam et al. 1991). Randhawa (1979) and Hobbs (1988) have reported that delaying the planting of wheat after mid November caused loss in grain yield at the rate of one percent, per day, per hectare. After identifying these problems, the Rice Wheat Consortium (RWC) for the Indo Gangetic plains, (involving International Agricultural Research Centres and National Agricultural Research Organizations) has developed and promoted a number of technologies that increase farm-level productivity, conserve natural resources and limit negative environmental effects.

To improve productivity in South Asia's rice-wheat cropping systems, zero-till methods were introduced into the region to encourage timely planting of wheat after rice. In Pakistan, adoptive research, designed to make zero-tillage methods suitable for local conditions, started during the mid 1980s following the importation of a prototype drill from New Zealand. Thanks to concerted long term efforts by researchers from Pakistan Agricultural Research Centre (PARC), researchers from International Maize and Wheat Improvement Centre (CIMMYT), and local machinery manufacturers, an effective zero-till seed drill was successfully developed for local manufacture. The adoption of these technologies has important implications for all farmers involved in rice-wheat farming systems and some of these will be addressed by this research.

Output 1: "Implications and benefits of new technologies on social well-being and system productivity and sustainability determined and key beneficial practices identified for each agro-ecosystem and social group within each community at selected benchmark sites."

1.1 Livelihood Impact Studies

Livelihood impact studies were conducted with 4 groups of farmers; cash-cropping/big farmers, subsistence, marginal and landless on the use of resource conserving technologies. Two villages in each of two districts were chosen for this study, i.e. Pindi Rateen Singh and Khohhar Ki Malian villages in Sheikhupura district and Bodha Goria and Malomay villages in Sialkot district. Presented below is an analysis and overview of the findings. The villages of Khohhar Ki Malian and Bodha Goria are non-adopted villages, which means that the machinery has not been introduced here. The other two villages are the initial core villages where the zero tillage technology was initially introduced under various agricultural programmes in 1998 (Malomay) and 1999 (Pindi Rateen Singh). The villages are also where agricultural extension workers have introduced new rice and wheat varieties through demonstration plots. This study captures the impact that these technologies have made to these villages. Future research work will focus on where and how the technology has spread from these villages to the wider area.

Using a Livelihoods Approach to Target the Poorest Farmers

The adoption of new technologies which impact on crop yields and/or household budgets pose a threat to the livelihoods of resource-poor farming families in terms of their food security and income, thus it is that only those farmers who have sufficient land to guarantee household food security throughout the year that can take the necessary risk. In an effort to target the poorest groups with our research, the following socio-economic categories were drawn up according to their ability to take risk:

- **Landless/food deplete farmer:** Must rent land or do paid labour to get food and pay for other necessities. *Cannot take any risks.*
- **Marginal/food deficit farmer:** Has insufficient land to achieve household food security. Regular shortage of food and cash. Must do labour in order to buy additional food, inputs and other basic necessities. Can enter a downward spiral very easily. *Cannot take any risks.*
- **Subsistence/self-sufficient farmer:** Has sufficient land to meet basic food needs under normal conditions. May need to do labour to pay for inputs and other necessities (including school fees). Remains vulnerable to economic and environmental shocks. *Is risk averse.*
- **Food Surplus/cash cropping farmer:** Has sufficient land to guarantee household food security. Able to produce surplus grain and cash crops for sale to buy inputs, send children to school and accumulate 'middle class' assets, e.g. bicycle, TV, electric fan. *Able to take risk.*

1.1.1 Background to introduction of zero tillage machine

In 1995, 96, 97 and 98, the dept of On Farm Water Management had been working on promoting the zero tillage technology with no budget. They did this by revamping old machines that had been given originally in the 1980's and giving them out to farmers. In 1999, a 3 year DFID funded project (covering Pakistan, India and Nepal) further promoted the use of this technology. This was followed by another project in 2000 from Massey University with New Zealand funding (which covered Uzbekistan and Pakistan) for 2 years. 2001 another New Zealand funded project (covering Pakistan and Nepal) for 3 years was

sanctioned and in 2001 the Asian Development Bank and New Zealand funded another project for 3 years.

However, in all this time there has been a conflict of interest between two government departments, i.e. On Farm Water Management and Agricultural Extension. The Director General of the Extension Department is clear in his views that he will "never" promote the zero tillage technology. This is a major bottleneck in the promotion and dissemination of the technology in Pakistan.

1.1.2 Background to introduction of new varieties

For assessing the impact of new varieties in the project sites, some basic information regarding varieties of wheat and rice has been collected.

(a) Rice

Previous grown varieties in the project areas were *Basmati 385, Basmati 386, Basmati 370* and *Hero*. These varieties were recently replaced with *Basmati Super, Basmati 2000*. A few farmers (10% of all interviewed) are still using *Basmati 385*, even though it is banned by the government. Reasons for replacing the old varieties were low productivity and lodging problems. In case of variety *Hero*, the problem was its bad taste.

New varieties give high yield, have a good market value and taste better. However, the problem associated with them is attack of rice leaf folder. With *Basmati Super*, manual threshing is a big problem. It is also reported by farmers interviewed that about 15% of farmers are using a variety known as *Supra* which is claimed to be an Indian variety. Agriculture extension workers have forbidden the farmers from using this variety.

Agriculture extension workers basically introduced these varieties through demonstration plots. But later on they spread to near by villages through the farming community.

(b) Wheat

Previous grown varieties in these areas were *Mexipak, Lailpur 33* and *Auquab*. These varieties have been replaced with *Pak 81, Inqalab 91* and *Watan*. The main reason for replacing the old varieties with the new is low productivity.

New varieties provide a higher yield, good market value and taste better. There are no insects, pest and disease problems on these wheat varieties, as indicated by the farmers interviewed. However, during field visits it was observed that WATAN variety is susceptible to rust.

Agriculture extension workers basically introduced these varieties through demonstration plots. But later on they spread to near by villages through the farming community.

1.2 Results of Zero Tillage Impact Studies

1.2.1 Machinery livelihood impact assessment

Of the four project sites in rice-wheat areas of Punjab, two are non adopted villages and two are adopted villages. Presented below are the findings of the impact studies undertaken. During the survey many questions were asked to the farmers in order to understand the reasons why they are and are not using the zero-tillage machine. The reasons are summarized below from the farmers perceptions from all the four project sites. The perception by each socio-economic group has been compiled together. Responses of farmers from each socio-economic group is compiled under a separate report.

1.2.2 Khokar Ki Malian, Sheikhupura District

This is a non-adopted village of the project. The farmers here have not had exposure to this machine in their village. Therefore they do not use it. However, in the neighbouring village of Soa Ki Malian there has been a farmer using zero tillage machine. The farmer in Soa Ki Malian used it in 2001-02 then left it in 2003-2004 and is now again using it. His reason for using it initially was that is was being provided by a research and development project. The machine

was then taken away and so he could not use it. Now again in this season, the machine is being promoted by another organization so he has access to it again and is using it.

Farmers from Khokar Ki Malain have seen the machine being used in other villages, such as, Farukabad (25km away), Muriedkay (16km away), Kathianwala (4km away). But the farmers who are using the machine in these areas are big landholders who have bought the machine from Daskar and do not lend it on hire basis. Daskar is the nearest town that manufacturers zero tillage machines, which is approximately 80-90km away from Khokar Ki Malian. There are no suppliers or dealers of this machine in Sheikhupura district. The farmers say the main constraint is access to the machine and timely availability. The tractor owners in Khokar Ki Malian say they cannot afford to buy zero tillage machines.

- **Options to improve access.** Through this project, the farmers from Khokar ki Malian are now linked with CARITAS (an NGO) to develop a Citizen Community Board (CCB) machinery pool group. This is where the government provide 80% subsidy to the group and the farmers provide 20% in order to obtain improved machines for farm work.
- **Supply centers/hire schemes.** The possibility of supply centers was discussed. However, small and Marginal farmers are afraid the larger farmers will get preference over them and so they will not benefit from hire schemes.

The situation regarding women in this village is that they are involved in agricultural work. Regarding staple crops, women are involved with, transplanting, weeding, harvesting, threshing, seed storage. In vegetable cultivation, they are involved with weeding, hoeing and picking. Women indicate that they want to get involved in activities that enable them to get an income e.g. agro-processing of vegetable and fruits. However they do not have any access to knowledge and information. Furthermore, women of subsistence and rich farmers are not allowed to go out for training but women of poorer and marginal farmers are allowed i.e. a status issues. There are various routes to get information to women. For instance through women trainers and NGO workers who can work with women directly in the villages.

(a) Farmer Field School (FFS) of zero tillage machine at Soa Ki Malian

In order to promote the use of zero tillage machine in the area, the project has undertaken a farmer field school at Soa Ki Malian which is near the project site. The field school has set up comparison plots i.e. under zero tillage and under conventional method. So far, the feedback from farmers is positive. The farmers feel that that there will be a better yield compared to the conventional plot. The farmers visit the plot every 14 days to see how the crop is establishing and progress is being monitored.

(b) Training of Trainers (TOT) plot

CABI has established a training of trainers plot at the Rice Research Station, Kalashah Kaku, Sheikhupura. The purpose of the TOT plot is to provide training to NGOs, Government extension, farmers groups on the zero tillage technology. The reason for this is that CABI cannot promote the technology itself, therefore, the TOT plots are used to train others so that they can pass information to their farmers via FFS so reaching many more areas and farmers. Progress on this is being monitored.

1.2.3 Pindi Rateen Singh, Sheikhupura District

The machine was initially introduced to Landlord Nasreen Begum for demonstration purposes in 1999 and where farmers could come an observe the plots. The farmers initially had access to the machine in 2000 when it was introduced by the On Farm Water Management Dept. The machine was kept in the OFWM office in Kanoka, 30 km away. Preference was given to larger farmers and farmers they were familiar with. The farmers used the machine in 2000-2001 and 2001-2002. In 2002-2003 fewer farmers had access to the machine. In 2003-2004 farmers did not get the machine at all. The machines were not in the office, probably being used by farmers elsewhere. The farmers in this village now did not have access to the machine at the right time and so they converted back to using the conventional method.

There are other zero till machines in the area: Chak No 26 – (1km away) where there is 1 machine and Joyanwala (8 km away) where there are 6 machines, 2 owned by subsistence farmers and 4 owned by big farmers.

In Pindi Rateen Singh in 2004-2005 one big farmer in the village, Malik Shahbaz (who has 15 acres of his own plus he rents 145 acres) owns a ZT machine and has hired it out to a few farmers. In 2004-2005, 6 farmers have hired the ZT machine to use in their fields.

The following issues have been raised about the use of the machine

- Drainage - ZT is a problem on clay loam soil especially when there has been heavy rainfall. When there is heavy rainfall, the soil becomes hard and does not allow the water to penetrate into the ground. The water is left standing in the wheat field. Wheat does not grow well in water-logged soil. The problem seems to one of poor drainage.
- Short spike length - this becomes an issue when farmers put too much seed into the field than the recommended amount. If the farmers use 60kg per acre there is not enough space per plant and results in short spike length but if they sow 40 kg/acre there is no problem.
- Rice stem borer is a problem as indicated by a number of farmers.
- Discouragement from Dept of Agricultural Extension - the agricultural extension staff came to the village to discourage farmers from using the machine because of soil compaction and short spike length.

One farmer who has clay loam soil and has been using zero tillage for 3 consecutive years indicated that there is no difference in wheat production between conventional and zero tillage methods. But there are differences in time saving and seed and fertilizer used. He did also observe short spike length.

The women in this village are involved in land preparation for vegetable production, sowing, transplanting, harvesting, weeding, threshing and seed storage. They have no access to any new knowledge or information.

1.2.4 Bodha Goria, Sialkot District

This is an non-adopted village. The nearest ZT machine to this village is in Chalaki Garia which is 1km away. There is one machine in Chalaki Garia which is owned by a big farmer. He is using it on 18 acres out of his 30 acres. He has been using it since 2002. There is another machine in Dugria, which is 3km away. It is owned by a big farmer who has 40 acres. He hires it out to others for 6-700 Rs/acre (including tractor). Other than these two villages, there is no other village in the neighbouring areas that have ZT machines.

One farmer in Bodha Goria hired the machine from Chalaki Garia in 2003-2004 for 500 Rs per acre. He is now interested in growing potatoes rather than rice/wheat so does not need the ZT machine. When he did use it in 2003-2004, the other farmers from the village told him not to because it will destroy his land and the birds will come and eat the seeds. But now they think it is good because they know of others who have used it outside of their village. The problem is that they cannot afford the hire charges.

In Bodha Goria there are 600 households and 14 tractors. The tractor drivers cannot afford to invest in buying a machine. They are also not guaranteed a rental market even if they did buy the machine so they are not willing to take the risk.

Through the help of this project, the farmers have been organised into a group and are working with CARITAS to develop a Citizen Community Board (CCB) machinery pool to get a ZT machine. This is where they will get 80% contribution from the Government towards the cost of a ZT machine and 20% will be the group's contribution.

1.2.5 Malomey, Sialkot District

The ZT machine was introduced in this village in 1998 under the FAO Crop Maximization Project. It was also promoted by the On Farm Water Management Dept. The farmers contributed 50% share towards the purchase of a ZT machine, the other 50% came from the FAO project. The machine is kept in the village farm service center. The farmers used the machine in 1999 and 2000. The responses from the farmers are given below.

On clay loam soil:

- Uneven land – the soil is not level because the rice is transplanted manually and the stubbles are left in the ground, this type of uneven land is not good for zero till machine.
- The weight of the combine harvester wheels running over the land makes the soil uneven.
- Insect infestation, mainly grasshoppers, which eat and cut the crop.
- Clay loam soil does not allow the root system to develop properly which results in plant lodging problems.
- Small spike length which is an indication of less yield.

When the farmers used the drill on silt soil there were no problems like the ones mentioned above.

60% of this village has clay loam soil whilst 40% has silt loam soil. The total land holding is 1400 acres out of which 80% is for rice and wheat, 20% is for vegetables and sugar cane. None of the farmers want to use the ZT, they prefer to use the rabi drill instead even though they recognise that under some soil types the ZT machine is useful. The rabi drill gives a better yield. Every year farmers use the rabi drill inside and outside the village.

In 2002, 7 farmers from outside the village have come to take the zero till drill, after that no one has come. The farmers want to sell it but no one wants to buy it. This may also be because it has not been used since 2000 and it does not look in good condition.

The farmers also indicate that the On Farm Water Management Dept have given false statements to them, such as, that 300 acres are under zero till when it is not. The Extension Dept do not provide any backup support.

The farmers are aware of machines that are sold in Daskar. But they believe that these machines are sold to farmers who have saline soil or silt soil not clay loam soil.

One of the reasons given for non-adoption of the machine in these villages is the use of early maturing varieties. Some of the farmers for the last 2-3 years have been growing early maturity rice varieties and so they have enough time to prepare the land by conventional methods.

1.2.6 Summary of zero tillage machine use

It is observed that the farmers' most important agenda is to have technology which should be suitable for the soil type, be of low input cost, be accessible and result in increased productivity. When a technology meets all these requirements then the farmers do adopt it. However, the situation regarding the use of the zero tillage machine in the field is different. From the results of the survey, the main issues regarding the use of this technology are summarised.

(a) Non –adopted villages

- Local access and availability at the right time of the season. In oder to overcome this problem, the project is developing Citizen Community Board Machine Pools in Khokar Ki Malian and Bodha Goria. This is where the government provide 80% subsidy to the group and the farmers provide 20% in order to obtain improved machines for farm work. As a model, it could be introduced into other villages too.

- Financial constraints – this is being dealt with via the CCBs.
- Lack of knowledge and awareness. This issue is being dealt with via FFS e.g. at Soa Ki Malian.
- Dissemination of knowledge on a wider scale – The project has under taken training of trainers programmes to educate NGOs, govt extension officers, field workers etc in the use of this technology and to spread the knowledge more widely.

(b) Adopted villages

- Drainage - ZT is a problem on clay loam soil especially when there has been heavy rainfall. When there is heavy rainfall, the soil becomes hard and does not allow the water to penetrate into the ground. The water is left standing in the wheat field. Poor wheat growth is associated with water-logged soil. The problem seems to be one of drainage.
- Short spike length - this becomes an issue when farmers put more seed into the field than the recommended amount. If the farmers use 60kg per acre there is not enough space per plant and results in short spike length but if they sow 40 kg/acre there is no problem. There is also an indication that because of soil compaction, the roots were not able to grow properly and this resulted in small spike length and results in lower yield.
- Pest problems – rice stem borer is a problem as indicated by a number of farmers.
- Discouragement from Dept of Agricultural Extension - the agricultural extension staff came to the village to discourage farmers from using the machine because of soil compaction and short spike length.
- The agriculture extension department is not keen to provide back-up support to the farmers on the use of this technology.
- Timely availability to small farmers - zero tillage machine is not available at the right time therefore they prefer to use conventional methods. Lack of availability is also a major reason for not adopting this technology.
- Gender issues - on average 90% of the farmers interviewed were not willing for any technology to reach the female community. The reason given was that they do not want women to be empowered, the fear is that once women are empowered the societal system will collapse. However, female farmers want to have such kinds of technology that generate income for them and do empower them. Women are also interested for income generating trainings such as, food preservation, dying etc.

1.3 Results on Impact of Using New Rice and Wheat Varieties

Only farmers from Malomay village have attended the demonstration plots only. In Pindi Rateen Singh village, farmers boycotted the demonstrations for political reasons although they are using these new varieties. However, in the village of Khokhar ki Malian and Budha Goria, not a single demonstration plot has been established so far.

1.3.1 Impacts of new varieties on the farmers in Malomay village, Sialkot District

In Malomay village, 15 farmers were interviewed. 3 were Marginal farmers, 8 Subsistence and 4 Cash croppers. The impact of new varieties on these different groups of the society have been summarised below.

(a) Impacts on Marginal farmers

Socio-economic impact

None of these farmers have any labourers to work with them on their farm. The farmer and his family do all the field work from transplanting to harvesting, grain storage and marketing. Through adopting new varieties, the income of these farmers has increased. On average of 5

maunds/acre i.e. 200Kg/acre increase in rice production and average 7 maunds/acre i.e. 280 Kg/acre production increase in wheat production. They are now food secure however there are some risks associated with the new rice varieties such as high pest infestation especially rice leaf folder. There are not any problems reported on new wheat variety.

Human impacts
The survey showed that farmers are confident while choosing these varieties for their use because of its high yield. But they did not have any knowledge about the recommended amount of nutrient/fertilizers and other inputs required even though agriculture extension workers have visited this village. More over they are using less amount of recommended dosages of fertilizers. These farmers have not had any training on IPM. The farmers purchase seeds and inputs from the middle man, often on credit basis. They have lack of knowledge about what seed they are getting, how to grow it, what the requirements are of that particular variety. The middle man is also illiterate and has little knowledge about the varieties he sells and inputs required. The middleman is often a local farmer/cash cropper of the area.

Overall male farmers have more access to knowledge compared to female farmers. It is also observed that male farmers are not willing to inform their wives mainly due to cultural barriers. Information and knowledge mainly flows from male family member to female family members, only if the male is willing to share his information.

Natural resource/biological impacts
The seeds of new varieties are available in the market with the middleman. But getting access to quality seed is a problem. Often, farmers will store some grains for using them as seeds in the next season. However, farmers do not have any technical training or knowledge of grain storage or grading. Grain storage is done by female farmers, who have even less access to new knowledge.

The yield of new varieties are comparatively higher than the previous varieties. For instance, approximately 200kg/acre yield increased in rice and 280kg/acre yield increased in wheat.

Land of these farmers were consolidated and clay loam type.

Farmers have reported rice leaf folder problem on rice. Farmers are unaware of applying balanced fertilizers and inputs. Not a single farmer had knowledge about the application of Potash in their field.

Institutional impacts
The farmers are willing to get training on integrated crop management, grading, marketing etc. There is interest to have more interaction with the agriculture extension system especially in introducing new varieties, checking problems they are facing as well as helping to purchase seeds from the local market or middleman.

Not a single farmer was willing to involve the female farmers in having access to new knowledge. Consequently, females of the areas are also not interested in agriculture work. They are more interested in training on income generating activities such as food processing or football stitching etc.

(b) Impacts on Subsistence farmers

Socio-economic impacts
None of the six farmers interviewed have any labourers to work with them on their farm. The farmers and their family members themselves work on their own fields.

Same as for marginal farmers.

Human impacts
Same as for marginal farmers.

The females of this group have the advantage of watching TV or listening to the radio. Only a few females showed their interest to be informed through TV or radio. Most are not interested in watching/listening on informative programmes.

Natural resource/biological impacts:
Same as for marginal farmers.

About half of the farmers reported rice leaf folder problem on rice but no pest or disease infestation on wheat has been reported by them.

They have no idea of applying the balance fertilizers and inputs. Only a few farmers knew the application of Potash in their field or zinc application to the rice nursery. They came to know about this information through watching TV.

