CIPT
Centers for International Projects Trust

TECHNICAL PAPER NO. 1

Farmers' Awareness, Perceptions and Knowledge Gaps: Looking for Innovations in Agricultural Extension

2015

Kamal Vatta
Garima Taneja

Farmers' Awareness, Perceptions and Knowledge Gaps: Looking for Innovations in Agricultural Extension

2015

Centers for International Projects Trust

ABSTRACT

The state of Punjab has followed a path of intensive agriculture, leading to prevalence of rice-wheat mono-culture along with higher input–use. As a consequence, it resulted into serious threat of long term sustainability of agriculture within the state. The present study evaluates the major challenges being faced by Punjab farmers in their farming practices, knowledge attainment and further assessing their perceptions about the future threats. The results of the study indicate that farmers are aware about the ill-effects of intensive agriculture and their causes, but they lack awareness on potential solutions for tackling them and access to more scientific and recommended set of practices for more effective operations. The paper generates a case for the innovations in the extension education system, where ICT can play an important role. Various options of web portals, mobile applications and bulk messaging services need to be explored to enhance the effectiveness of the traditional approaches of extension education. Furthermore it emphasize on the set of information, which can be routed more effectively through the innovative extension tools and can add value to the farmers' decisions.

Centers for International Projects Trust (CIPT) aims at bringing long term water sustainability and meaningful improvement in water quality. It works towards providing rigorous, research-based knowledge as the foundation for various field based initiatives.

Centers for International Projects Trust
910-911, Pragati Towers, Rajendra Place
New Delhi - 110008
T: +91-11 - 4056 5989
W: www.cipt.in

1. Introduction

The state of Punjab, with a strong agricultural base, led the momentum of green revolution which started during the late-1960s and early-1970s in India. The state has undergone a rapid transformation during this period due to the adoption of new agricultural technology (PSFC, 2013). The adoptioncomprised the use of high-yielding varieties, particularly for rice and wheat, rapid expansion ofthe application of chemical fertilizers, expansion of irrigation facilities especially lifting the groundwater through tube wells & pump sets and farm mechanisation within the state (Ibid). The modern production practices and effective public procurement of grains at remunerative prices contributed significantly to the attainment of national food security and also put the state economy on a higher growth trajectory (Sidhu and Bhullar, 2005; Joshi, 2004). Thestate recorded an annual growth rate of 5.4% in net domestic product (NDP) at constant prices during 1970s as compared to the national average of 3.4%. Thehigher growth rate wasretained tillthe 1980s. However, a decline in growth was observed during 1990s as the state achieved an annual growth of 4.3% in NDP compared to the all-India rate of 6.1% during this period (Gulati, 2002). The intensive agricultural practices in the state have resulted into severe over-exploitation of the natural resources such as depletion in groundwater table and soil health in Punjab (Sidhu, 2002). The decline in agriculture growth and stagnation in agricultural productivity in the state, have largely been attributed to the ecological problems associated with the intensive agriculture (Swaminathan, 1999).

Within the state, most of these problems are mainly characterized by excessive input-use such as fertilizers and pesticides and over-exploitation of groundwater resources which have adversely affected the soil health, environment and ground water aquifers (Mishra et al., 2013; Perveen et al., 2012). The fertilizer use in Punjab is 249 kg/ha of the cropped area (PAU, 2015), which is much higher than the recommended levels of fertilizers use for the most dominant crops of Punjab. Apart from excessive use, the fertilizer use is highly imbalanced. Against the recommended levels of 4:2:1, the NPK ratio was 18.1:7.1:1 in 1980-81 which worsened further to 26.2:8.3:1 in 2011-12(Johl et.al, 2014). Chemical fertilizers have been reported to account for 8-9% of the gross value of production in Punjab (Sombillaet. al,2002) their excessive and imbalanced use points towards their sub-optimal use, which leads to an increase in the cost of production with a corresponding decline in crop productivity(Kumar, 2003). The intensive cultivation of land coupled with imbalanced use of fertilizers has led to the deficiency of micro-nutrients in the soils (Ibid). Numerous state level studies have observed micronutrient deficiencies such as zinc, iron, copper, manganese, magnesium, boron etc., with the state. A study by Shiva (1989), reported about 50% of the tested soil samples (8706 samples) in Punjab exhibiting zinc deficiency, thereby reducing the productivity of rice and wheat by 3.9 tonnesand 1.98 tonnes per ha,respectively.

The expansion in irrigation network, with increasing access to groundwater, rising cropping intensity and low water-use efficiency have led to severe depletion of groundwater resources. In Punjab, 98% of the area is irrigated, out of which 76% is irrigated by groundwater. The demand-supply gap for groundwater in agriculture has increased substantially over time, causing a much faster decline in the water table at 75cm per annum during the last decade, while the earlier decline was much lower at 18cm per annum during 1982-97 and 42cm per annum during 1997-2002 (Singh, 2009). Currently, water table is declining in almost 80% of the blocks due to over-exploitation. The policy of free power supply for agriculture has further worsened the situation by promoting water intensive crops such as rice and also encouraging wasteful use of water for irrigation. Pumping ground water from deeper aquifers has resulted into more than doubling of the power consumption in agriculture from 5105 million kilowatt hours in 1990-91 to 10898 million kilowatt hours in 2010-11 and has also pushed the power subsidy burden of the state government to more than nine times from Rs 385 crore to Rs 3487 crore during this period (Vattaet al., 2013).