75% of the farmers land is consolidated while 25% is fragmented. The soil is clay loam.

Institutional impacts:
Same for marginal farmer.

(c) Impacts on Cash croppers

Socio-economic impacts
Four farmers were interviewed. This group of farmers do employ labourers to work for them on their farm. Most of these labours are Landless people and get paid daily wages. These farmers also employ poor peoples from neighbouring villages. Employees are both male and female. However, women are paid half the amount given to men for the same work.

Through the introduction of new varieties, the income of these farmers have increased on average 6 maunds/acre i.e. 240Kg/acre increase in rice production and on average 7 maunds/acre i.e. 280 Kg/acre production increase in case of wheat production. This group of farmer are food secure but have the problem of high pest infestation especially rice leaf folder. No pest problems have been reported on new wheat crops. Chemicals are used for the control of some pests.

Human impacts
Same as for other farmers. Except that this group purchase the seeds and inputs from the market and from the agriculture officer after observing the demonstration plots.

Natural resource/biological impacts
Seeds of these new varieties are available from the agriculture extension officers and they are purchasing these seeds from them. The farmers store some grains for using them as seeds source for the next season crop. However, they do not have any technical training of grain storage or grading etc.

There is no knowledge of applying the balance fertilizers and inputs. Only a few of the farmers interviewed knew the application of Potash in their field or zinc application to the rice nursery. They came to know about this information through agriculture extension officer.

Institutional impacts
The farmers are willing to get training on Integrated crop management, grading, marketing etc. The majority of farmers indicate that there needs to be more interaction with the agriculture extension system particularly in introducing new varieties and providing back-up support to problems occurring.

Not a single farmer was willing to involve the female farmers in getting new knowledge. Also, the females of this group are also not interested in any field related activity.

1.3.2 Impacts of new varieties on the farmers in Pindi Rateen Singh village, Saikhupura District

In Pindi Rateen Singh 15 farmers have been interviewed. Of this, 6 were Marginal farmers, 6 Subsistence and 3 Cash croppers. The impact of new varieties on these different groups of farmers is summarised below.

(a) Impacts on Marginal farmers

Socio-economic impacts
Six marginal farmers were interviewed. The same observations as for Malomey village.

The only difference between this group and the same socio-economic group in Malomey village in the yield increase obtained from using new varieties. The income of these farmers have been increased as an average 5 maunds/acre i.e. 200Kg/acre increase in rice production and on average 6 maunds/acre i.e. 240 Kg/acre increase in wheat production.

Human impacts
The same observations as for Malomey village. The only differences are that here, the farmers apply excessive amount of Urea and most of the research and extension activities in this village are carried out with landlords and not with the common farmers.

Natural resource/biological impacts
The same as for Malomey village except here 100% grain storage is done by female farmers.

Yield of these new varieties are comparatively higher than the previous varieties as about 200kg/acre yield increased in rice while 240kg/acre yield increased in wheat. Fifty percent farmers have consolidated land while other 50% have fragmented land. The soil of the area is very much suitable for the zero-tillage technologies. It is Loamy soil.

About 40% farmers reported rice leaf folder problem on rice while no pest or disease infestation on wheat has been reported by these farmers.

Institutional impacts
The farmers are willing to get training on Integrated crop management, grading, marketing etc. More than half of the farmers interviewed are interested in interaction with the agriculture extension system.

Not a single farmer was willing to involve the female farmers in getting the knowledge. However, the females of this area are interested in getting new knowledge about agricultural works since they are involved in agriculture from land preparation to seed storage. They also wanted to get training in income generating activities like vocational training or food processing, etc.

(b) Impacts on Subsistence farmers

Socio-economic impacts
Six subsistence farmers were interviewed. Same observations as for Malomey village.

Human impacts
The same as for Malomey except. Agriculture extension workers visit only selective places in the village and introduce new varieties to the farmers who have a close relationship with some high authorities. The rest of the farmers have been completely ignored. Due to this, farmers have no regard for this department and this is also the reason for lack/little knowledge about the new agricultural practices and crop management.

Male farmers have more assess to the knowledge as compared to the female farmers. It is also observed that male farmers are not willing to inform their females because of several reasons i.e. cultural constrains. The information flows from male family member to female family members, only if the male is willing to share information.

Natural resource/biological impacts
Same observations as for Malomey village.

A few subsistence farmers have reported rice leaf folder problem on rice while no pest or disease infestation on wheat has been reported by them.

The land of 50% of these farmers are consolidated while the other 50% has fragmented land. The soil is clay loam.

Institutional impacts
The same observations as for Malomey village.

(c) Impacts on Cash croppers

Socio-economic impacts
Three farmers were interviewed in this category. This group of farmers do employ labourers to work for them on their farm. Most of these labours are landless people and get paid daily wages. These farmers also employ poor peoples from neighbouring villages. Employees are both male and female. However, women are paid half the amount given to men for the same work.

Through using new varieties, the income of these farmers have been increased on an average 5 maunds/acre i.e. 200Kg/acre in rice production and on average 7 maunds/acre i.e. 280 Kg/acre production in wheat.

Same observations as for Malomey village.

Human impacts
Same observations as for Malomey except that most of the time the farmers purchase the seeds and inputs from the market or neighbouring village farmers. They have better access to agricultural extension workers for information.

Natural resource/biological impacts
Same as for Malomey village except that seeds of these new varieties are available with neighbouring farmers. They purchase then replicated them.

Institutional impacts
Farmers are willing to get training on Integrated crop management, grading, marketing etc. The farmers are not interested in the agriculture extension system and prefer that NGOs play an increased role in introducing new agricultural technology, varieties and providing back-up support.

Yield of these new varieties are comparatively higher than the previous varieties as about 200kg/acre yield increased in rice while 280kg/acre yield increased in wheat.

Only one cash cropper reported rice leaf folder problem on rice while no pest or disease infestation on wheat has been reported by them.

They have no idea of applying the balance fertilizers and inputs. Only one farmer knew the application of zinc to the rice nursery. While rest of them didn't know this. He came to know about this information through fellow farmers of the other village.

Not a single farmer was willing to involve the female farmers in getting the knowledge. While the female of this group is also not interested in any field related activity.

1.3.3 Impacts of new varieties on the farmers in Khokhar Ki Malian village, Saikhupura District

The community of Khokhar ki Malian village have different religious backgrounds. Since they do belong to different religions, the environment is some what liberal and conducive for women. In this village, an integrated crop management training programme has been planned only for women farmers using the farmer field school approach. During the survey, 15 farmers were interviewed, out of them 6 were marginal farmers, 6 subsistence and 3 cash croppers. The impact of new varieties on these different socio-economic group has been summarised.

(a) Impacts on Marginal farmers

Socio-economic impacts
Same observations as in Pindi Rateen Singh.

Human impacts
Same observations as in the previous villages except that here there is some awareness about nutrient/fertilizer applications on rice. This is because CABI Pakistan in collaboration with Caritas Pakistan launched a season long Rice ICM training program with the farmers of

this village. No agriculture extension worker has visited this village. The farmers have become aware of new varieties from neighbours and village farmers.

Male farmers have more access to new knowledge as compared to the female farmers. The information flows from male family member to female family members. But now the trends are changing day by day.

Natural resource/biological impacts
Same as for previous villages.

Yield of these new varieties are comparatively higher than the previous varieties. It is approximately 250kg/acre yield increased in rice and 290kg/acre yield increased in wheat.

The majority of farmers have consolidated land. A few have fragmented land. The soil of the area is basically clay loam.

The majority of farmers report rice leaf folder problem on rice while no pest or disease infestation on wheat has been reported by these farmers.

Institutional impacts
The farmers are interested to have training on integrated crop management of different crops, vegetables and cereal crops. There is also particular interest in vegetable ICM training for female farmers, grading, marketing etc. No varietal demonstration plots have been ever established in this village by the agriculture extension department. There is considerable interest by the farmers to have interaction with the agricultural extension department.

(b) Impacts on Subsistence farmers

Socio-economic impacts
Same observations as in the previous two villages. Except that in this village there is more awareness of insecticide application on crops.

Human impacts
Same observations as for Malomey village.

Male farmers have more access to new knowledge as compared to the female farmers but the information does seems to flow from male family member to female family members. The females of this group showed their keen interest in getting some vegetables IPM/ICM training and vocational training in order to generate income.

Natural resource/biological impacts
Same observations as for Malomey village.

Land of these 50% farmers are consolidated while 50% is fragmented. While soil is clay loam.

Institutional impacts
The majority of farmers have expressed their interest in developing links with the agricultural extension system. They are aware that having a link will provide them with new agricultural knowledge. Unfortunately the agriculture extension workers are not operating in this village.

Females of this village are interested in the agriculture sector. They want to get training in income generating activities like vocational training, food processing, IPM, grading, packing, marketing etc.

(c) Impacts on Cash croppers

Socio-economic impacts
In this category, three farmers were interviewed. They do not have labourers to work for them but they do hire some farmers, mostly from outside the village, occasionally on a temporary basis. Most of these labours are landless people and work on daily wages. Women earn half as much as men for the same work.

The income of these farmers have been increased on average 5 maunds/acre i.e. 200Kg/acre increase in rice production and 7 maunds/acre i.e. 280 Kg/acre in case of wheat production after the introduction of these new varieties. They are food secure but having the same

problem of high pest infestation especially rice leaf folder attack on rice crop. While they didn't reported any problem on wheat crop. They used chemicals to control of pest problems. The yield of new varieties of both, rice and wheat, is comparatively higher than the previous varieties.

Human impacts
Survey showed that farmers are confident while choosing these varieties for their use because of its high yield, good taste and market value. They are aware of the recommended amount of nutrient/fertilizers and other inputs required in rice crop but not in wheat crop. Almost all the farmers are using less the amount of recommended dosages of fertilizers in wheat crop. They purchase seeds and inputs from the market or from neighbouring village farmers.

Male farmers have more access to new knowledge as compared to the female farmers but they are willing for females to have more awareness as well. But females of this group have little interest in field activities. They only take care of their household activities or play a role in seed storage only.

Natural resource/biological impacts
New seed varieties are available from neighbouring farmers and from the market. The seeds are purchased and then replicated. Most of the time the farmers store grains from the previous crop for using them as seed source for the next season. But they don't have any technical training of grain storage or grading etc.

Yield of these new varieties are comparatively higher than the previous varieties as about 200kg/acre yield increased in rice and 280kg/acre in wheat crop.

All of the cash croppers reported rice leaf folder problem on rice while no pest or disease infestation on wheat was reported.

Institutional impacts
The farmers are willing to get training on integrated crop management, grading, marketing etc. Farmers showed their interest in improving agriculture extension system for the accessibility of new technologies along with NGOs. NGOs are playing a great role in creating awareness among the farming community.

1.3.4 Impacts of new varieties on the farmers in Bodha Goria village, Sialkot District

Like Khokhar Ki Malian, the residents of this village come from different religious backgrounds i.e. Muslims and Christians. They have been are settled in the village for generations. But the relationships between these two groups are formal rather than informal.

In this village 20 farmers were interviewed. Of this 11 are marginal farmers, 7 subsistence and 2 cash croppers. The impact of using new varieties on these different socio-economic groups has been summarised.

(a) Impacts on Marginal farmers

Socio-economic impacts
The same observations as for the previous villages except that the income of these farmers have been increased by an average 4 maunds/acre i.e. 160Kg/acre in rice production and by an average of 6 maunds/acre i.e. 240 Kg/acre in wheat production.

Human impacts
Same observations as in the previous villages.

No agricultural extension staff visit this village.

Male farmers have more access to new knowledge as compared to the female farmers. The information flow is from male family member to female family members.

Natural Resource/biological Impacts
Same as for Khokar Ki Malian villages.

Yield of these new varieties are comparatively higher than the previous varieties as about 160kg/acre yield in rice while 240kg/acre yield in wheat.

Some farmers have consolidated land while others have fragmented land. The soil of the area is basically clay loam.

Approximately half of the farmers reported rice leaf folder problem on rice while no pest or disease infestation on wheat has been reported.

There is no knowledge of applying balance fertilizers and inputs on rice and wheat crops.

Institutional Impacts:
Same observations as for Khokar Ki Malian

(b) Impacts on Subsistence Farmers

Socio-economic impacts
Same observations as for Khokar Ki Malian.

The income for these farmers has been increased by an average of 5 maunds/acre i.e. 200Kg/acre in rice, and an average of 6 maunds/acre i.e. 240 Kg/acre in wheat.

For the control of pest problem they apply chemicals mainly to control rice leaf folder. The yield of new varieties of both, rice and wheat, is comparatively higher than the previous varieties reported by these farmers.

Human impacts
Same observations as for Khokar Ki Malian.

Male farmers have more access to new knowledge as compared to the female farmers. Any new information flows from male family member to female family members.

Natural resource/biological impacts
Same observations as for Khokar Ki Malian.

The majority of farmers report rice leaf folder problem on rice while no pest or disease infestation was reported on wheat.

The majority of farmers have consolidated land. A few have fragmented land. Soil of the area is clay loam.

Institutional Impacts:
Same observations as for Khokar Ki Malian.

(c) Impacts on Cash cropper

Socio-economic impacts
The two farmers interviewed do not have labourers working for them but they do hire some farmers from neighbouring villages occasionally on daily wage basis. Women are paid half the amount than men for the same work.

The income of these farmers has been increased by an average of 5 maunds/acre i.e. 200Kg/acre in rice and 7 maunds/acre i.e. 280 Kg/acre in wheat after the introduction of these new varieties.

They use chemicals for the control of pest problem, leaf folder on rice.

Same observations as for Khokar Ki Malian.

Human impacts
Same as for Khokar Ki Malian except here there is no knowledge of application of fertilizer dose.

Male farmers have more access to new knowledge as compared to the female farmers. Males of this area are not interested in the development of females. Meanwhile females of this group have also very little interest in field activities. They only take care of their household activities or play a role in seed storage.

Natural Resource/biological Impacts
Same as for Khokar Ki Malian.

Yield of these new varieties are comparatively higher than the previous varieties as about 200kg/acre yield in rice and 280kg/acre in wheat crop.

All of the cash croppers reported rice leaf folder problem on rice while no pest or disease infestation was reported on wheat.

Institutional Impacts
The farmers are willing to get training on integrated crop management, grading, marketing etc. Farmers showed interest in improving the agriculture extension system for the accessibility of new technologies along with NGOs, because NGOs are playing a greater role in creating awareness among the farming community. The farmers want demonstration plots of new varieties, field days, awareness creating workshops at community level, etc.

1.3.5 Summary of impact of using improved rice and wheat varieties

Socio-economic issues
In all four villages, the impact from the increase in production of rice and wheat from adopting new varieties is clear. All the farmers interviewed now state that they are food secure. However, what remains unclear is the cash benefit from adopting new varieties. How much of the increase in production is for home consumption and how much is sold for income.

Cash croppers have the greatest amount of land and they are in a position to hire labourers to work on their land for daily wages. It is also the larger farmers who are able to purchase and use chemicals to control insects and pests. None of the marginal farmers indicated that they control pests using chemical pesticides. This could also be because they do not have the knowledge on how to tackle pest control.

Human Issues
Despite the fact that the majority of farmers from across the four villages have not attended field trials or demonstrations of new rice and wheat seed, the level of adoption of new rice and wheat varieties is excellent. All the farmers interviewed are using improved rice and wheat varieties. This suggests that knowledge is disseminating among the farming community but mainly via informal routes such as farmer-farmer rather then formal routes such as the government agriculture extension system.

Access to improved seeds is mainly via a middleman who is often a local farmer or cash cropper. These farmers are illiterate and have little knowledge about the seed they are selling, or the required doses of inputs needed to maintain healthy crop growth. As a result, the farmers who purchase the improved seeds also do not know about how to maintain a healthy crop.

In two villages, Bodha Goria and Khokhar Ki Malian, there has been no visit by agricultural extension staff. In these villages there is very little information and awareness of how to grow new varieties properly and how to deal with problems as they arise, particularly pest control. In Khokar Ki Malain, there has been some NGO activity on nutrient/fertiliser application which has increased knowledge a little but much more institutional interaction and linkages development is required.

In Malomey and Pindi Rateen Singh, agricultural extension activities are done with the landlords and better off farmers, the rest of the farming community is ignored.

As a result, the poorer farmers are always playing catch-up in obtaining any new knowledge and information.

Overall, male farmers have more access to knowledge and information on new agricultural practices than female farmers. In three of the villages is was observed that male farmers are not willing to pass information to inform their females mainly due to cultural barriers and the fear of women empowerment. Information and knowledge mainly flows from male family member to female family members, only if the male is willing to share his information. In

Pindi Rateen Singh, women do work in agriculture and they do want access to information but they are denied this by their male counterpart. But in Malomey and Bodha Goria, the women are actually not interested in gaining new agricultural knowledge. They prefer to work around the home. The only exception is the village of Khokar Ki Malian where there is an active interest by women in the agriculture sector. They want to get training in income generating activities like vocational training, food processing, IPM, grading, packing, marketing etc.

Natural Resource/Biological Issues

For marginal and subsistence farmers, access to quality seed is a problem. On the whole, cash croppers can obtain seeds from the agricultural extension officers, markets and neighbouring farmer contacts.

Another major problem is grain storage. Often, farmers will store some grains for using them as seeds in the next season. However, farmers do not have any technical training or knowledge of grain storage or grading. To complicate matters further, grain storage is done by female farmers, they have even less access to new knowledge and their male counterparts are not willing to provide any new information to them.

All most 70-80% farmers of farmers interviewed indicate that rice leaf folder is a real problem. The cash cropper and better-off farmers are able to control pests through using chemicals, the exception being Khokhar Ki Malian village where they are practicing an ICM approach because they have been trained by CABI Pakistan and CARITAS. Since rice leaf folder is a problem it is suggested that research trials be done at farm level to check varietal susceptibility.

The marginal and subsistence farmer has no knowledge of balance use of nutrients and fertiliser for their crops.

Not a single farmer has reported any pest or disease problem on wheat crop. However, it was observed during field observations that there is a rust problem in wheat all four project sites, especially the area where wheat variety *Watan* is cultivated. The extent to which this is a problem requires further study.

Institutional Issues

There is considerable interest from all socio-economic groups of farmers on obtaining knowledge and training on ICM, grading, marketing etc.

In marginal and subsistence farmers indicate interest in developing better links with the agricultural extension system particularly to introduce new practices, technologies, varieties and to provide essential back-up support. Whereas, the cash croppers indicate more interest on the extension support offered by NGOs. The farmers want demonstration plots showing new varieties, field days, awareness creating workshops at community level, etc. It would be interesting to explore why this is the case. It maybe because marginal and subsistence farmers are unaware of alternatives to the government agricultural extension system.

Output 2: "Agriculture knowledge systems identified in regions concerned, uptake and adoption blockages ascertained and strategies developed to overcome these blockages and optimise pro-poor development"

2.1 Introduction

The results of our survey of access and control of RCTs in the four project villages were shared with other the regional project teams form India, Nepal and Bangladesh at the Dhaka workshop, held in May 2004. The objective of this workshop was to share the results of the surveys conducted by each project country for achieving Output 1 and also to share information on the knowledge systems prevailing in the areas associated with the uptake of new agricultural interventions, also identification of knowledge system blockages in the areas and developing strategies to over come those blockages. Thus at the end of that workshop, activities were planned in order to achieve project Outputs 2 and 3.

Knowledge is one of the important factors that can positively contribute in enhancing agricultural productivity. According to Ricardo (2004), in addition to the formal research institutions, there are multiple sources of information within farming systems i.e. input suppliers, traders and private individuals who supply information. The ability of farmers to control their environment is dependent on the resources they have. Among these resources, knowledge is an important component. To understand farming systems, it is just as important to understand its communication networks, as it is to understand its environmental situation. Farmers are stakeholders in a rural community; these stakeholders interact constantly, seeking knowledge to fulfil their needs. These patterns of communication constitute an integral part of a farming system and are part of an elaborate system: an agricultural knowledge and information system (Röling, 1988).

Many new technologies will not be effectively adopted unless communities are able to assess the value for themselves and prioritize and take up interventions that are relevant and suitable for their own circumstances. This requires a community-based approach to uptake via participatory process for technology evaluation and engagement with local knowledge, organizational, microfinance and small enterprise systems to catalyze change. This will involve identifying specific priority concerns with communities, exploring local farmer-support systems and industries (where mechanization is integral) and catalyzing change by introducing prioritized technology options to communities and exploring mechanisms by which they can be adopted and sustained within local systems. The technologies appropriate to particular communities will vary widely across the region (CABI Project Document, 2001).

Our main objectives under Output 2 were;

- To identify the agricultural knowledge system with its mechanisms and blockages, with the aim to find the solutions by which communities and particularly women, learn new about technologies, which help in maintaining/increasing food security.
- To improve the access to information and knowledge in order to empower farmers with confidence to make informed decisions on adopting any new technology of change in working practices.
- To develop a community based approach to create an enabling environment for technology uptake via participatory process for technology evaluation and engagement with local knowledge, organizations, microfinance and small enterprise systems to catalyze change.

Agriculture knowledge system in the area, its blockages and developing strategies for overcoming those blockages are as follows:

2.2 To Identify the Knowledge Blockages and the Most Effective Knowledge Pathways of Resource Conserving Technologies (Mainly Zero-Tillage and Improved Varieties)

2.2.1 Background

Dr Tahseen Jafry, CABI Associate visited Pakistan in March 2004. During her stay, the Pakistani team shared their activities with her and different important points regarding the fore mentioned Bangladesh workshop were discussed. Among those points, it was decided that group interviews were to be made in two project villages i.e. Malomay (Sialkot) and Khokhar ki Malian (Sheikhupura) in order to identify agriculture knowledge blockages and to identify the most effective knowledge pathways used for dissemination of resource conserving technologies. Further that this information should then be shared at the Bangladesh workshop held in May 2004, which would also help in planning activities to achieve project Output 02. It must be noted that in Malomay, people have been using the selected RCTs since the 1990's while in Khokhar ki Malian, people in general do not have much knowledge about the RCTs.

The questions used for getting the information from the groups were as follows:

Q1: What are the existing knowledge pathways for both male and female of all socio-economic groups of the area?

Q2: How to prioritize the effective knowledge pathways?

Q3: What are the strengths and weakness of the existing pathways?

Q4: What are the new and best pathways?

Q5: In contrast to RCT, what has been the failure of knowledge pathways?

Q6: What are the correct pathways?

Q7: Are there any NGO/ local organization working on the same line or not?

Q8: What is the institutional structure of knowledge dissemination?

2.2.2 Research findings

The results of the study are given below.

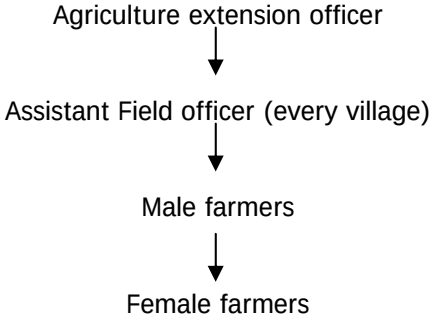
(a) Malomay Village

A group of 15 male farmers were interviewed and more than 25 women were also interviewed. The interview findings helped the project team to identify knowledge pathways existing in the village. The existing pathways for knowledge dissemination mainly for both male and female are as follows;

- Agriculture extension
- NGOs/projects
- Television/radio
- Print media

The strengths and weaknesses of these knowledge pathways are described as follows:

Agriculture extension



Strengths	Weaknesses
• They reach us timely when there is some kind of problem emerging in field. • Direct linkages developed. • Observe regularly disease incidence on crops. • Provide proper assistance for using recommended dosages of fertilizers, preparation of land, usage of insecticides etc for increasing per acre yield. • Provide proper guidance for water conservation. • Introduce seeds of new improved varieties. • Introduce new farm machineries and help in purchasing them.	• They make false promises. • There is no female extension officer for providing technical assistance to our farming female community. • They do not provide any advance technical training to farmers like that of off-season vegetable production, seed storage or food processing etc. • They have no innovative ideas in farming. • They do not arrange exchange visits for farmers and so farmers do not learn about new technologies and do not get motivated to adopt new and modern methods of farming.

NGOs

So far, there is no NGO working in this area so the villagers are not familiar with the strengths and weakness of NGOs but they think that if the workers from the NGO are honest and dedicated enough then it would be a good information channel for farming communities**.** Regarding weaknesses of the NGO, the villagers fear that they might only target one or two different kinds of socio-economic groups rather than all the groups of the village.

TV/Radio

The villagers made the following comments regarding TV and Radio as a communication channel.

Strengths	Weaknesses
• This is the best channel for getting information regarding new technologies throughout the world. • TV/Radio is available in each and every house throughout the country so an easy channel for communication.	• Not providing appropriate information. • Irrelevant information. • One way communication only. • The people loose their interest because the programmes are too boring. • Programmes are too short and complicated to address the farmer's real issues. • Improper time of programmes telecast. Almost all farmers were agreed that these programmes should telecast between 8 to 9 p.m. rather at 2-3 pm. When farmers are busy in field. • People are now not much interested in listening to radio. • Women in the area said that they don't like listening agricultural programmes on radio or TV. When these programmes were telecasted they turn over the channel or switched off TV or radio.

Print Media

Regarding print media, almost all of the male community were unhappy because of there is less projection of agricultural information and more projection of show biz world and violence in the society articles. The literacy rate is also very low in the villages so farmers are not able to read the newspapers. Societal relationships are also not good enough to allow people to sit together and share the necessary information.

According to the groups, the following is the percentage usage of different knowledge dissemination channels:

AT least 50% of farmers from each socio-economic group have TV/Radio:

- About 50-60% of landless farmers have both facilities
- 60% of marginal farmers have both facilities
- All subsistence farmers and cash croppers have both facilities.

And for Print media:

- Only 10% of landless farmers can use/access print media.
- 20% of marginal farmers use/access print media.,
- 25-30% Subsistence farmers use/access print media
- All most 100% cash croppers use/access print media.

According to the villagers, the reasons for failure of knowledge pathways regarding adoption of RCTs are as follows:

- Lack of backup support by institutions introducing the technology.
- No amendment in the machine according to our climate or situation.
- No provision of technical training for farmers.
- No good way of technology transfer to all socio-economic groups of farmers.

The correct pathways mentioned by the farmers to promote the RCTs are:

- Exchange visits to model farms arranged by government institutes or by NGOs.
- Publicity of model farms through TV/radio for example, telecast the interview of model farm owners. This could motivate the small farmers.
- Extension department should be involved more actively.

During the survey it was observed that there were no landless farmers in the village and the reason is that small farmers sold their land and have moved to the city and are working as daily wage labourers because farming was not sufficient to meet their needs. Many are working in the sports goods production factories. This is also one of the reasons why the remaining farmers in the villages were in need of daily waged farmers for rice transplantation in rice transplantation season because there is a shortage of labour availability.

There is no NGO working in the village of Malomay. The government department On Farm Water Management Department started a project in 1997 for introducing zero-tillage technology in the area for wheat cultivation. According to the farmers, zero-tillage machine worked for 3 years very efficiently and the yields increased but after 3 years the yields started to decrease. So now the farmers don't use the machine regularly unless time is a constraint for the cultivation of wheat.

In the year 2000 a project named the 'Food Maximization Project' was also working in the area through the Governments' agriculture extension department. This is project is still on going. The project is following a process of knowledge dissemination to farmers as follows:

Agriculture officer → Field assistants → Farmers → Farmers

There is no interaction between the agriculture extensions staff and the female farming community in the area.

(b) Khokhar Ki Malian (KKM) village

In this village a group discussion was conducted on the above mentioned questions with 23 male and 15 female participants. The findings were as follows:

The existing knowledge pathways are same as that of Malomay village but the group claimed that the Government's extension department is favouring a few people in the village but most of the villagers have no useful access to this department. Most of the farmers disseminate knowledge via farmer to farmers contact. The women in this area are more active in farming than in Malomay village and showed their interest in capacity building in food processing, seed storage, IPM on vegetables etc. The existing knowledge pathways prioritized by the farmers of KKM are:

1. via NGOs: Caritas Pakistan, Lahore has been working in this area for the last few years in the health and education sector but last year they entered into the agriculture sector in collaboration with CABI Pakistan. Another NGO was also working in this area in the agricultural sector but it is no longer functional. The name of that NGO is "Loc Sanj Foundation". The villagers did not trust this organization.
2. via Agriculture extension.
3. via TV/Radio.
4. via Print media.

The strengths and weakness of these knowledge pathways are:

NGOs

Strengths	Weaknesses
• More informative. • They build farmers capacity through providing different training courses. • They prefer to work with poor and marginal farmers.	• Funds shortage. • Lack of research. • Contacted limited number of farmers because of shortage of funds and/or limited staff etc.

Agriculture extension

Strengths	Weaknesses
Farmers said that they had no good experiences of working with the agriculture extension department.	• They made false promises. • They do not provide any advance technical training to farmers like that of off-season vegetable production, seeds storages or food processing etc. • They have no innovative ideas in farming. • Most of the time they come to us and write our names. They do not work on real ground but just do paper work.

TV/Radio

Strengths	Weaknesses
• This is the best channel for getting information regarding new technologies through out the world. • TV/Radio is available in each and every house through out the country so an easy channel for communication. • It provides information prior to and in time to the farmers for helping in decision making. For example weather forecast etc.	• Sometimes give irrelevant information. • One way communication only. • People loose interest because the programmes are too boring. • Programmes are too short and complicated to address the farmers' issues. • Unsuitable time of programmes telecast. Almost all farmers were agreed that these programmes should telecast between 8 to 9 p.m. not at 2-3 pm. when farmers are busy in field. • People are now not much interested in listening to the radio. • Females in the area said that they don't like listening to agricultural programmes on radio or TV. When these programmes were telecasted they turn over the channel or switched off TV or radio.

Print Media
The villagers gave the same comments as the villagers from Malomey. But according to the groups, the following is the percentage usage of different knowledge dissemination channels:

More than 90% of villagers from each of the four economic categories have TV/Radio:

- 90% of the landless farmers have both facilities.
- 90% of marginal farmers have both facilities.
- 100% of subsistence farmers and cash croppers have both facilities.

The main reasons for the failure to adopt 0 tillage, according to the villagers were:

- Lack of proper introduction of 0-tillage technology in the village.
- People from the nearby villages experienced negative yield impacts from using this technology, thus the farmers in KKM have lack of interest in this technology.

According the villagers, the correct pathways to be used for the proper introduction of this technology are:

- Via NGOs: involve NGOs of a good reputation in the dissemination of this technology in the area.
- Farmer-to farmer: Exchange visits to the model farms arranged by government institutes or by NGOs.
- Publicity of model farms through TV/radio. Telecast the interview of model farms owners. This could motivate the small farmers.
- Extension department should be involved more actively.

Overall a public institutional knowledge dissemination system is required like that in Malomay, where an NGO (such as Caritas Pakistan) is working in the area and following a social mobilization and social organization concept.

2.3 Knowledge Mapping

In order to conduct a knowledge mapping exercise in the four selected project sites, a template was designed by the CABI Project Leaders and sent to the project countries for getting information on sources of knowledge available to them. This template had three criteria:

1. To ask the farmers from each socio-economic group to list the various sources of information available to both male and female farmers and in these groups.
2. To ask the farmers to tell you which source of information listed by them works better for them, and to tell you why some works better than others.
3. To identify with what are the blockages in getting knowledge to farmers (men and women).

To fulfil this assignment, a group discussion was made with male and female farmers in each of the four project sites in Pakistan. The results are described below:

2.3.1 Malomay Village (Sialkot)

Table 1: List of various source of information available to both male and female farmers

Food surplus		Subsistence		Marginal		Landless	
Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Agri.ext.	From their husbands	Agri.ext.	From their husbands	Agri.ext.	From their husbands	Agri.ext.	From their husbands
NGOs	-	NGOs	-	NGOs	-	NGOs	-
TV/Radio	TV/Radio	TV/Radio	TV/Radio	TV/Radio	TV/Radio	TV/Radio	TV/Radio
Print media	-	Print media	-	Print media	-	-	-

Table 2: Best sources of information identified by the farmers

Food surplus		Subsistence		Marginal		Landless	
Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Agri.ext.	-	Agri.ext.	-	Agri.ext.	Agri.ext.	Agri.ext.	Agri.ext.
NGOs	-	NGOs	-	NGOs	NGOs	NGOs	NGOs
TV/Radio	-	TV/Radio	-	TV/Radio	TV/Radio	TV/Radio	TV/Radio
Print media	-	Print media	-	Print media	Print media	Print media	Print media

Table 3: Knowledge blockages

Food surplus		Subsistence		Marginal		Landless	
Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Although information is available but need better quality information.	Not interested in Agriculture.	Although information is available but need better quality information.	Not interested in Agriculture	Low literacy rate so not able to read newspapers.	Very low literacy rate so not able to read newspapers	No interest in agriculture b/c they sold their lands and now working in sports goods factories in Sialkot.	Same as that of their husbands. Outside working environment is not suitable for us in farms so we preferred to stay at home and get money by stitching footballs.
Need training on new technologies.	-	Need training on new technologies	-	Need training on new technologies	Need training on new technologies	-	-
-	-	Accessibility	-	Accessibility	-	-	-
-	-	Subsidy	-	Subsidy	-	-	-
-	-	Lack of back up support by Govt. – department.	-	Lack of back up support by Govt. department	-	-	-
Lack of interest	-	Lack of interest	-	Lack of interest	-	-	-
Need information in Urdu in newspaper.	-	Need information in Urdu in newspaper. Can't read English.	-	Need information in Urdu in newspaper. Can't read English.	-	-	-
-	-	Hiring cost is high	-	Hiring cost is high	-	-	-

2.3.2 Pindi Rateen Singh village (Sheikhupura)

Farmers from PRS have also almost the same kind of issues except for those expressed by landless farmers/poor farmers. These farmers said during the group discussion that the Government departments never pays attention to them. They only contact cash croppers or people who are "favoured".

Marginal and poor women, from this village, showed interest in acquiring agricultural training particularly in food processing, vegetable IPM, seed storage etc. Although the literacy rate is low among women, they showed interest in getting information through pamphlets, bulletins and newspapers.

2.3.3 Villages Khokhar Ki Malian (Sheikhupura) and Bodha Goriya (Sialkot)

Table 4: List of various source of information available to both male and female farmers

Food surplus		Subsistence		Marginal		Landless	
Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Agri.ext.	From their husbands	Agri.ext.	From their husbands	Agri.ext.	From their husbands	Agri.ext.	From their husbands
NGOs	-	NGOs	NGOs	NGOs	NGO	NGOs	NGO
TV/Radio	TV/Radio	TV/Radio	TV/Radio	TV/Radio	TV/Radio	TV/Radio	TV/Radio
Print media	Print media	Print media	Print media	Print media	-	-	-

Table 5: Best sources of information identified by the farmers

Food surplus		Subsistence		Marginal		Landless	
Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
NGOs	NGO, as they have female workers	NGOs	NGO, as they have female workers	NGOs	NGOs, as they have female workers	NGOs	NGO, as they have female workers
Agri.ext.	From their husbands	Agri.ext.	From their husbands	Agri.ext.	From their husbands	Agri.ext.	From their husbands
TV/Radio	-	TV/Radio	-	TV/Radio	TV/Radio	TV/Radio	TV/Radio
Print media	-	Print media	-	Print media	Print media	Print media	Print media

To answer the question "What are the blockages in getting knowledge to male and female farmers"?, the farmers from both the villages said that since 0-tillage had not been introduced into their area, they don't know about the benefits and problems of this new technology. But they said that governments departments are not paying attention to their villages and thus they have lack of knowledge/information. They also said that they had heard and seen the machine in the villages nearby when this machine was introduced, and heard that it has negative effects on crop yields after continuous use. Hence, they showed lack of interest.

2.4 Stakeholders Involved in Acquiring and Disseminating RCT Technologies

In total nine institutions were studied for their direct or indirect involvement with the RCTs knowledge acquisition/dissemination process of the rice-wheat system of irrigated Punjab area. These include:

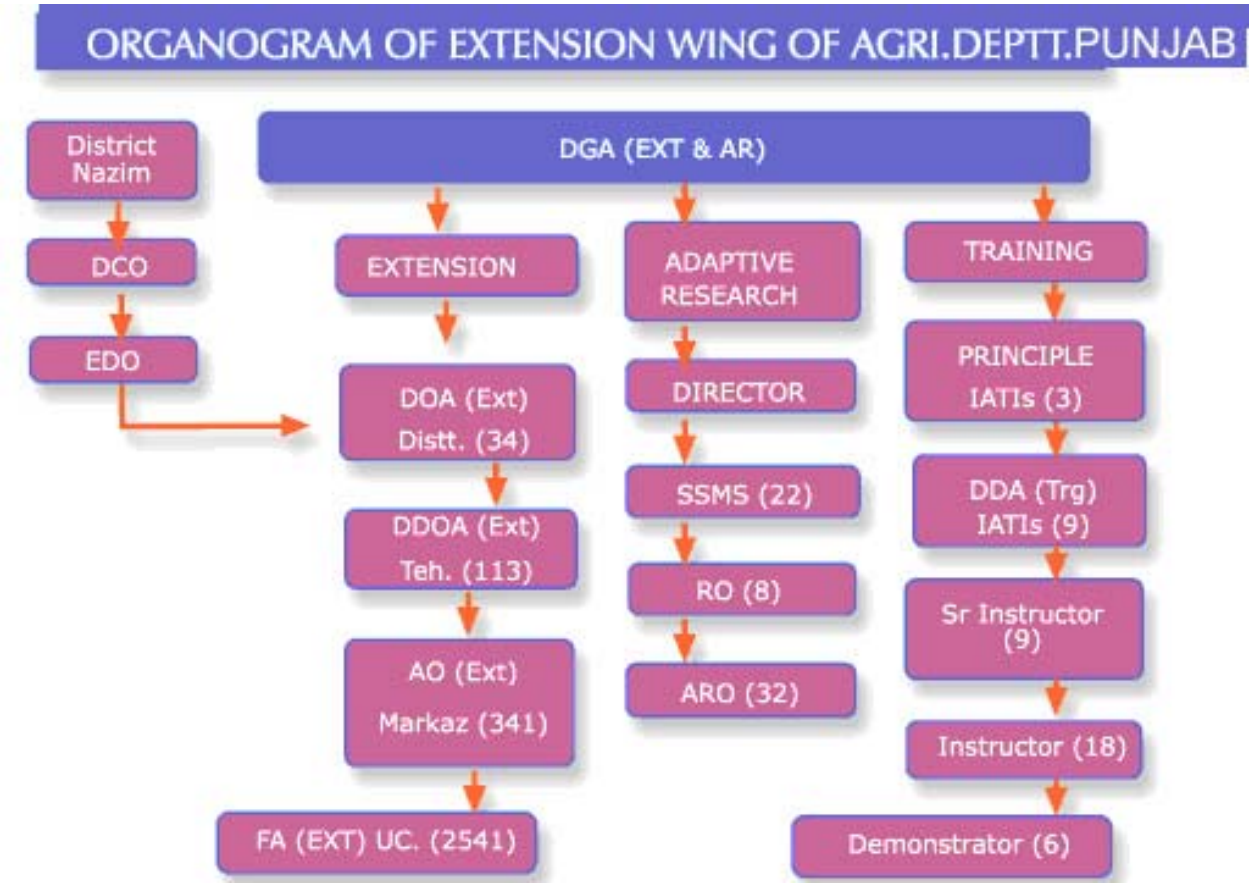
1. Agricultural Extension Wing
2. Directorate of Agricultural Information
3. On-Farm Water Management
4. Adaptive Research
5. Rice Research Institute, Kala Shah Kaku
6. PARC Field Office at Kala Shah Kaku
7. Seed Distributors
8. Drill Manufacturers
9. Non-Government Organizations

A brief introduction about the profile of these institutions is discussed below.