These emerging problemsof rising costs of production due to excessive input use, over-exploitation of natural resources and stagnation in agricultural production and productivity pose a different set of challenges as compared to the challenges faced by Punjab agriculture in the beginning of the green revolution period. Previously, the focus of research and extension was on enhancing the input use for enhancing production but rejuvenation of agriculture in the present context requires focus on research and development on optimizing production with respect to the natural resources and enhancing the farm profitability through judicious use of farm inputs. It calls for an innovative policy planning to prepare the farmers to move towards sustainable production. This is, possible if a comprehensive assessment on farmers' awareness, knowledge gaps and perceptions on sustainability options

for agricultural production exists. This paper makes an attempt in this direction by assessing the farmers' awareness and perceptions about different input-use, marketing opportunities, technological awareness etc. for tackling the major challenges faced by the farmers in Punjab. The paper further explores the strategies to strengthen extension education efforts for ensuring sustainable food production systems in the State.

2. Objective of the study

The objective of the study was to assess farmers' awareness levels on agricultural production along with their knowledge gaps for developing effective extension education strategies to promote synergies between agricultural production and natural resource conservation. The study intends to answer the following research questions:

- What is farmers' awareness on agricultural inputs, technologies and practices?
- What are farmers' perceptions on adverse impacts of intensive agriculture, their causes and solutions?
- What are the priority areas of interventions and potential options for more effective extension education strategies aiming at sustainable farming systems?

3. Data base and methodology

3.1 Study area

The study was undertaken in Punjab, a north-western state in India. The average annual rainfall in Punjab ranges from 580 mm in the plains to 960 mm in sub-mountain regions, and decreases from North to South. The temperature ranges from minus 2° to 40° C (min/max) in Punjab (ADB, 2011). In the state, agriculture and allied services play a significant role in Punjab's economy as 70% of the population of Punjab is engaged in agricultural activities. The Punjab Annual Plan, 2011-12 states that 83% of total geographical area in the state is under cultivation, with over 98% of the cultivable area being under assured irrigation.

3.2 Survey design

A household survey was carried out using a structured questionnaire by applying both qualitative and quantitative methods of data collection and analysis. The questionnaire assessed demographic characteristics, cropping pattern, awareness and sources of information on use of inputs, perceptions about adverse impacts on agriculture, problems faced in farming by the farmers and information on progressive technologies/practices. The survey was conducted in 11districts across five agro-ecological zones of Punjab during the year 2013. A total of 2083 farmers were surveyed across 11 districts (Table 1). The sample contained 255 marginal farmers (12.2%), 401 small farmers (19.2%), 685 semi-medium farmers (32.9%), 611 medium farmers (29.3%) and 141 large farmers (6.4%), operating less than 1 ha, 1-2 ha, 2-4 ha, 4-10 ha and 10 ha and above of land, respectively.

3.3 Data analysis

A cross-sectional data wasused for the analysis. Descriptive statistical analysis was conducted by using frequencies, percentages and means to facilitate the description of farmers' awareness on seeds, seed treatment, methods of sowing, fertilizer use, use of micronutrients, irrigation, water-saving, machinery-use, marketing, agro-chemicals&others and perceptions about impacts of intensive agriculture such as groundwater depletion, decline in drinking water, soil quality, micronutrient deficiency, deterioration in air quality, water-logging, toxic residues in food and identification of problems faced by them in farming.

Table 1: Distribution of the sample across various districts of Punjab

District	Sample Size	% of total sample
Hoshiarpur	181	8.7
Barnala	175	8.4
Ludhiana	201	9.7
Amritsar	330	15.8
Gurdaspur	247	11.9
Muktsar	197	9.5
Kapurthala	111	5.3
Moga	181	8.7
Faridkot	169	8.1
Bathinda	171	8.2
Tarn Taran	120	5.7
Total	2083	100.0

Table 2: Summary statistics of households' survey

Variables	Mean	Std. Dev.	Max	Min
Household/head characteristics	**181**	**8.7**		
Education of the household head (years)	9.16	3.20	0	20
Household size (number)	5.72	2.02	1	30
Number of workers in the family	1.90	0.95	0	10
Land holding/ Machinery owned details	**247**	**11.9**		
Owned land (ha)	3.12	2.87	0	28.28
Operational land (ha)	3.73	3.41	0	28.28
Irrigated land by electric motor (ha)	3.67	3.21	0	12.12
Tractor owned (number)	0.94	0.22	0	1
Number of electric motors	1.34	0.72	0	8
Average horse power of motor	8.93	3.67	0	20

4. Results and discussions

4.1 Basic characteristics of the farming households

It is important to highlight some basic characteristics of the surveyed households before examining the awareness, access to information and knowledge gaps. Within the households surveyed, 82% of the household heads were having attended school, 98% of them were having workers in the family, 69% of household owned a tractor and 91% of the land was irrigated by electric motors. The mean level of education of the household head was more than 9 years and the average family size in the sample was around 6 members. The other basic information on the sampled households is also provided in Table 2. The average size of operational holding was 3.73 ha. The average number of electric motors owned by the farmers was 1.34 with average horse power of 8.9. More than 80% of the electric motors were submersible. Majority of the electric tubewells were installed at the depth ranging from 200-300 ft. While 75% of the farmers owned only one motor, 24% owned two or more electric motors for irrigation (Table 2).