2.4.1 Agricultural Extension Wing

The Agricultural Extension Wing of Punjab has the responsibility for the extension of the latest tested technologies generated by national agricultural research system (NARS). A Director General, assisted by the Directors of Extension and Adaptive Research, heads the Extension Wing. At the district level, there is an Executive District Officer (EDO) who has a subordinate District Officer (DO). Each DO is assisted by a Deputy District Officer (DDO) in each Tehsil. Tehsils are further divided into various sections called Markaz where an Agricultural Officer (AO) is posted. He is the junior most officer in the hierarchy and is assisted by a Field Assistant. Regarding their qualifications, all the officers are basically graduates from an agricultural university while the supporting staff either possess general qualifications or a diploma in agriculture. Figure 1 is an organogram of the Extension Wing

Fig. 1. Organogram of the Extension Wing



Source: www.punjab.gov.pk

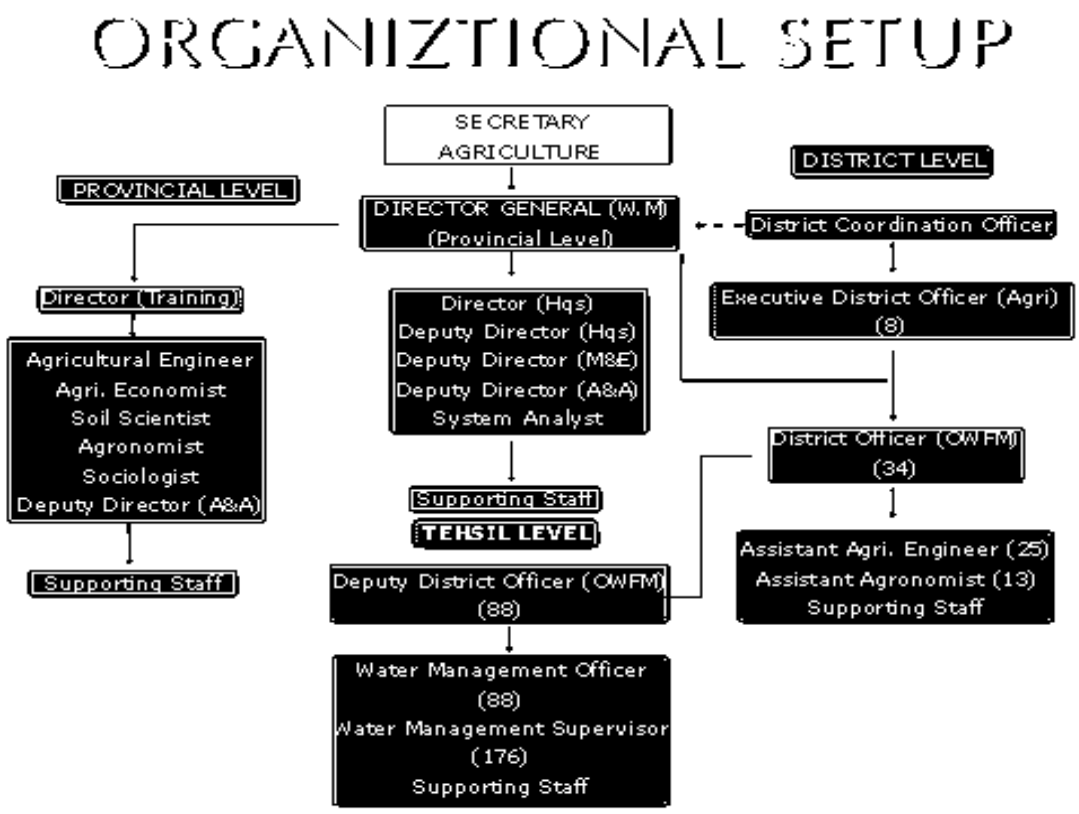
The primary function of the Directorate General of Agriculture (Extension & Adaptive Research) is transfer of the technology generated at research stations to the farmers. This is achieved through personal/group contacts, demonstration of new technology at farmer's fields, print and the electronic media. Other functions include regulating of pesticides and fertilizers business, testing of research findings through Adaptive Research under local conditions. The Directorate also acts as a bridge between the farmers and the agriculture researchers by gathering feedback from the farmers and communicating it to the researchers.

Adaptive Research aims at devising site specific technology packages for increasing agricultural production. It helps to adjust the results of research into a suitable form before transmitting it to the farmers, keeping in view their local agro-climatic and socio-economic conditions. It bridges up the gap between research findings and farmers achievements and extension.

2.4.2 On-Farm Water Management Wing (OFWM)

The On Farm Water Management program in the province is part of the Punjab Agriculture Department. The program is headed by the Director General Agriculture (Water Management) and is assisted by the Director Training and Director Headquarters. After promulgation of Devolution Plan 2001, OFWM activities have been devolved to the District Governments. Accordingly, officers for 34 District Offices (OFWM) and 88 Deputy District Officers (OFWM) at tehsil level were recruited. The OFWM functions devolved at the District Government include watercourse Improvement, LASER Land Leveling, promotion of resource conservation technologies, and Barani water management. The organization chart of OFWM wing of the Punjab Agriculture Department is given in Figure 2.

Fig. 2. Organizational setup of On-Farm Water Management Wing



Source: www.punjab.gov.pk

According to the On Farm Water Management wing, it follows a bottom-up approach to practicing efficient irrigated agriculture through active involvement of the farming community. Farmers/Water Users are informed about the objectives of the OFWM Program and its expected outcomes. Afterwards, farmers are motivated through a number of follow-up visits to organize themselves into Water Users Associations (WUAs) and to register under the On Farm Water Management and Water Users Association Ordinance [Act]-1981. The WUAs undertake watercourse improvement works and other OFWM improvements like LASER land levelling, irrigation agronomic improvements, on farm surface drainage schemes (through organizing farmers into Drainage Beneficiary Groups i.e. DBGs), transfer/installation of community tubewells (through organizing Community Tubewell Groups i.e. CTGs) etc. (www.punjab.gov.pk).

Activities of OFWM Department

In order to make efficient use of land, water, energy, human resources etc., the OFWM wing of the Agriculture Department is promoting various resource conservation techniques. Zero-

Tillage technology is being introduced for sowing wheat after rice harvest without ploughing the land. Use of Furrow Bed shapers is being demonstrated in cotton growing areas to grow cotton, with Furrow and Bed Irrigation System for proper application of irrigation water. Mechanical transplanting of rice is being tried with transplanters modified in Pakistan. Presently, the later two technologies are at experimental stage and results attained so far are quite encouraging. Resource Conservation technologies are gaining popularity amongst the farming community. Wheat area sown with zero tillage technology has increased from 50 acres during 1996-97 to 469,000 acres in 2002-03. Sowing wheat area through Bed Planting was demonstrated on 135 acres in 1999-2000 and on 3,500 acres in 2001-02. Moreover, cotton has been sown on about 200,000 acres using Bed and Furrow Irrigation System (www.punjab.gov.pk).

Fig. 3. Zero tillage drill and bed planter in the field

Source: *www.agripunjab.gov.pk*

Fig. 4. Laser land levelling in progress

Source: www.agripunjab.gov.pk

2.4.3 Adaptive Research

With its head office in Lahore the Adaptive Research forms an effective linkage between extension and research aiming at minimizing the gap between potential and farmers' average yield. The organization further strives to develop site-specific improved production technologies. Headed by Director General (Extension & Research) Punjab, the organization works through its eight Adaptive Research Farms (ARFs) including two in the rice-wheat area of Gujranwala and Shiekhupura.

2.4.4 Pakistan Agricultural Research Council's Field Office

The PARC office has been conducting field research on rice crops based at the Rice Research Institute, Kala Shah Kaku. The office is very small as far as staff strength is concerned, with only two scientists working there. One is a Senior Scientific Officer with considerable experience in the field of Entomology while the other is a Scientific Officer with less than one year of experience. The office has one computer, which has been out of order for a long time due to lack of funds. The office has been involved in creating awareness among the farmers regarding rice production technologies, decision making in input use, identification of useful fauna and pest controlling technologies, such as the rope dragging technology for the control of leaf folder pest.

2.4.5 Rice Research Institute, Kala Shah Kaku

The Rice Research Institute is a specialized institute concentrating on rice research. It is situated in the heart of the rice belt and is playing a key role in the generation of knowledge, which eventually passes to the farmers through the extension system. Headed by a Director, the Institute focuses on the development of high yielding, early maturing and short stature rice varieties having better grain quality and resistance to insect pests and diseases, development of optimum cultural and agronomic practices suited to different rice growing regions, evaluation of the genetic stock for grain quality characteristics, training of extension workers for transfer of rice production technology to the growers and to train rice procurement staff, millers and exporters in the identification of rice varieties, production of pre-basic and basic seed and Hybrid rice development. The RRI has produced Super Basmati and Basmati 2000, which are high value export items.

2.4.6 Seed distributors

Seed distribution is a generally a multi-tier process. The seed companies either produce seed on their own farms and/or purchase from their contract farmers who obtain seed from these companies for multiplying purposes. The company then purchases this seed under some pre-decided agreement. The companies after necessary treatments and packing into appropriate sized packing sell it directly as well as through a network of distributors. A seed that gives higher yield with the same level of inputs is in fact a resource conserving agent. Based on this logic the seed dealers/distributors were included in the study and their role if any in the information channel.

2.4.7 Zero-tillage drill manufacturers

The ZT technology requires ZT drill so the drill manufacturers were also interviewed to see where they fit in the information flow channel. In tracing the history of ZT drill manufacturing, credit goes to the Farm Machinery Institute (FMI), NARC, Islamabad. The FMI scientists helped farm machinery manufacturers in Daska.

Most of the manufacturers interviewed have been in the farm machinery manufacturing business for more than twenty years but have picked up the ZT drill quite recently. About 90% of the ZT manufacturers have four years' experience of manufacturing this drill. The oldest maker of the ZT drill in our sample has been in this business for the last seven years. On an average each manufacturer was producing four machines per month while the capacity they clamed was three times the present production. This however cannot be taken as a formula to calculate their overall capacity as they depend on hired labour which may not be available. Only two out of nine manufacturers were unable to increase production of ZT drills, while the rest could possibly double their production if the demand arises.

2.4.8 Zarai Taraqiati Bank Limited (Ztbl)

To see if the credit advancing institutions also had a role in knowledge dissemination, Zarai Taraqiati Bank Limited (ZTBL) formerly Agricultural Development Bank of Pakistan (ADBP) was contacted in the rice-wheat zone. It was observed that the bank concentrated on advancing loans for agricultural machinery in general and the dissemination of knowledge regarding RCTs was not a specific area of focus. However, if anybody wished to buy a ZT drill

he could easily obtain credit under the farm machinery head. The interest rates have dropped to eight percent to encourage farmers to obtain loans.

2.4.9 Non-government organizations (NGOs)

Three NGOs in the rice–wheat area were visited and detailed information was collected. It was however observed that although the NGOs were involved in the technology transfer process did not include RCTs for Rice or Wheat. One of the NGOs was found to be in the process of obtaining information regarding RCTs for dissemination among the farming communities.

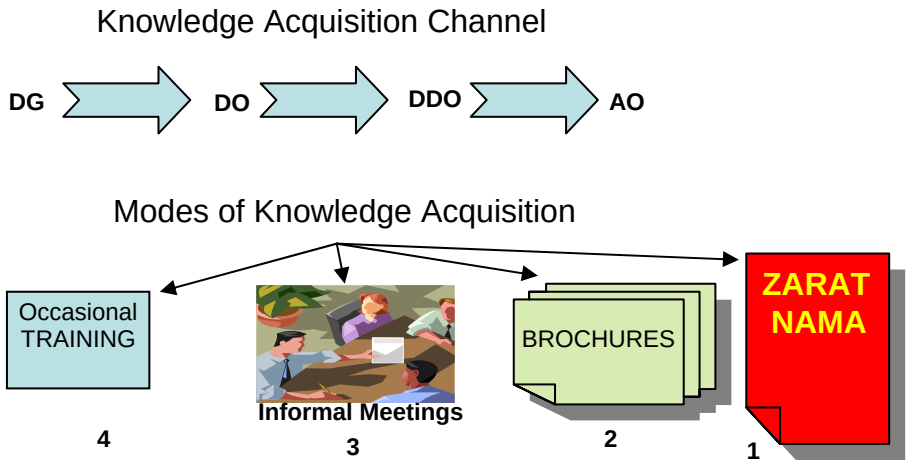
2.5 Knowledge Acquisition System of RCT Stakeholders

Knowledge acquisition is the first step in the flow of knowledge from research to farm. However the quality of knowledge dissemination depends upon the method adopted. Knowledge acquisition takes place whenever a new player enters the channel. To study the flow of knowledge in the agriculture sector of the Punjab's Rice-Wheat area, knowledge acquisition processes of all the major stakeholders was documented by social scientists from NARC and their findings are discussed in the following text.

2.5.1 Agricultural Extension Wing

Knowledge is what extensionists need to extend: The better the mode of knowledge transfer to the extensionists, the better will be the chances of proper knowledge communication with famers. It was therefore decided to make inquiries about the most important modes of knowledge transfer that is available from the extensionists. All 12 officers from the Department of Agricultural Extension that were interviewed regarded Zarat Nama as the first source while seven out of twelve extensionists said that brochures being received from the Agriculture Department is the second most important source of knowledge transfer. Thus Zarat Nama and brochures are major sources of information for the agricultural extensionists of the area. Figure 5 depicts the knowledge acquisition process of the Agricultural Extension Wing.

Fig. 5. Knowledge acquisition process at Agricultural Extension Wing



Key: Ranked from 1-4, 1 being primary source

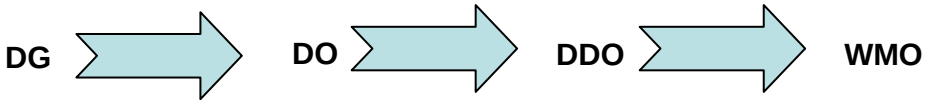
In terms of knowledge dissemination, the knowledge is disseminated to farming communities through fortnightly meetings arranged in the villages by the agricultural extension field assistants. This involves speeches by the farmers', talks/discussions with the farmers in

various formal and informal meetings, and the opportunity to arrange visits by farmers to the office of agricultural extension to seek solutions to their day-to-day crop production problems. The agricultural extension department also plans demonstration plots to display the effects of improved practices and write slogans about various crop management practices on "*burjies".*

2.5.2 On farm Water Management

The main sources of knowledge acquisition by the OFWM officers were brochures and trainings arranged by either the OFWM themselves or other organizations on their behalf. The flow of information from higher authorities in hierarchy to the lowest position is given below in Figure 6.

Fig. 6. Knowledge acquisition process by On-Farm Water Management Wing

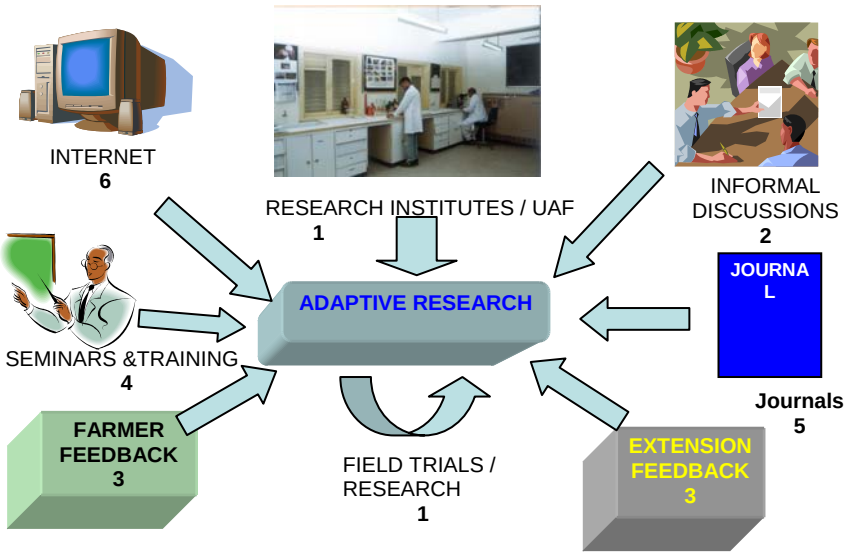


The knowledge about methods of efficient use of irrigation water and ZT-Drill is acquired mainly through training and brochures. The department is also actively involved in lining of water channels at farmers' fields.

2.5.3 Adaptive Research

The Directorate of Adaptive Research acquires knowledge through a variety of channels. Their primary sources are agricultural research institutes and agricultural universities. The acquired knowledge and technologies are tested under farmer field conditions for examining their adaptability in various agro-ecological zones before taking them to farmers. Thus this becomes a second source of knowledge. Other sources include informal discussions with fellow scientists and scientists from other research organizations, journals, seminars/training and internet. Finally when the technology is released, feedback both from extensionists and farmers becomes the final source of knowledge acquisition.

Fig. 7. Knowledge acquisition process at Adaptive Research

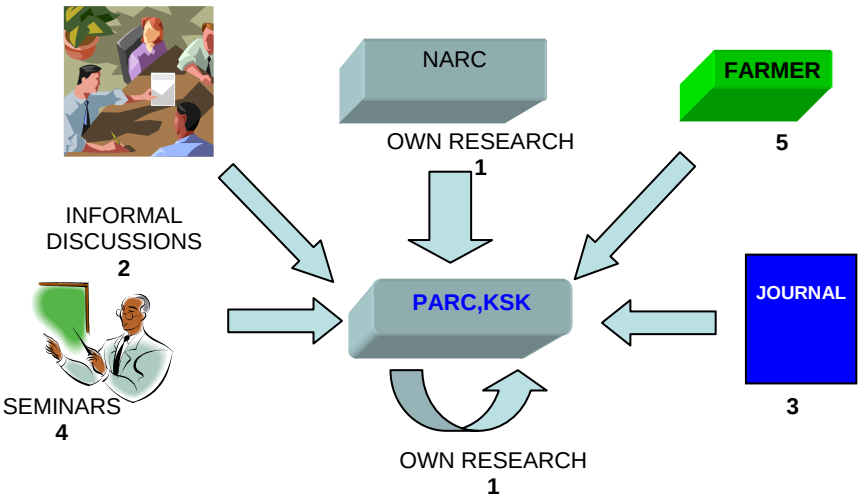


Key: Source Ranking-First=1 Last=6

2.5.4. PARC Office Rri-Kala Shah Kaku

The primary objective of the Pakistan Agricultural Research Council's office at Kala Shah Kaku is to conduct the rice related trials in the rice-wheat growing environment (i.e. soil and climate) for validating the technologies suitable for the ultimate target area. The staff here use different sources of information for updating and enhancing their knowledge about the technologies and problems of the rice-wheat farming system. These are in the form of journal articles, discussions with the farmers, feedback of the farmers through on-farm trials, seminars and technical discussions with their colleague scientists. As far as dissemination is concerned, the tested knowledge is disseminated to farmers through the demonstration activities of the Rice Research Institute, Kala Shah Kaku and PARC (Fig.8). The findings of the experiments (both at research station and farmers' fields) are also published in the form of research reports, popular articles and research papers in professional journals.

Fig. 8. Knowledge acquisition process at PARC Kala Shah Kaku

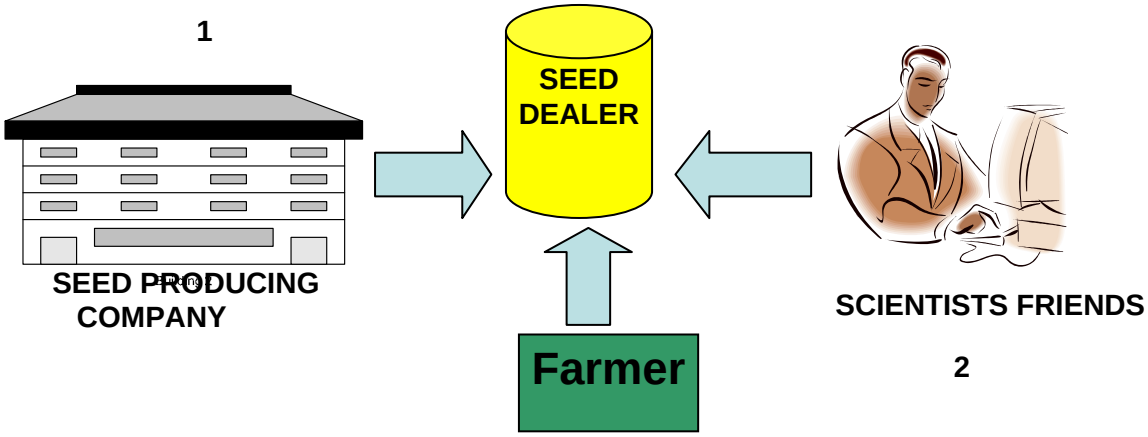


Key: 1=Primary source, 3=Last source/Least utilised

2.5.5 Seed dealers

The seed distributors only acquire knowledge about new varieties about to enter the market. The knowledge about the production technologies is however delivered by the seed producing companies in the form of brochures. The sources of knowledge for new varieties and later feedback from the farmers regarding the performance of various varieties is shown in Figure 9. The information about new varieties primarily comes from the seed companies followed by farmers who at times bring in new varieties from other research stations. Very few had links with the research stations or universities themselves and those who had such links were due to their friends and relatives who happened to be agricultural scientists.

Fig. 9. Knowledge acquisition process – seed dealers

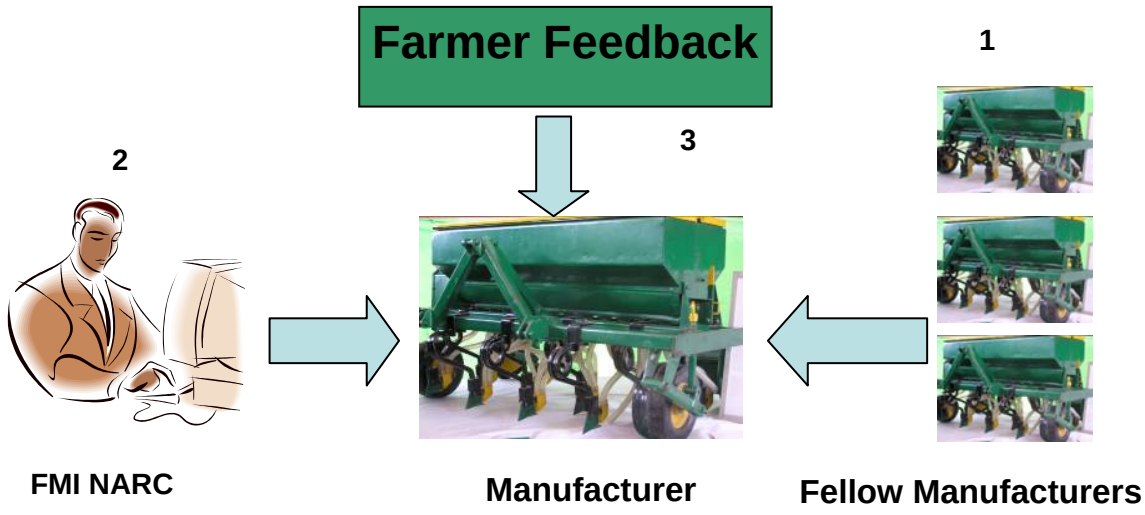


Key: 1=Primary source, 3=Last source/Least utilized

2.5.6. Drill manufacturers

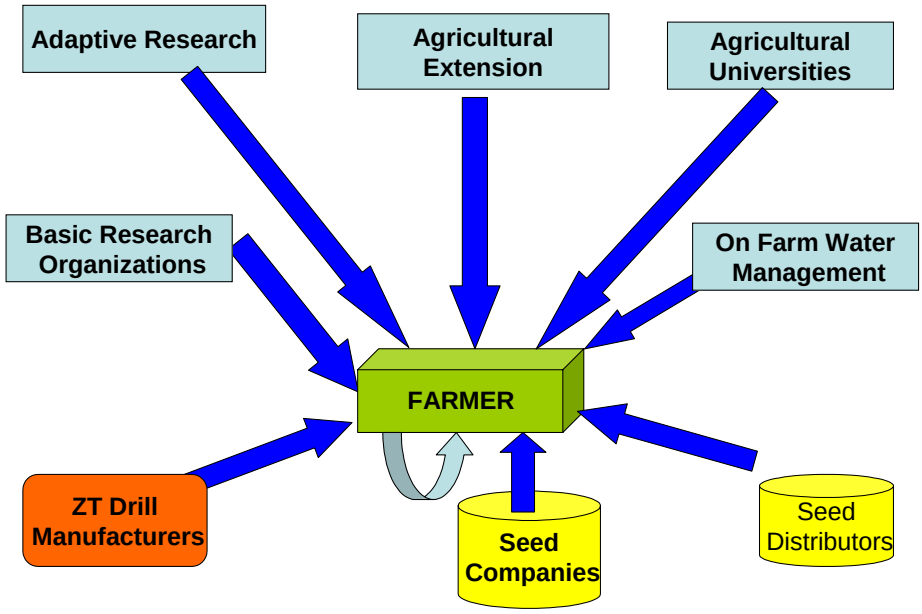
The knowledge acquisition channel for the ZT drill manufacturing industry in general has changed over time. The process started with the big manufacturers of farm machinery who obtained the designs and guidance from FMI, NARC. With the technology newly introduced and experimentation by both government organizations and farmers increasing, the ZT drill sales rose sharply. This had the effect of encouraging manufacturers in the same Daska bazaar to share and copy the technology. This led to machines of all standards appearing in the market. When the ZT drill started giving problems due to various problems and farmer feedback was received, local ingenuity also started to have an affect: Local modifications such as the use of plastic liners to prevent fertilizer clogging and a lathe cutting tool added to the tines of the drill to add extra strength and improve cutting ability were seen. Most of the manufacturers were satisfied with the technology transfer method i.e. copying from fellow manufacturers or hiring a trained team of mechanics. A few however, wanted agricultural engineers to visit them with a sample drill and guide them and also invite manufacturers to the government's agricultural engineering institutes and guide them. The manufacturers reported no formal training in the recent past by any organization on production of the technology. See Figure 10 for details.

Fig. 10. Knowledge acquisition process – ZT drill manufacturers



Key: 1=Primary source, 3=Last source/Least utilized

Fig. 11. Sources of knowledge for farmers



2.6 Knowledge Dissemination System

Knowledge dissemination is the second step in transferring knowledge from research to farm. In this section, the means and methods of dissemination of acquired knowledge by various institutions are detailed.

2.6.1 Agricultural Extension Wing

(a) Visit of extensionists to farmer fields

Extensionists conduct a pre-planned schedule of visits to farmers' fields. According to the schedule they divide each main cropping season into two, each of 45 days duration. The extensionists mainly AOs and FAs (but at times accompanied by the DDOs) also visit the farmers' fields at the rate of one village per schedule and there are four such schedules in a year which results in each village being visited four times a year. According to the extensionists, each AO usually covers two villages per day and is in the field for on an average 20 days per month. In Figure 12, the farmers are listening to a group lecture delivered by extensionist.

Fig. 12. Agricultural extension in progress

Source:
www.agripunjab.gov.pk

(b) Modes of knowledge dissemination:

The main mode of knowledge dissemination is the group lectures during which brochures are distributed among the attending farmers. The number of Brochures received at DDO level varies a lot, that is, from 4,000 per year to 10,000 per year while at AO level the number varies between 1,000 to 3,500 per year. In addition to the lectures the other modes include wall chalking and writings on earth-made pyramids "*Burjies*". These are supposed to carry vital crop production and protection tips. The procedure for organizing group lectures is that the field officer visits the target village and gets an announcement made at the mosque that the agricultural experts are going to visit the village so those interested should gather at the declared venue on the fixed date and time. The AO and at times DDO then visit the decided place and deliver the lectures. In Figure 13 the knowledge dissemination process of the extension wing is depicted. The Agricultural Officer and DDOs have a pre-approved annual plan of work. They move to the field according to the plan, which has two phases per crop.

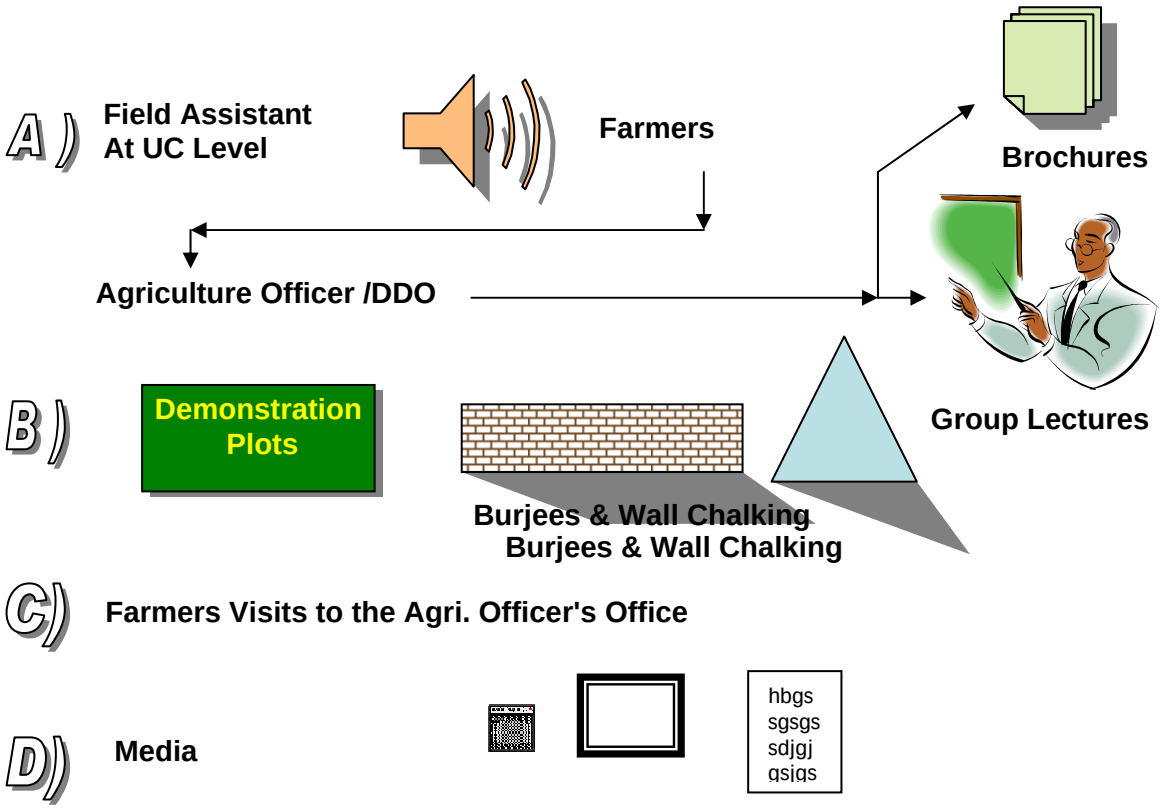


Fig. 13. Knowledge dissemination process – Agricultural Extension Wing

2.6.2 On-Farm Water Management

Knowledge dissemination is carried out through training, informal meetings and brochures. The dissemination about the ZT Drill was said to be completed a few years back while that of Laser leveling was in full swing and the services of leveling were being provided to as many farmers as possible. The knowledge dissemination scheme of OFWM is portrayed in Fig.14.

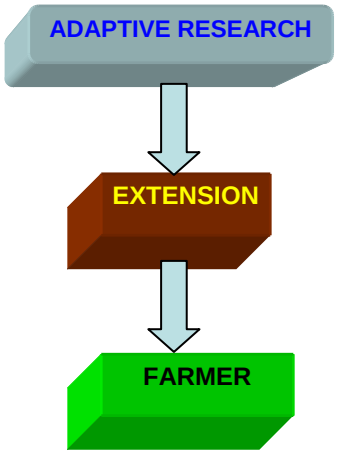
Fig. 14. **On Farm Water Management Knowledge Dissemination Process**

Note: Dissemination of Knowledge about ZT Drill has been Completed a
Drills Returned

2.6.3 Adaptive Research

For dissemination of research results the Directorate of Adaptive Research utilizes the services of the Extension Wing, which takes the knowledge to the farmers' fields. The knowledge dissemination process of Adaptive research is represented in Fig.15.

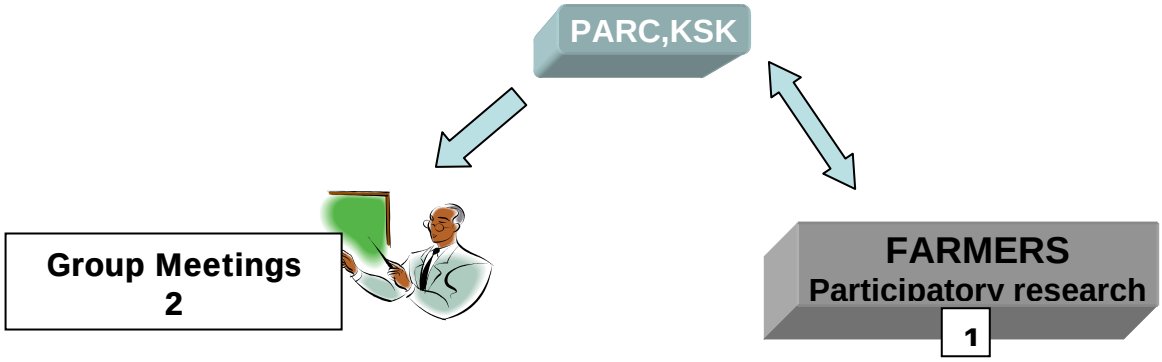
Fig. 15. Knowledge dissemination process – Adaptive Research



2.6.4 PARC Office Kala Shah Kaku

The dissemination process was found to be a simple one. There were two main channels, one was through participatory research while the other through group meetings with the farmers. The scientists were content with the methods but shortage and irregular supply of funds coupled with the lengthy procedures needed to gain permission to spend the funds posed problems including absence of continuity in participatory research / field plots.

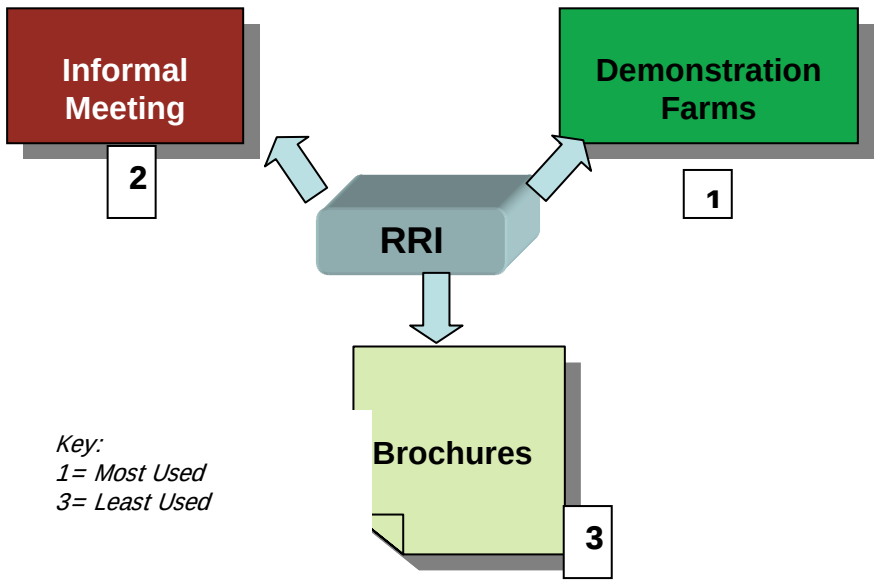
Fig. 16. Knowledge dissemination process – PARC, Kala Shah Kaku



2.6.5 Rice Research Institute, Kala Shah Kaku

RRI Kala Shah Kaku uses three main methods to disseminate knowledge viz. informal meetings with the farmers, distribution of printed brochures and setting up of demonstration plots. About thirty plots are maintained to demonstrate the latest technologies. On an average 10 to 12 farmers visited the interviewee's office every month during the rice season. This flow of information is shown in Figure 17.

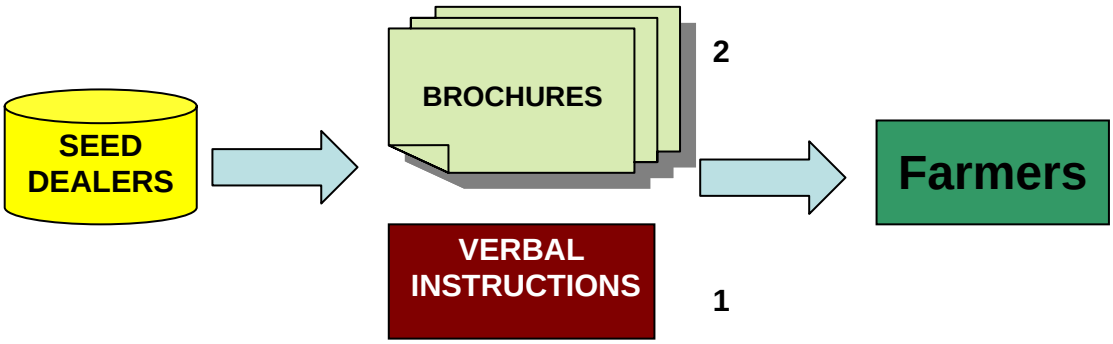
Fig.17. Knowledge dissemination process – Rice Research Institute, Kala Shah Kaku



2.6.6 Seed distributors

The seed dealers passed on information about the recommended production packages to the farmers mainly in verbal form followed by the brochures they received from the seed companies. Respondents were also asked for samples of brochures received and it was observed that full colour brochures in large numbers were available with the dealers. This is illustrated in Figure 18.

Fig. 18. Knowledge dissemination process – seed dealers



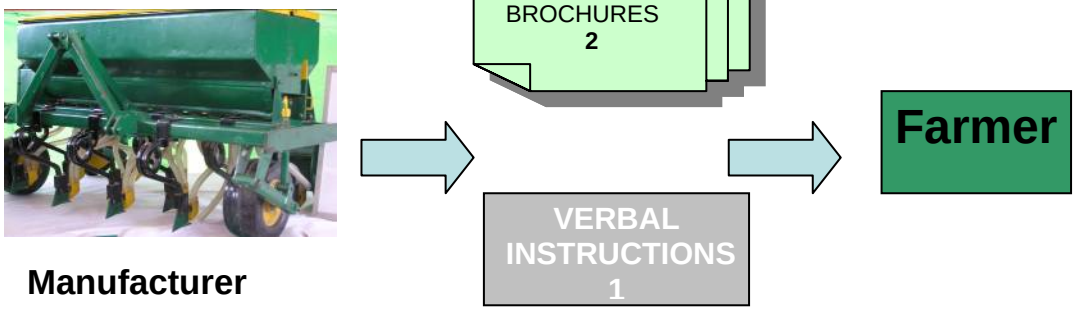
Key: 1=Primary 2= Secondary Source

The respondents were in general not satisfied with the yield levels attained by the farmers using their seed. The main reason for this was due to the low doses of fertilizer applied due to the high cost. Seed dealers were of the view that both the mass media and extensionists should educate the farmers about the latest technologies, new seed varieties and recommended seed rates. They also think that information about any new seed should also be announced on TV. The dealers however did not know much about the ZT technology nor promoted it.

2.6.7 Drill manufacturers

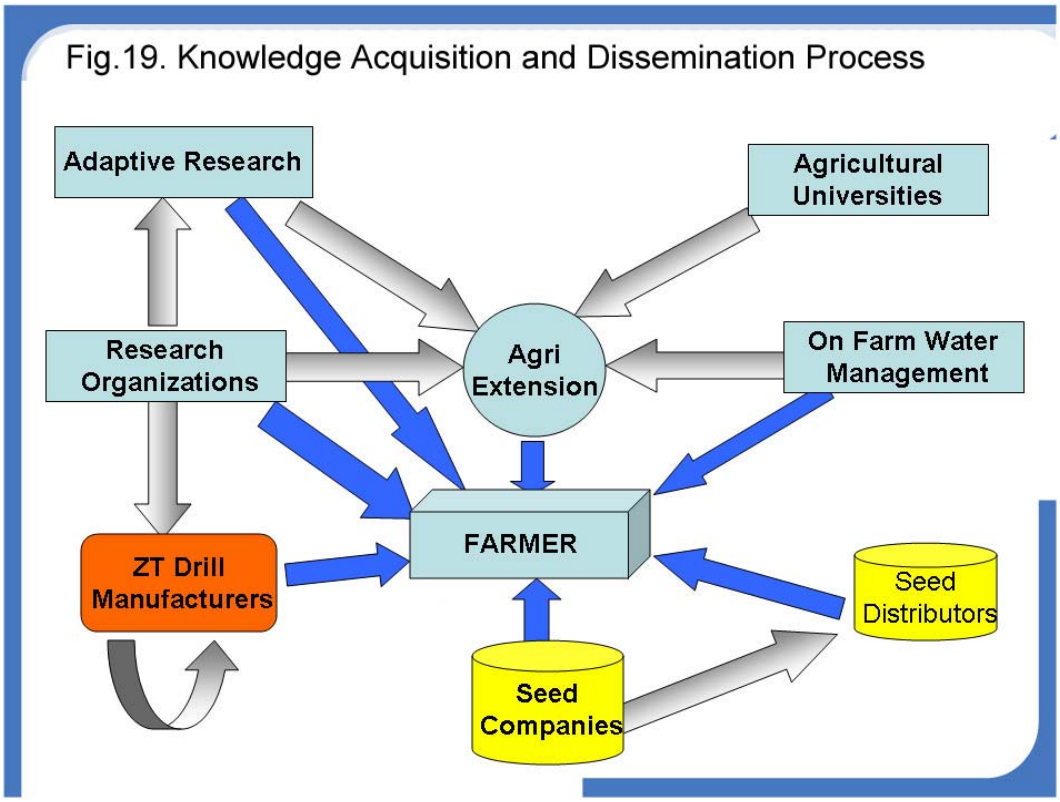
The manufacturers do not perform any particular role in disseminating knowledge about the ZT drill. However, a few (two out of nine) had brochures containing information about the general usage and maintenance of the machinery. Their engineers/mechanics mostly provided verbal instructions to the customers while a few also demonstrated the use of the machine, but most were of the view that the machine was so simple to use that no training was required for its proper operation.

Fig. 19a. Knowledge dissemination process – Drill manufacturers



2.6.8 The whole picture

The above literature gives and overview to the processes of knowledge acquisition and knowledge dissemination by the key stakeholders associated with the ZT drill technology. Figure 19 is an illustration of how the various stakeholder systems are acting together to reach the farmer.



2.7 Bottlenecks in the Knowledge Dissemination

Interviews were conducted with ZT technology stakeholders to determine bottlenecks in the dissemination process on a wider scale and to different socio-economic groups of farmers. The results of these interviews are given below.

2.7.1 Agricultural Extension Wing

The bottlenecks range from psychological to physical and financial in nature. The poor service structure leaves extensionists without promotion for almost their entire careers. This leaves little incentives to work hard with devotion especially when performance is not linked with any reward or credit. The job of the Agricultural Officer is very demanding in nature. A dutiful officer must travel to the villages in his territory regularly and every time he must be relatively more updated and provide better recommendations and suggestions to the farmers. Therefore, on the one hand he has to work hard in seeking knowledge about the latest developments and solutions to various problems in crop production while on the other hand, he has to convince farmers to adopt the recommendations suggested by him. The problem is that when this officer sees other officers who have an equivalent qualification but enjoying better facilities like housing, medical and education in other departments, there is a sense of frustration and lack of motivation to continue.

2.7.2 On Farm Water Management

There were a small number of laser levelers, shortage of staff, vehicles and budget. If these bottlenecks were solved the dissemination could have been improved. Also there was a clash in message associated with the ZT drill, e.g. "*Dab key wah tay raj kay kha*" i.e. "More ploughing increases productivity", which was given out by the Agricultural Extension Wing. This caused a lot of confusion among the farmers and should have been resolved.

2.7.3 PARC Kala Shah Kaku

Budget constraints and the lengthy processes required to use the existing budget is a big constraint to work on participatory research and knowledge dissemination. Enhanced budget and financial power needs to be provided to the PARC office instead of the present system of routing all financial matters via NARC. Furthermore, staffing is a problem. Currently there are only two scientists and one of them has just started his career with PARC.

2.7.4 RRI Kala Shah Kaku

Shortage of budget was the major bottleneck in disseminating knowledge. According to the scientists the operational budget needs to be doubled.

2.7.5 Adaptive Research

As dissemination of knowledge was done through the Agricultural Information Directorate, the Adaptive Research Wing had no problems in this regard.

2.7.6 Seed distributors

The information channel that passes through the Seed Distributors is dependent on the Seed Producing Companies. There was no mention of any bottlenecks in the dissemination of knowledge channel but the channel being an important one should also be used by the Agricultural Extension Wing. The seed dealers could be provided with the latest information on ZT technology and they could therefore act as a sub-extension agent at no extra cost.

2.7.7 Zero-tillage drill manufacturers

The information passage from manufacturers to farmers is mainly verbal supplemented by leaflets with insufficient information. The research institutes like FMI should prepare proper user manuals for the farmers and service manuals for the servicing personnel and provide these to manufacturers for distribution.

2.8. Conclusion and Recommendations

The agricultural knowledge system in the rice-wheat zone of Punjab in relation to the Resource Conservation Technologies was studied in detail. The knowledge system was found to be a very elaborate one and theoretically good but when it came to practicalities of its transfer to farmers' fields, the scenario changed. Many shortcomings were found. The major ones include:

- Farmers have the opposite views of key institutions regarding the suitability of the Zero Tillage Technology
- High cost and non availability of laser land leveling machines
- Low use of certified seed due to its high cost
- Farmers are not convinced.

Extension Officers were found to be working under very discouraging circumstances. With poor service structures they had little incentive to work with the desired vigour to promote the technology. The information about ZT Drill was found to be available with almost all the respondents. However, regarding the institutional support to farmers concerning the ZT Technology, On-Farm Water Management scientists and PARC were found to be supporting the ZT technology while the Agricultural Extension Wing was in general not convinced by the technology. On the equipment supply side i.e. the manufacturing area, drill manufacturers seemed to be disappointed by the stagnating or decreasing sales of their products. NGOs did not focus much attention on the ZT Drill technology.

In the light of above findings, the following suggestions are put forward for more effective dissemination of RCT:

- The information about RCTs should be included in the wheat planting campaign in electronic and print media during wheat planting
- The Agriculture Officers should get regular trainings and timely updates regarding latest technological packages.
- Farmers must be supplied with coloured brochures educating them on diagnosis of plant diseases / pest attack and their remedies.
- Input prices need to be reduced drastically and strict quality checks should be imposed, if the knowledge system is required to yield the desired results.
- Separate small and medium land holder cooperatives should be organized for efficient acquisition of knowledge.
- Electronic and print media should be given priority as a source of information for the farmers. PARC has compiled a very rich stock of knowledge both in print as well as electronic (audio/video) which can be utilized for the purpose. The material can also be made available at town level through local shops.
- A government supported "setup" needs to be developed (on a pilot project basis) at Union Council level, providing a one stop solution to all the farmers' needs i.e. knowledge as well as physical resources (e.g. seed, fertilizer) and financial (credit) inputs. This would ensure better quality and prices of inputs, as the government would be able to purchase the inputs in bulk at competitive prices from the original producers.

2.8.1 Strategies for addressing the different farming communities

According to our survey data, it was found that overcoming knowledge gaps and effectively transferring knowledge of RCTs to different farming communities requires a new strategy. During the survey it was observed that the most effective way of communication among farmers is "farmer-to-farmer" interaction particularly in case of women farmers. Moreover the most appropriate pathways mentioned by them were as follows:

- Involving NGOs of good reputation for dissemination of this technology in the area.
- Exchange visits of farmers to the model farms arranged by government institutes or by NGOs.
- Development and distribution of pamphlets/ brochures etc in Urdu or pictorial form.
- Publicity of model farms through TV/radio. Telecast the interview of model farms owners. This could motivate the small farmers or exposure visits to model farms.
- Extension department should be involved more actively in RCT knowledge dissemination.
- Training of farmers/ NGO's staff as master trainer in RCT usage and maintenance.

On the basis of above mentioned pathways by the farming communities and institutions, the following strategy was developed for creating an enabling environment for farmers to adopt RCT. A methodology was used for targeting the different farming income groups. This is described below:

- Groups meeting, discussions at "Haweli" (the place where farmers sit together at evening after hard working day for sharing their experiences, joys and sorrows). All income categories were involved. Particular emphasis was given to poor and marginal farmers.
- Sharing of literature in the form of pictorial calendars and manuals in community meetings and trainings. (All income categories to be involved)
- Training of Facilitators and Farmers Field Schools on RCT usage and maintenance, for NGOs staff (working in the project areas) and for farmers. Eighty percent of the farmers were from marginal group, 12 % from subsistence while 8 % were from better off households.
- Develop a documentary movie in Urdu and sharing with the farmers in "Haweli".(All income categories to be involved) .
- Organized farmers into Citizen Community Board. (All income categories to be involved, including female farmers in the village of Khokhar Ki Malian).
- Meetings arranged for female farmers in project villages at common place/ home and shared information, literature in terms of manual, calendars and discussed their farming issues and identified their needs.
- Women farmers are more interested in vegetable production and processing i.e. pickle, jam etc. So they are more interested in getting training in food processing (women from all socio-economic groups to be involved, among them more than 80% belonging to poor and marginal farming groups while rest will be from subsistence and well off farmer groups).
- Arrange exposure visits of farmers to model farms and RCT manufacturers. (All income categories to be involved).

Output 3: "New technical innovations evaluated and developed by communities at pilot sites and enabling environments (including local manufacture, micro-finance, input access and training) established for participatory technology development"

3.1 Project Activities to Create and Enabling Environment

Following the work done under Outputs One and Two, CABI Pakistan was able to develop a strategy for unblocking knowledge pathways and creating an enabling environment to improve access to zero tillage for all socio-economic groups. The same four villages were selected in Punjab Pakistan for the purposes of delivering this output, i.e. Pindi Rateen Singh and Khohhar Ki Malian villages in Sheikhupura district and Bodha Goria and Malomay villages in Sialkot district.

3.1.1 Curriculum development workshop For FFS program on zero tillage - wheat management.

On November 4th 2004, a one day curriculum development review workshop was arranged by CABI Pakistan in Rawalpindi to think about how to initiate farmer field schools for promoting the zero-tillage technology in the area. Participants were from research organizations, farming communities, NGOs, Professors from Agriculture University and Commissioners from Ministry of Agriculture and Livestock Pakistan.

The agenda of the workshop was:

- To determine the problems related to the use of zero-tillage technology,
- To prioritize and categories these problems, and
- To suggest solutions to these problems.

On the basis of thorough discussions the issues / exercises were prioritized in to three categories;

- Issues that *Must* be included in the curricula.
- Issues that *Could* be included in the curricula.
- Issues that are *Nice* to be included in the curricula.

The results can be seen in Tables 6 and 7.

After identifying the issues and options surrounding zero-tillage technology in Rice-wheat areas, a Transfer of Technology (TOT) and FFS program was developed. This program was designed to build farmers' capacity in wheat sowing through zero-tillage. It was implemented by scientists from CABI Pakistan and field workers from Caritas in the Sialkot & Sheikhupura areas. One TOT and four FFS were planned: two in non-adopted villages and two in adjacent villages. In the end only three FFSs were established due to heavy rainfall which prevented the farmers in Bodha Goria village from sowing wheat using either tillage method.

The details of the FFS activities are given below.

Table 6: Curriculum development for farmer training on zero tillage technology

Target	Issues	Activities / Exercises	Remarks
Pre–planting	Organic matter & fertility management	Do not burn the crop residues	Must be included
		Green manuring during the fallow period between harvesting of wheat crop & planting of rice	Could be included. Conduct participatory study trial
		Soil testing / analysis	Must to be included
		Zero tillage improves organic matter	Conduct participatory study trials
	Seed quality	Sow certified seed	Must be included
		Seed dressing with fungicides	Could be included
	Land preparation & residue management	Management of rice stubbles	Must be included. (Chopper kind of things must be develop for cutting the rice stubble)
		Break up soil hard pan developed by rice sowing after every two years	Nice to be included
	Integrated pest management	Wheat ecosystem analysis	Must be included
		Use of minimum till to lacerate rice stubbles	Conduct participatory study trials
		Monitoring of stem borer hibernation	Must be included Conduct participatory study trials
		Role of predators & parasitoids in controlling insect pests of wheat & rice	Must be included Conduct participatory study trials
		Farmers' participatory training in identifying insect pests, diseases & natural enemies	Must be included
		Farmers' participatory training on conservation of bio-control agents	Must be included
	Soil moisture management	Use of residual moisture coupled with minimum tillage	Must be included
		Observe the moisture level in the field	Could be included
		Manage the last irrigation of rice.	Could be included
		If very low moisture, soak the seed & then sow it	Must be included
		Spread the rice straw in the field after wheat sowing to conserve moisture. This should be if manual harvesting of rice take place.	Nice to be included Conduct the participatory study trials
Post-planting	Stand establishment Poor germination, plant population, missing hills with zero tillage drill, yellowing & death of seedlings	Optimum planting time	Must be included Conduct the participatory study trials
		Use of optimum moisture	Must be included
		Use of good quality seed	Must be included
		Proper fertilizer placement	Must be included
	Weed management	Proper herbicide applications	Could be included
		Competition studies of weeds management in zero tillage & conventional technology	Could be included Conduct the participatory study trials

continued

Table 1 continued

Target	Issues	Activities / Exercises	Remarks
Post-planting		Weeds monitoring & its identification to farmers'	Must be included
	Water management More number of irrigation's, rain fall in poorly drained soils, delayed first irrigation, non availability of irrigation water & last irrigation	Moisture management at critical stages of crop growth	Must be included. Conduct participatory study trials and Top priority.
		Increase water use efficiency through constructing water cannels.	Must be included
	Integrated pest management	IPM strategies to control insect pests & diseases	Must be included
		Sowing of disease resistant wheat varieties	Could be included
		Use of baits, fumigants & traps for rodents control	Must be included Conduct the participatory study trials in zero tillage & conventional sowing
	Fertility management	Fertilizer application on crop need basis	Must be included Conduct the participatory study trials
		Application of nitrogen fertilizer in split dosage.	Could be included
Socio – economic	Community development, traditional mindset & social awareness	Social organization	Must be included
	Non availability of quality inputs	CBOs	Must be included
	High cost of inputs & marketing of produce	CBOs	Must be included
	Micro credit facility	Institutional Support/CBOs/ Linkages develop.	Must be included
	Economic feasibility	Measure the cost / benefit ratio	Must be included.
	Quality of zero tillage drill	Assurance of quality drill Development of service providers	Must be included

Table 7: Options for technology recommendations

Moisture	Turn out time	Harvesting method	Soil type / condition	Option
Low / medium	< 2 week	Manual	Normal	Zero tillage
Low / medium	< 2 week	Combine	Normal	Zero tillage with different version drill
Low / medium	< 2 week	Manual	Hard pan, salinity	Zero tillage
Low / medium	< 2 week	Manual	Hard pan	Seed soaking & zero tillage
High (tractor can be operated)	< 2 week	Manual	Normal	Zero tillage
High (tractor can be operated)	< 2 week	Combine	Normal	Improved zero tillage drill
Low / medium	> 2-3 weeks	Manual	Normal	Conventional with rabi drill
High (tractor can be operated)	> 2-3 weeks	Manual	Normal	Wait for proper moisture & zero tillage
High (tractor can be operated)	> 2-3 weeks	Combine	Normal	Wait, use disc & conventional rabi drill
High (tractor can be operated)	> 2-3 weeks	Manual	Salinity & poor drained	Bed planting

3.1.2 Establishing Transfer of Technology (TOT) and Farmer Field School (FFS) sites for wheat sowing through zero-tillage technology in Sheikhupura and Sialkot Districts of Punjab, Pakistan.

(a) Background

Conventional tillage operations in north-west Indo-Gangetic Plains require 6 to 8 ploughings followed by 2-3 plankings before the wheat crop can be sown after harvesting the rice crop. This entails high costs, results in delayed sowing and affects the wheat yield adversely. To overcome these issues, the zero tillage technology can be used. However, farmers need to gain confidence about how to use this machine. For these reasons, the Farmer Field School approach was adopted.

A season long participatory learning and action program was conducted through Farmer Field Schools in the Sheikhupura and Sialkot districts during the year 2004-2005.

A Farmer Field School is primarily a learning approach. It is a season long learning experience. In the field schools, farmers learn about the ecology of the crop by conducting regular observations and hypothesis testing. During the FFS, a group of 25 farmers break into groups of 5 to carry out field observations involving two plots i.e. zero-tillage and farmers' practice (conventional tillage) plots. The small groups examine the wheat plants, take the observations of plant height, number of tillers, number of leaves per plant, water and fertilizer requirements, collect the samples of weeds in the wheat field and take note of their observations. These observations are used to produce agro-ecosystem diagrams of a graphical presentation of the wheat field. The drawing may include weather conditions, plant water requirement conditions, sketches of weed plants found in the field, the condition of the soil and many other interesting details. Each group then presents the results of its agro-ecosystem analysis to the whole group after which an open discussion and questions will follow. In addition to wheat field ecology, the FFS provides farmers with an opportunity to examine human social dynamics. As a result, farmers who participated in the FFS not only learnt about the cause and effect relationships that exist in the wheat field, but also acquired a greater understanding of human relations.

Technical training was planned with farming communities so as to build their capacity in the proper operation of the zero-tillage seed drill through TOT/FFS approach. For this training scientists from CABI Pakistan collaborated with field workers from Caritas International Pakistan. Caritas Pakistan is a Catholic international NGO, based in the Lahore Diocese. It was established in 1965 after the Pakistan-India war for the rehabilitation of Pakistan's war victims. Now agriculture is one of its priority areas. CABI scientists equipped 18 agricultural staff members from Caritas Pakistan to facilitate the FFS. Most of these people were trained animators and had experience of social mobilization and organization in the respective project districts. Thus 5 Farmers Field Schools were established in the Sialkot and Sheikhupura districts, i.e in Mundiyala werka, Khokhar ki Malian and Soia ki Malian villages in Sheikhupura and Bodha Goriya , Randhawa villages in Sialkot district. Four of these farmers groups went on to be converted and registered as Citizen Community Boards, see Appendix.

This training course were conducted with the following objectives:

(b) Objectives

The main objectives of the training program were as follows

- To build and enhance the capacity of Caritas staff in wheat sowing through o-tillage technology through TOT/FFS approach.
- To transfer these technologies to the grassroots level and build the capacity of farmers in their working areas.
- To empower the farming community to identify and adopt sustainable wheat production technologies.
- To promote zero-tillage drill in rice-wheat farming systems.

(c) Methodology

The three Farmer Field Schools in Sheikhupura and Sialkot districts and the TOT plot in Kalashah Kaku were established for a season long participatory learning and action program for wheat crop, which are mentioned in Table 8.

Table 8: The FFS sites, name of villages and number of participants in each FFS

FFS site / Village	No. of Farmers
Khokhar Ki Malian/ Saho Ki Malian	25 (five groups)/ 20 (four groups)
Mundiyala Werka	16 (three groups)
Pasroor	25 (five groups)

The two plots (zero-tillage and conventional tillage) of one acre each were established on each FFS site. The wheat in all the zero-tillage plots was planted with the zero-tillage drill while in conventional tillage plots it was planted by adopting the conventional practices. The irrigation requirement, weed management and other farm inputs, of the zero-tillage plots were adopted as required. This was decided by the farmers' groups after presenting the results of their wheat ecosystem analysis (WESA) whereas in the FP plots (conventional tillage) the farmers made individual decisions. The benefit/cost ratio for each tillage method was calculated on the basis of farm inputs and outputs. Inputs were seed, water, herbicides, fertilizer and cost of agronomic practices. All data was recorded on an acre basis and is shown in Tables 10 to 13b .

3.1.3 Zero tillage training

(a) Curriculum development workshop

Before starting season long zero-tillage technology training for improved wheat production, a one-day curriculum development workshop was held in CABI Pakistan's offices in Islamabad on November 04th 2004. This workshop was facilitated by CABI scientists. Various issues relating to wheat cropping and zero tillage technology were discussed as activities in the season-long TOT program. At the end of this workshop a curriculum for the TOT/FFS programme was developed. The main farmer activities focussed on quality seed, sowing through zero tillage and time of sowing, plant density, water shortage, soil fertility issues, time and dose of fertilizers application, weed management, pest management, crop harvesting and marketing issues.

(b) TOT participants

TOT participants were nominated by the Caritas Pakistan Lahore from Lahore Dioceses. There was diversity among the selected participants regarding areas of specialization and work experience. Before starting the season long training, an orientation session was conducted in which the participants were briefed about the programme and its objectives using participatory approach and pre-evaluation of the participants was also conducted in order to know their level of understanding about zero tillage technology on wheat crop and its management. Expectations and fears of the participants were also addressed during the first session. A list of participants is attached with this report in Annex I.

(c) TOT field study team and TOT plot

For the TOT field experiments the main group of the TOT participants were divided into 2 subgroups. The groups then selected their team leaders among their group members and also adopted their team name based on the names of beneficial insects. The groups and their member's names are listed in Table 9.

Table 9: Groups and names of teams

S.No	Team name	Team members
01	Lady Bird Beetle	Ashir, Rafiq Anayat, Javeed Ninu, Estephen David, Asiq Charlis
02	Spider group	Amir Rafiq, Sudheer, Samson Khokhar, Youhana Ishaq, Khalid Matoo, Johnson Naveed,

During the capacity-building process, two plots, each of 0.01 acre were selected on land at Kala Shah Kaku Research Station, for the comparison study of wheat sown by zero-tillage Machine vs wheat sown according to Conventional practise. The yield of both the plots were the same while input costs of the zero-tillage plot was Rs: 1,500 less than the input costs of the conventional plot.

(d) Activities in the Farmer Field Schools (FFS)

Pre-FFS activities: curricula development workshop
The main aim of the workshop was to identify the technical issues related to the adoption of zero tillage technology in the areas of post harvesting of rice, stubble management, soil fertility management, weeds management, pest management, wheat planting time, seed quality, plant nutrition, water management, informal participatory training, zero tillage manufacturing and socio economic conditions of the farmers.

(e) Farmer Field School training contents

The training contents were designed in accordance to the situation being faced by the farmers so that they could participate with enthusiasm in the training activities. The following activities were conducted.

Adult learning activities.
- Decision making process
- Problem solving
- Group dynamic activities

Science
- Concept of ecosystem
- Ago-ecosystem analysis
- Concept of zero-tillage
- Soil, water, fertilizer and weed management
- Communication and facilitation skills

(e) Farmer Field School program and topics

Agro-ecosystem analysis
- What is this?
- Wheat ecosystem
- Agro-ecosystem analysis (discussion on wheat field)
- Presentation of data on charts.
- Group presentations.
- Crop management decision.

Wheat physiology
- Seedling stage
- Quality seed
- Crop stand establishment
- Critical stages of wheat crop

Special topics
- Wheat agronomy
- Water holding capacity of soil
- Water and soil health
- Weed management
- Water infiltration in the soil
- Weather and wheat
- Water quality
- Insect, pest and diseases of wheat crop
- Biological control agent

Experiment
- Zero-tillage vs conventional tillage

(f) Group dynamics

To build the cohesiveness, trust and teamwork spirit among the participants of season long training, requires good group dynamics. Group dynamics play's an important role in group formation, collaboration, improving listening skills, observational and analytical skills. For this purpose several group dynamics have been conducted with the participants. Mean while participants were also encouraged to develop their own group dynamics, which was collectively done by the whole participants. These group dynamic activities conducted were as follows:

- Hopes and fears
- Name game
- Who will be the leader?
- Cutting cake with four cuts.
- Play the rope.
- Back to back and speak (communication exercise)
- Sing and act
- Making a coconut.
- Trust each other
- Relaxing exercise
- Knowing each other
- Programmed learning
- The paper ball game
- How many squares?
- Nine dots
- Drawing together
- Drawing buffalo
- Wayward whisper
- Body language
- Hot Hot, Cold Cold
- Water brigade
- Observing things
- Door game, Communication gap

(f) Training methods / approaches used in the FFS

Group process used to enhance team building

Team building – among the farmers this was considered important because it encourages interactions that promotes co-operation, relationship and participatory planning among the farming community.

Brainstorming – was used to allow the participants to open up their minds to find out about the practical solutions to their problems and to develop consensus on a single solution.

Role-plays – was used to provide an opportunity for the participants to put themselves in another persons' shoes to identify the issues and solutions.

Fortnightly agro-ecosystem analysis

This was the core activity in the FFS sites. This helped in understanding the relationships among the components of the ecosystem. Collection of data by small groups and presentation of this data in an agro-ecosystem drawing.

Collection of data on plant mapping and other farm inputs

The data collection on plant mapping and application of other farm inputs in both zero-tillage and conventional tillage plots helped build the confidence among the farmers who in turn demonstrated this in their own fields.

Special topics

Special topics on specific issues were discussed with the participants as the need arose. Some topics were initially designed to be discussed in the FFS.

(g) Results of the zero-tillage and conventional tillage plots

Table 10: Wheat yield at FFSs

FFS	Yield kg / acre	
	Zero tillage	Conventional tillage
Khokhar Ki Malian/ Saho Ki Malian	1000	1200
Mundiyala Werka	1000	1200
Pasroor	1000	1100

(h) Economics of the zero-tillage and conventional tillage plots

A close look at the economic analysis of the FFS plots indicated that the benefit / cost ratio was high in all the zero-tillage plots even though the wheat yield was lower, see Tables 11a to 13b. The soil was clay at Mundiyala Weika and Pasroor, while it was clay loam at the Khokhar Ki Malian/ Sohi Ki Malian sites. The rains in winter negatively affected the wheat crop in clay soils leading to low yields. Our results indicate that it is virtually impossible to provide blanket recommendations on zero tillage. Successful use of this technology depends upon the soil structure, precipitation, temperature, fertilizer placement etc. The selected sites had not been under zero-tillage before and the results may vary when there is continuous zero tillage. There is need to conduct farmer-participatory research trials for at least 5-7 years in the same fields in order to determine the true impact of this technology in Pakistan.

Table 11a: Cost (Rupees per acre) of different farm inputs, net income and benefit cost ratio of the zero-tillage and conventional tillage plots at FFS in Khokhar Ki Malian, Sheikhupura

Plot	Herbicide cost	Spraying charges	Agronomic practices & fertilizer cost	Total cultivation cost	*Income	Net income	Benefit / cost ratio
Zero-tillage	300	50	1500	1850	7500	6000	4.05
Conventional tillage	300	50	2500	2850	9000	6150	3.15

**Cost of wheat Rs. 300/40kg*

Table 11b: Agronomic practices & fertilizer cost in relation to Table 11a

	Zero tillage			Conventional tillage		
Practices	No.	Cost / unit	Total cost (Rs)	No.	Cost/unit	Total cost (Rs)
Ploughing	-	-	-	2	200	400
Disc harrow	-	-	-	1	500	500
0-drill	1	300	300		-	-
Urea	1	400	400	2	400	800
DAP	1	800	800	1	800	800

Table 12a: Cost (Rupees per acre) of different farm inputs, net income and benefit cost ratio of the zero-tillage and conventional tillage plots at FFS Mandiyala Werka, Sheikhupura

Plot	Weedicide cost	Spraying charges	Agronomic practices & fertilizer cost	Total cultivation cost	*Income	Net income	Benefit/cost ratio
Zero-tillage	300	50	1500	1850	7500	6000	4.05
Conventional tillage	300	50	2500	2850	9000	6150	3.15

**Cost of wheat Rs. 300/40kg*

Table 12b: Agronomic practices & fertilizer cost in relation to Table 12a

	Zero tillage			Conventional tillage		
Practices	**No.**	**Cost / unit**	**Total cost (Rs)**	**No.**	**Cost/unit**	**Total cost (Rs)**
Ploughing	-	-	-	2	200	400
Disc harrow	-	-	-	1	500	500
0-drill	1	300	300		-	-
Urea	1	400	400	2	400	800
DAP	1	800	800	1	800	800

Table 13a: Cost (Rupees per acre) of different farm inputs, net income and benefit cost ratio of the zero-tillage and conventional tillage plots at FFS Pasroor, Sialkot

Plot	**Weedicide cost**	**Spraying charges**	**Agronomic practices & fertilizer cost**	**Total cultivation cost**	***Income**	**Net income**	**Benefit/cost ratio**
Zero-tillage	-	-	1500	1850	7500	6000	4.2
Conventional tillage	-	-	2100	2100	8250	6150	3.1

**Cost of wheat Rs. 300/40kg*

Table 13b: Agronomic practices and fertilizer cost in relation to Table 13a

	Zero tillage			Conventional tillage		
Practices	**No.**	**Cost/unit**	**Total cost (Rs)**	**No.**	**Cost/unit**	**Total cost (Rs)**
Ploughing	-	-	-	4	400	400
Disc harrow	-	-	-	1	500	500
0-drill	1	300	300		-	-
Urea	1	400	400	1	400	400
DAP	1	800	800	1	800	800

3.1.4 Study of zero-tillage machine sales

A survey was conducted in six districts of Punjab i.e. Lahore, Hafizabad, Okara, Daska Sialkot, Mundi Bahawal din and Sheikhupura to document the sales of zero-tillage machines in these districts. The study results showed that from 1995 to 2004, only 2000 drills have been manufactured and sold. Now the demand for the machine has moved from Sheikhupura and Sialkot to Okara and Multan. Although there seemed to be an issue of dis-adoption increases in Sheikhupura and Sialkot project villages, it was due to number of reasons. Some of the reasons are high cost of machine which is beyond the capacity of marginal farmers, lack of awareness, lack of technical support, lack of back up support by the government institutions, lack of skilled manpower etc. In order to the sales of machines in more detail, a further study is being conducted by SARC Pakistan which is a Social Science Institute, National Agriculture Research Centre Islamabad to provide more details.

3.1.5 Exposure visits

One of the activities planned for the promoting and solving the issues raised by the farmers about zero-tillage machine in the project sites was, exposure visits of the farmers to the zero-tillage manufacturers, R & D institutions and large-scale farmers who have been using this technology for the last couple of years and have good experiences. For this purpose, exposure visits of 4 project sites from Sheikhupura i.e. Mundiyalawarka, Khokhar ki Malian, Saho ki Malian and Pindi Rateen Singh, while 3 sites from Sialkot i.e. Malomay, Bodha Goriya

and Randhawa, were planned on 7, 8th and 11th of April. The farmers from Sheikhupura visited manufacturers as well as Model farms. While the farmers from Sialkot only visited the model farm. Brief details of the visits is given below:

(a) Exposure visit of Sheikhupura Farmers to Daska, Sialkot

On April 7th 2005, sixty farmers from four sites in Sheikhupura i.e. Pindi Rateen Singh, Khokhar Ki Malian, Sao Ki Malian and Mundiyalawarka, visited the zero-tillage manufacturers in Daska, Sialkot. They visited Forward Agro Engineers, Daska and met Mr. Farooq, the owner of the Forward Agro Engineers.

During this visit, the farmers saw the zero-tillage machine and asked questions to Mr. Farooq about its performance, trend of sales, distribution areas, numbers of farmers who have purchased this machine this year, what are the problems/issues related to the performance of this machine, and type of farmers purchasing this machine, is there any rental services of this machine available or any manufacturer thinking about starting this services etc. Mr. Farooq demonstrated the machine to them and also answered their questions. It was noted that mostly cash croppers were purchasing this machine and in 2004-5, this machine had mainly been purchased by farmers from Sindh rather than Punjab province. While in Punjab, this machine mainly went to Multan areas. There was no rental service available either by any manufacturer although Mr. Farooq was interested in starting a rental service. Overall the manufacturers are more interested in selling than rental services. He also explained the technicalities of machine operation. Regarding answering the question of performance problems/issues, the manufacturer replied that it needs minor repairs and it could be done at any tractor repairing workshop while major issues need to be solved only by their manufacturers. At the end of this visit the farmers were very pleased about getting this information but they were still concerned at its high price, which is beyond the means of both marginal and subsistence farmers.

(b) Exposure visit of Sheikhupura Farmers to Bilal Nagar Farm, village Bilal Nagar, Farooqabad

The same 60 farmers from four sites of Sheikhupura districts, visited the Model farm of Mr. Maqbool Qadar Shah in village Bilal Nagar, Farooqabad. He had 150 acres of land and had been practising zero-tillage prior to wheat sowing for the last 6 years. His cropping pattern is rice-wheat-rice. His average wheat yield is 45 maunds/acre i.e. 1,800 Kg/acre and rice is 65 maunds/ acre i.e. 2,600 Kg/acre. His soil type is 70% Rohi (clay loam), with 10% on lower land, and 30% Mera (Silt loam). The smallholder farmers asked this large-scale farmer many questions, the main ones were as follows:

Q-1: On what type of soil does it work properly? Have you experienced soil compaction by continuously using this machine on the same piece of land.?

Q-2: Have you observed shorter size of wheat spikes following continuous use of this technology?

Q- 3: After three years of consecutive use of this technology does it result in lower wheat yields?

Q- 4: Have you observed increased insect pests after using this technology?

Q-5: What overall benefits have you observed?

Q-6: Did you buy the machine? Why did you start using this technology?

Q-7: Are you helping fellow farmers by providing this technology on rental basis?

Q-8: How much land is tilled by this machine per day or within an hour?

Mr. Maqbool Qadar Shah, the owner of the farm and the zero-tillage machine, replied in detail that there was no problem with the zero-tillage machine on any type of soil. Although he had observed some soil compaction in Rohi soil after 3rd year of continuous use, he said that it can be managed by 1-2 extra ploughings and planking in rice land preparation for rice cultivation. In response to the shorter spike length he had also observed the same problem but said that it did not affect the yield of the crop and it was observed only after the 3rd or 4th year of continuous use. In response to lower production/yield, he did not agree with this concept and said that he was confident in the technology because it saved in input costs in

term of money, time and labour. He had experienced higher insect/pest infestation in rice crops after using this technology, especially by rice stem borer. He noted that stem-borer attacks on rice seem to increase following continuous use of zero tillage for wheat. He said that there was about a 20% increase in insect attack on the following rice crop. This was more prominent when the rice crop is harvested with a combine harvester before cultivating wheat with zero-tillage machine. He said that weeds were also a problem in wheat when using the zero-tillage machine.

He was the owner of the machine and had purchased it from Daska after a demonstration trial by On Farm Water Management Department in 1999 on his land. So far he had not rented this machine to any other farmer of the area. This is because he is busy after harvesting his rice crop in December, he did not have much time to rent it to others as he had to cultivate his land in time for planting a timely wheat crop. This machine can plough on average 12 acre/ day. He was satisfied by using this machine and recommend it for other farmers. He also said that some times due to unfavourable climatic conditions the results were not in accordance to our will but that did not mean that the technology is not good.

The farmers from this visit seemed to be very satisfied and seemed to be persuaded to purchase zero-tillage machine in the form of a group or register themselves as a Citizen Community Board with local government in order to seek help in purchasing and providing this machine to farmers in the village. In this regard CABI Pakistan scientists and Caritas staff took the initiative and organized farmer groups at project sites in both districts, Sheikhupura and Sialkot, by providing information on registering as a CCB with the local government.

(c) Exposure visit of Sialkot Farmers to Model Farm, village Gujar Kay, Pasroor, Sialkot.

About 58 participants from villages Malomay, Bodha Goriya and Randhawa, district Sialkot, participated in exposure visit to Mr. M. Aslam Farm at village Gujar Kay, Pasroor, Sialkot on April 11th 2005. Mr. Aslam has 120 acres of land and out of which he has used zero-tillage on 40-50 acres every year since 2001. His cropping pattern on this land is mainly rice-wheat-rice while on rest of the land he cultivates sugar cane, kharif and rabi fodders, vegetables etc. His average wheat yield is 43 maunds/acre i.e. 1,720 Kg/acre while his rice yield is 46 maunds/acre i.e. 1840 Kg/acre. His soil type is both Rohi 55% and Mera 45%. He had no complaints of soil compaction, although he did say that if he feels some sort of hardness in the soil then he uses an extra plough in rice land preparation. He was also asked similar questions as the previous farmers's group and his replies were almost the same as those given by Mr. Maqbool Qadar Shah of Bilal Nagar. Mr Aslam had also observed rice stem borer in his rice crop after continuous use of zero-tillage for wheat crop sowing. He is also the owner of this machine and has not rented it out to any other farmers in the area. Although he said that he had shared this machine with his friends in nearby villages whenever they asked, without taking any benefits from them.

3.1.6 Meetings with different NGOs in Lahore working for rural women in education, health and agriculture sector for development of a project

CABI planned to initiate an activity for rural women to improve their education, health and agriculture. In this regard a one day workshop was facilitated by Dr. Tahseen Jafry on May 24th 2005 at WWF Pakistan, Lahore. As a preliminary activity for this workshop, some NGOs who work country wide for the development of rural women in education, health and agriculture sector were contacted. Meetings were held with these NGOs between 6th to 9th May at Lahore. The contact details for these NGOs are given in Table 14.

All of these organizations showed interest in the workshop and contributed to the development of a project proposal for uplifting rural women in Pakistan through education, health and agriculture. They were keen to work with CABI Pakistan in future. An outline proposal was developed following this meeting.

Table 14: NGOs involved in women's education in Pakistan

S. No	NGO Name	Contact person	Contacts
01	Aurat Foundation	Misbah Tahir (Resident Director) Farzana Mumtaz (head community organization and Editor of magazine)	042-6306534 Near China Chock
02	Sudhar Foundation.	Fawad Usman (CEO) Sofia Aziz (In- charge ALC through quality education for Girls)	042-5868176 134 Abu. Bakar Block New garden town, Lahore.
03	Kashif Foundation.	Roshan -i. Zafar (CEO) Attaf (operation associate) Sadaf Abid (chief operation officer)	042-5847812-5 19 Abbot block, New Garden town Lahore.
04	Shirkatgah.	Dr. Rehana (In- charge Health section) Sajida (librarian) Waris (Librarian)	042-5838815-5836554-5832448. 68 Tipu Block, New garden town, Lahore
05	All Pakistan Women Association.	Mrs. Rizwan (Chairperson)	042-7586073 65 Jail road Lahore
06	Buniyad	Syed-ur-Rehman (Executive director) Yasir Nazir (admin officer)	042-5600621, 5600235,5600692. Badian Road, Lahore
07	SAP	Admin officer	042-5426471-4
08	Sahi Foundation Lahore.	Zakiya	042-5868115

3.1.7 Citizen Community Boards

Another activity planned for this project was the registration of FFSs as Citizen Community Boards (CCB) with the District Social Welfare Department. The devolution of power to Union Council level has been taking place in Pakistan since 2001, under the authority of President Pervez Musharaf, to promote fund allocations for the development of rural communities in agriculture, health, sanitation, education and the environment. In order to get involved in this process, first the community has to organize themselves into a group of at least 25 persons/farmers (this group may be either only male or female or both), they then need to register themselves with the government department on a prescribed form along with National Identity Card of each participant (participants must be resident of the particular village and by birth a citizen of the Government of Pakistan). Next they need to write a development project proposal in one of the above mentioned sectors with estimated costs. The Government department will then conduct a feasibility study and 20% of the cost must be borne by the CCB participants and 80% by the Local/ district council. The project implementers are the CCB participants, while project monitoring is the duty of the Government sector. The farmers were unaware of this funding source prior to CABI and CARITAS working in their villages.

Fig 20. Meeting at Khokhar Ki Malian for CCB

The high price of zero-tillage machines (Rs: 40,000) prevents access by small (marginal or subsistence) farmers. However, following their exposure visits to the zero till drill manufacturers and the model farms most farmers in both districts seemed to be pleased with their experience and showed interest in forming a groups in order to purchase a zero-tillage machine in order to improve access to this technology by all farmers. To this end scientists at CABI have provided information and guidance on registration as a Citizen Community Board with the local government.

After several meetings with farmers to clarifying the CCB concept, 4 FFS converted into CCBs by registering themselves with the Government department. These are:

1. Pindi Rateen Singh (Sheikhupura)
2. Khokhar Ki Malian (Sheikhupura)
3. Malomay(Sialkot)
4. Bodha Goriya (Sialkot)

Fig 21. Meeting at Pindi Rateen Singh for CCB

The farmers from Khokhar Ki Malian and Malomay CCBs have submitted their project proposal for a machinery pool at village level to the Government department. The farmers from Pindi Rateen Singh are in the project development process. A further development is that Caritas International Lahore are planning to purchase a zero-tillage machine in order to provide rental services to their organised communities using their own funds. Annex II contains the registration certificates of the groups and meetings held with farmers.

3.1.8 Development of literature

There is a lack of literature available to farmers on zero-tillage technology except for a one page brochure by manufacturers or Farm Machinery Institute, National Agriculture Research Centre, Islamabad. This is insufficient to disseminate knowledge about the technology. In order to overcome this gap, literature was developed in the form of posters, pamphlets and calendars on rice-wheat production technology. This literature was in Urdu and pictorial, to have maximum understanding by farmers even if they are illiterate.

Another achievement of the project was the development of a manual on zero-tillage technology, its usage, repair and maintenance. It was first time in national history that such a manual has been developed. Even, the FMI, NARC did not have this before. Farmers as well as researchers of FMI are very pleased and satisfied with the manual. The manual is in Urdu. This activity was done in collaboration with the scientists of FMI, NARC. The manual and pamphlets were distributed among the farmers in the project sites as well as in nearby villages. Copies are available from CABI Pakistan. The content of manual is as follows:

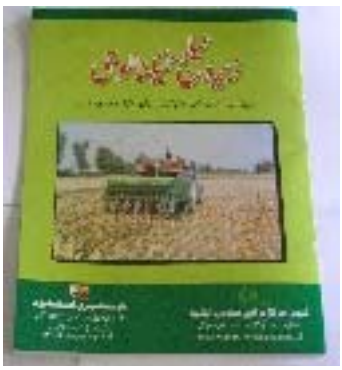


Fig. 22. Zero tillage manual

- Wheat sowing
- Wheat sowing in paddy field
- Zero Tillage Technology
- History of zero-tillage Technology in Pakistan.
- Qualities/properties of a good zero-tillage drill.
- Inverted T opener or Tine.
- Power transmission system.
- Calibration system for seed and fertilizers.
- Proper depth for seed and fertilizers.
- Recommendation for proper usage of zero-tillage drill.
- Setting of per acre seed and fertilizers in zero-tillage drill.
- Few considerations for farmers before purchasing the drill.
- Proper usage technology of zero-tillage drill.

- Safety instructions during machine operation.
- Safety instructions after machine usage.
- Some important issues of zero-tillage drill and their solutions.
- Some issues of the drill that can be solved by the farmer themselves.

Annex III shows a series of five posters that were produced by CABI Pakistan in support of this project.

3.1.9 Development of documentary video

Another activity planned for the CABI project was the development of a documentary movie on zero-tillage, its issues, farmer's perceptions and activities to over come those problems/issues. It is an informative and beneficial documentary movie for overcoming the knowledge blockages of zero-tillage among farmers and institutions involved in promoting it. It is available from CABI Pakistan.

3.1.10 Capacity building of farmers in zero-tillage machine repair and maintenance

Detailed information has been collected in the project sites to understand the issues related to zero-tillage drill repair and maintenances. On the basis of the identified issues, a one day workshop in each district was arranged in Sheikhupura and Sialkot districts on March 24th and 25th, 2006 to discuss issues and potential solutions. Almost 50 participants from both districts participated in these workshops. Mr. Shabir Kalwar Engineer (Senior Scientific Officer, FMI, NARC, Islamabad) addressed the issues raised by participants and workshop was facilitated by Mrs. Bushra Raza. The main problems raised by the participants and their solutions is given in Table 15.

Table15: Repair and maintenance issues

Issues	Solutions
Blockage of pipe during the operation of seed/ fertiliser application due to soil.	The position of tines and pipes should be adjusted so that soil did not stick in it. Drill used in Indian is better than us. Engineers should work on it.
Rice stubbles disturb the sowing process during sowing.	Addition of chopper before front wheel.
Improper calibration. Seeds were destroyed due to excess dropping.	Engineers should work on it.
Lack of standardized machine.	Government should check and regularise the standards of machine.
No working literature available from research institutes or manufacturers.	CABI, Research or NGOs should provide working literature.
Problem in back wheel at turning point when tractor raises drill, the seeds and fertilisers dropped.	Back wheel should be small in size so that it can be lifted easily during turning.
Lack of operational training of zero-tillage to farmers.	Training should be imparted to farmers in zero-tillage operation and maintenance.
Tines are of not good quality so break before the time claimed by the manufacturers.	Tines should be of good quality and if it possible, government should import them from overseas.
Machines tyres are too small and thus jump over uneven places in field, causing gaps in placement of seed and fertiliser.	Machine tyres should be big enough to prevent this problem.

Mr. Shabir Kalwar addressed these issues one by one. He also shared with the farmers the new version of zero-tillage machine in which the chopper is added and calibration is also corrected. But this new machine is still in the process of research and he said that hopefully it will be in market within next 2 years.

CABI Pakistan staff distributed the zero-tillage manuals that they had prepared among the farmers. They were very well received as it was first time that these farmers had ever got such kind of information from any institute. Pictures of the event can be seen in Annex IV.

Capacity Building in Zero-tillage Machine Repair and Maintenance

Fig. 23 (a–c). Farmers in Sheikhupura district

Fig. 24 (a–b). Farmers in Sialkot district

Final discussion on assessing the impact and facilitating the uptake of resource-conserving technologies in Pakistan

Output 1: Impact studies of Using the Zero Tillage Machine

The villages adopted for this CABI research project can be classified into adopted and non-adopted; adopted means that the farmers have not had exposure to the machine in the village and thus have not used it. Adopted means that the machine has been introduced to the village under various schemes and farmers are either using it, have used it and are not using it any longer, or choose not to use it at all.

In the non-adopted villages, farmers indicated that access and non-availability at the right time of the season is the reason why they are labelled as a non-adopted village. There are also financial constraints because the majority of the farmers are marginal and subsistence and cannot afford to buy the machine. However, it is not just financial and material constraints that seem important, the research findings highlighted the fact that knowledge, information and awareness about the technology is a barrier to adoption. The CABI project addressed this problem under Project Outputs 2 and 3 (see below).

In the adopted villages, many issues were raised concerning the effects of using the machine; these included: poor drainage, soil compaction, increased infestations with rice stem-borer, timely availability and disagreements between the Agricultural Extension Dept and the Water Management Dept on whether or not to recommend the use of the machine.

The issue of increased stem-borer activity in the following rice crop has been discussed in a number of studies (see link below) and the farmers' experience of a 20% increase has been confirmed in Pakistan by Inayatullah *et al* (1989) and Srivastaava *et al* (2004). However, according to Hobbs (pers. com.) there are 2-3 million hectares of no-till wheat now being produced across the Indo-Gangetic plain and so far there have been no reports of any massive outbreaks of this pest. Considering that the larvae survive in the base of the rice stubble, very few are able to survive until March or April if wheat is grown, irrigated and fertilized according to recommended practices. The problem usually only arises in fields left fallow and un-irrigated after a rice crop. It has been found that when stubble is left in the field it provides a habitat for beneficial insects that prey on the larvae. The RWC have prepared an extensive paper on this subject in all 4 countries and this can be found at http://www.rwc.cgiar.org/Pub_Info.asp?ID=111 on the Rice Wheat Consortium web site. Although this issue has been debated many times by scientists, the fact that farmers in these adopted project villages still remain unclear about the impact of zero tillage on the rice stem-borer suggests the need for farmer-participatory research, comparing both tillage practices and cropping systems on the over-wintering of this pest.

On the issue of compaction, it is thought that this is not a problem in rice-wheat systems as long as the fields are ploughed and puddled for the next rice crop, any compaction or plough pan would be there as a result of this puddling anyway. Govaerts, *et al* (2005) working in highland areas of Mexico found that compaction and declining yields are only problematic if all the residues are removed, however if sufficient residue from either a cereal or a cover crop remains, compaction does not occur and yields remain high. An earlier DfID-funded project which investigated soil fungi and nematodes under zero tillage systems in Pakistan and India concluded that the adoption of this technology did not adversely affect soil health (Duveiller, *et al,* 2003).

Disagreements between the Agricultural Extension Dept. and the Water Management Dept. over the impacts of zero tillage have been continuing for several years. The conflicting views of these two influential organisations have led to a situation which is extremely confusing for farmers. Farmers, particularly those who are more vulnerable to risk, need clear and concise information to help them make decisions about whether or not to adopt this new tillage

practice. The project team were aware of the conflict of interest between these two important departments and hopefully the information contained in this report will help to resolve it.

Lack of availability and timely availability of the machine are issues that the project addressed in Outputs 2 and 3.

Impact studies of Using New Rice and Wheat Varieties

This research indicated that the immediate impact of using new varieties is increased production which leads to improved food security for the farmers. Food surplus farmers benefit most because they have most land and enough money to purchase the necessary inputs. Marginal farmers are at a disadvantage because they lack knowledge in pest management.

Although improved seed is available and seems to be adopted by most farmers in the project villages, there is little knowledge and information about the seed they are growing, doses of inputs needed to maintain a healthy crop (balance of nutrients), pest control (e.g. rice leaf folder) and grain storage. Access to quality seed is an issue for the marginal and subsistence farmers due to their dependence on some unscrupulous middlemen

Agricultural extension services hardly ever visit the villages and if they do, they only interact with landlords and better off farmers.

The research also highlights, that male farmers are not willing to pass on information to women due to cultural barriers and fear of female empowerment. Many women who work in agriculture e.g. in Pindi Rateen Singh, indicate that they do want information but that they are denied this by their male counterparts. For instance grain storage is done by women but they are denied access to information and technology on how this can be done using improved techniques.

On, the whole, every socio-economic group of farmer indicated that they wanted more interaction with extension services and NGOs for new knowledge and information. The project team under Output 2 addressed how to get knowledge and information to all socio-economic groups of farmers.

Output 2: Agricultural Knowledge Systems pertaining to zero tillage machine

This research has identified that there are many agricultural knowledge systems and information pathways, including government agencies, NGOs private sector, universities and media (T.V and radio). The research has also identified that although all these institutions are highly informed theoretically, in practise they fall short of actually delivering the type of information that farmers need. According to the results of our study, the better off food surplus and 'favoured' farmers are usually contacted more than the marginal and poorer farmers by Government departments. This coupled with the fact that the poorer/marginal groups have low literacy rates and are not able to read promotional literature and learn about new technologies. Subsistence farmers indicated that although they do have access to information, it is of poor quality. These farmers require clear information about the technology and back-up support to answer queries and to address the need for trouble shooting.

The farmer's quest for knowledge and information is also hampered by the ability of promoting organisations to provide information in a form that is accessible to all socio-economic groups. A number of suggestions were put forward for more effective dissemination of the RCTs (see section 2.8). However, many of these recommendations require changes at institutional levels, in terms of policy and logistics. The project team therefore, felt that in order to reach farmers effectively a new strategy was required and a

farmer-to-farmer approach was developed. In addition to this, a methodology was used for targeting different socio-economic groups of farmers, including women farmers. The strategy was based around well established forums, such as the 'Haweli', rather than creating something artificial. These community meetings are part of the daily routine for all men in the village. Through these meetings, a number of dissemination activities were identified which included all socio-economic groups. These activities included sharing literature in the form of pictorial calendars and training manuals, conducting Farmer Field Schools, developing documentary video in *urdu* for sharing knowledge, organising farmers into Community Citizen Boards and arranging exposure visits.

Output 3: Creating enabling environments

All of the activities identified under Output 2 created an enabling environment. One of the major activities undertaken was to develop a Farmer Field School (FFS) programme for wheat sowing through zero tillage. With careful selection of participants interaction between individual farmers of different socio-economic groups was encouraged in a way that may not have occurred previously. The majority of farmers participating in the FFS were from the marginal group. These FFS were supplemented by a transfer of technology exercise. This exercise was essentially an experiment to compare the use of ZT machine with that of conventional tillage method and was conducted by farmers in their own fields. The results (see section 3.1.3 (e)) indicate that the zero tillage machine is beneficial in economic terms. This was an important exercise as it allowed farmers to focus on economic returns rather than increased yields.

Exposure visits to various field sites also enabled the farmers from the project villages to ask questions to help remove doubts about the technical aspects (3.1.5). However, the cost of the machine for marginal farmers remained a crucial issue as most of the farmers who owned the machines did not want to hire them out to others. As a result, the project village marginal farmers collectively decided to form Citizen Community Boards. A CCB is a way of getting funds from the government for improving rural development. The marginal farmers were unaware of the CCB registration process prior to the CABI project. Through the the efforts of CARITAS, 4 FFSs were converted into CCBs by registering themselves with the government department. After a government feasibility study, 20% of the cost of the ZT machine will be met by the farmers, with the government contributing the remaining 80%.

This research project has also identified that there was a lack of suitable literature for farmers to learn about this technology, except for one page brochures available from the drill manufacturers, despite the fact that the zero tillage machine has been promoted in Pakistan for a number of years. To overcome this gap, posters, pamphlets and calendars on rice-wheat production technology was developed. This was in *urdu* and mainly pictorial to have maximum impact.

A zero tillage manual was also developed in collaboration with the FMI and NARC. This is the first manual on the zero tillage machine to be produced and distributed in Pakistan. A documentary video was also developed for overcoming knowledge blockages among farmers. A further workshop was held for farmers in the project villages to learn how to maintain and repair the machine.

Conclusion

The Pakistani project team has undertaken extensive research to understand what impacts RCTs are having on the Indo-Gangetic Plains in Pakistan and to focus on how to get all socio-economic groups of farmers (poor as well as better off) to be able to benefit from such technologies.

The results, although pertaining to the specific project villages, revealed some significant findings. Access to knowledge and information was found to play an important part in helping farmers come to decisions about whether to use RCT or not. But, more specifically, knowledge and information that is understandable by all socio-economic groups. This study

revealed that it is the better off farmers who initially benefit from RCTs such as the zero tillage machine and indeed this technology has had widespread impacts on the rice-wheat farming system of the Indo-Gangetic Plains. However, this study shows that the marginal farmers, who have the lowest literacy rate, are the ones who are 'left behind'. Marginal farmers have a constant desire for new information (maybe more than other socio-economic groups), but the information either does not reach them or they cannot understand the information that has been provided to them. This study has also revealed that women farmers are almost completely denied access to information for fear of empowerment.

Education is a very powerful strategy in helping people out of poverty. In relation to this project, knowledge and information about RCTs is a way of educating farmers about new technological practices so that they are better able to survive through more food production (whether this is sold or not). This project has shown that poorer farmers do have the ability to adopt new technologies, such as the zero tillage machine, if they are given an environment which enables them to do so. This was demonstrated via the formation of Community Citizen Boards as a vehicle to move forward.

This project has demonstrated that through correct facilitation and identification of the needs of all socio-economic groups many more farmers can benefit from the introduction of new technologies such as the zero tillage machine. Thus, in conclusion to this project, knowledge is for life and without it we all cannot go forward.

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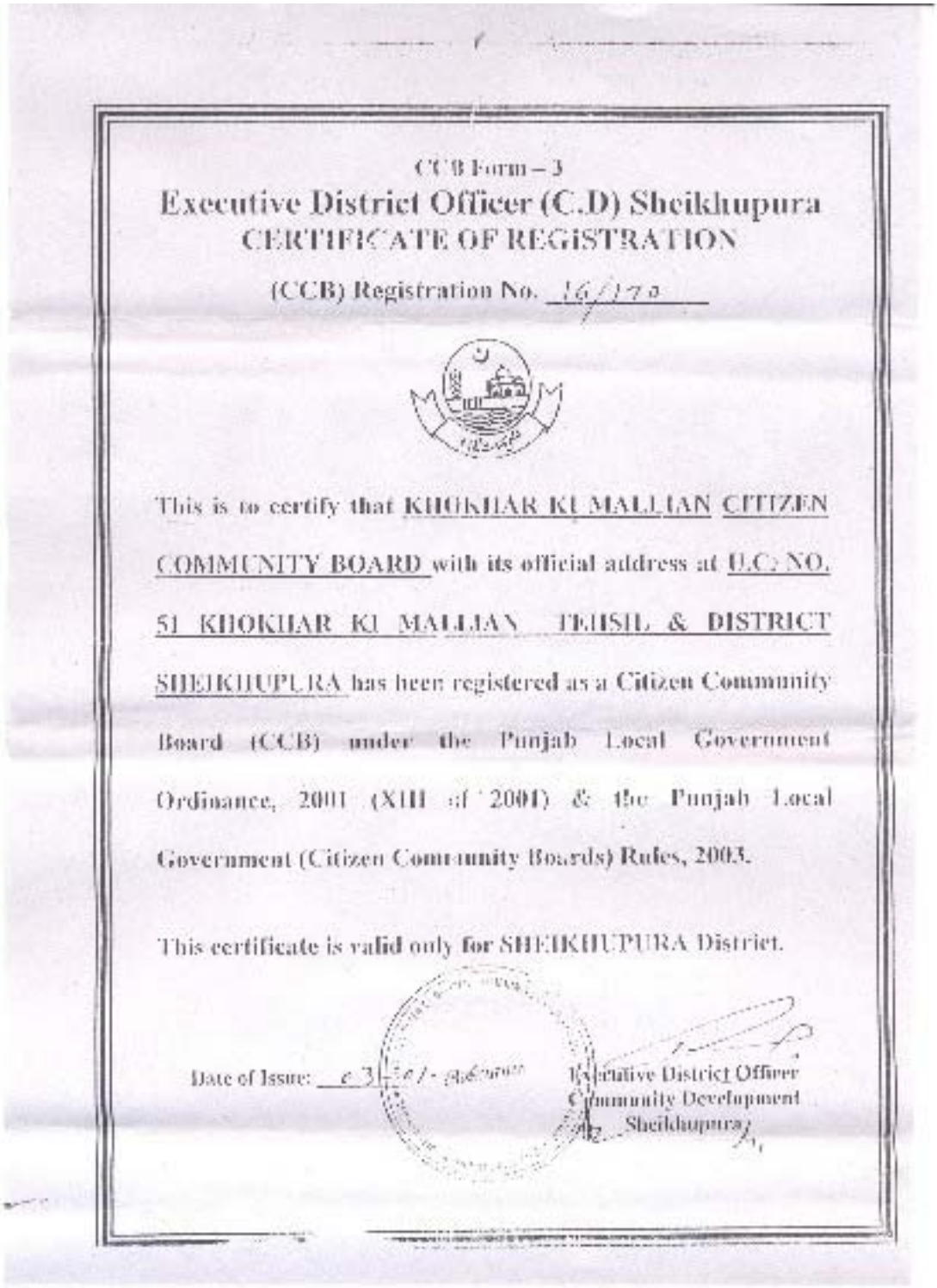
Annex I: List of TOT Participants of the Training of Wheat Sowing through Zero-tillage Drill

Names	Designations
1- Mr. Asher	Agriculture Coordinator, Lahore Dioceses
2- Mr. Amir Rafiq	Laboratory Supervisor, Lahore
3- Mr. Rafiq Anayat	Animator, Lahore Diocese
4- Mr. Javeed Nino	Animator, Lahore Diocese
5- Mr. Ashiq Charlis	Animator, Lahore Diocese
6- Mr. Johnson Naveed	Animator, Lahore Diocese
7- Mr. Estephan	Animator, Lahore Diocese
8- Mr. Sudheer	Animator, Lahore Diocese
9- Mr. Khalid Matoo	Animator, Lahore Diocese

Annex 11: Citizen Community Board Registration

Khokhar Ki Malian Registration Certificate



CCB Form – 3

Executive District Officer (C.D) Sheikhupura

CERTIFICATE OF REGISTRATION

(CCB) Registration No. 16/170

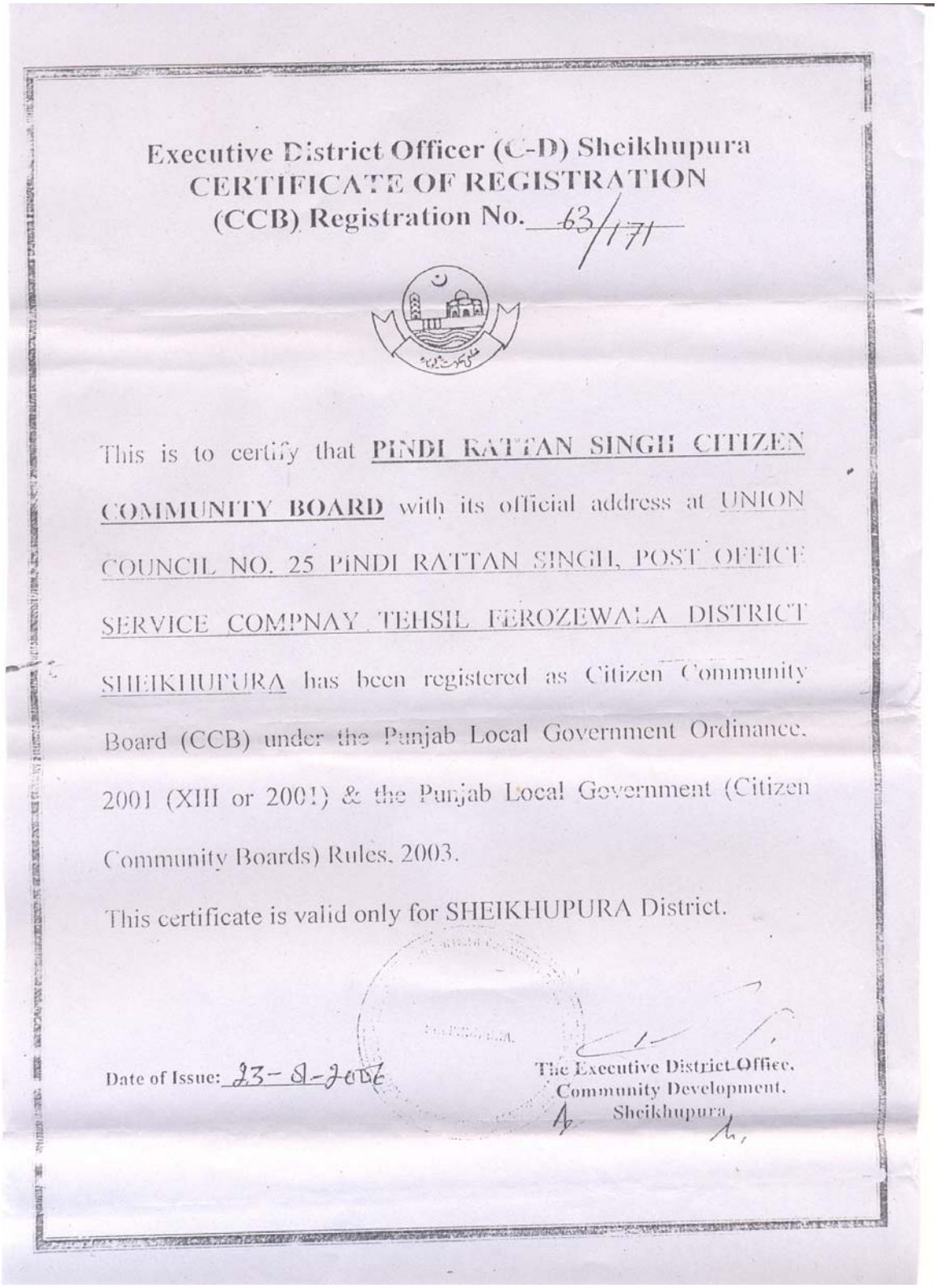
This is to certify that KHOKHAR KI MALLIAN CITIZEN COMMUNITY BOARD with its official address at U.C. NO. 51 KHOKHAR KI MALLIAN TEHSIL & DISTRICT SHEIKHUPURA has been registered as a Citizen Community Board (CCB) under the Punjab Local Government Ordinance, 2001 (XIII of 2001) & the Punjab Local Government (Citizen Community Boards) Rules, 2003.

This certificate is valid only for SHEIKHUPURA District.

Date of Issue: 23/01/2006

Executive District Officer
Community Development
Sheikhupura

Pindi Rateen Singh Registration Certificate



Executive District Officer (C-D) Sheikhupura
CERTIFICATE OF REGISTRATION
(CCB) Registration No. 63/171

This is to certify that PINDI RATTAN SINGH CITIZEN COMMUNITY BOARD with its official address at UNION COUNCIL NO. 25 PINDI RATTAN SINGH, POST OFFICE SERVICE COMPNAY TEHSIL FEROZEWALA DISTRICT SHEIKHUPURA has been registered as Citizen Community Board (CCB) under the Punjab Local Government Ordinance, 2001 (XIII or 2001) & the Punjab Local Government (Citizen Community Boards) Rules, 2003.

This certificate is valid only for SHEIKHUPURA District.

Date of Issue: 23-8-2006

The Executive District Officer,
Community Development,
Sheikhupura

Annex III: Posters prepared by CABI Pakistan

Fig. 25. Rice production technology; insect pests and diseases; beneficial insects

Fig. 26. Wheat production with zero tillage drill; wheat diseases

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