In addition to the above, all the farmers were growing paddy and wheat, 73% were also growing basmati rice and maize, cotton and sugarcane were being grown by 2.3%, 6.6% and 5.4% farmers, respectively (Table 3). Apart from that, majority of the farmers were growing only one variety of the crops they were growing. This is in line with the usual argument that varietal diversity has declined within and across the farms in Punjab (Vattaet al., 2013; Singh et al., 2004; Singh and Kalra, 2002).

4.2 Farmers' awareness and access to agriculture related information

An attempt was made to assess the awareness levels of farmers on important inputs which have larger bearing on the production process and productivity. The information was collected on awareness regarding the recommended varieties of major crops being grown by the farmers, seed rate, fertiliser use and the levels of seed and fertiliser as recommended by the

Table 3: Proportion of the farmers growing important crops

Name of the crop	Number of farmers growing the crop	Percentage of the farmers growing the crop	Percentage of the farmers growing one variety
Paddy	**2083**	**100.0**	**79.9**
Basmati rice	1515	72.8	85.1
Maize	48	2.3	100.0
Cotton	137	6.6	93.9
Sugarcane	113	5.4	69.1
Wheat	2083	100.0	81.1

Table 4: Proportion of farmers naming recommended varieties of major crops

Crop	Percentage of farmers who named recommended varieties		
	Only one variety	Only two varieties	Three or more varieties
Paddy	8.7	32.3	59.0
Maize	25.0	50.0	25.0
Cotton	13.0	52.2	34.8
Sugarcane	10.6	6.2	29.2
Wheat	18.8	22.1	59.1

Punjab Agricultural University.When asked to name three recommended varieties of the respective crops, only 59% of the farmers could name three or more varieties of paddy and wheat and 35% could name three varieties of cotton and 25% and 40% that of maize and sugarcane (Table 4).

The awareness on the use of inputs in major crops of Punjab is revealed by Table 5. The proportion of farmers correctly responding to the recommended levels of seed rate ranged between 12-22% for paddy, wheat, maize and sugarcane. The proportion was much higher at 62.5% for cotton, where the private companies were more active due to the hybrid nature of seed. The proportion of farmers answering the recommended levels of urea in the cultivation of major crops ranged between 7-14%, while it ranged between 7-12% for DAP. Very small proportion of farmers correctly answering the recommended levels of input use points towards their sub-optimal use. The sub-optimal use may have adverse impact on crop production and productivity. The actual use of fertilisers in Punjab is much higher than the recommended levels as also revealed by the state level data. More than the recommended use of fertilisers will also add to the cost of production with two-sided effect on the crop profitability (higher costs and lower gross returns due to lower yields).

It is important to explore access of the farmers to various sources of information and purchase of inputs for different farm activities/operations before deriving any concrete implications. The farmers were asked information on sources of purchasing inputs such as seeds, seeds treatment, fertilizers, agro-chemicals, harvesting/machinery. Market appears to be the most dominant source for purchase of majority of the inputs, though a larger proportion of farmers were buying fertilisers from the cooperative societies (Table 6). More than three-fourth of the farmers reported buying agro-chemicals from the market (commission agents/ shopkeepers), while 20% of the farmers reporting buying them from cooperative societies. In case of purchase of seeds, 26% of the farmers reported buying from PAU/ Agri Department.

Further, the accesses to sources of information for purchasing inputs were estimated according to the education of the household head. Table 7 shows the level of accessibility of different sources according to the education levels. It indicates that at all the education levels, the commercial & personal source is relatively more preferred source for inputs such as seeds, agro-chemicals and harvesting/machinery. For fertilizers and seed treatment, the non-commercial and personal sources are the more preferred.

Table 5: Proportion of farmers reporting thelevel of application as recommended by the Punjab Agricultural University

Crop	Percentage of farmers using the recommended levels of inputs		
	Seed rate	Urea	DAP
Paddy	12.2	13.0	11.7
Maize	-	-	-
Cotton	62.5	13.8	8.3
Sugarcane	21.7	-	-
Wheat	14.1	7.6	7.0

Table 6: Frequency distribution of various sources for purchase of inputs

Inputs/Sources	Market		Cooperative Society		Fellow Farmers		Own		PAU/Ag Department	
	No.	%	No.	%	No.	%	No.	%	No.	%
1. Seeds	1505	72	63	3	330	16	439	21	537	26
2. Seeds Treatment	831	40	31	1.5	-	-	-	-	-	-
3. Fertilizers	496	24	1200	58	-	-	-	-	-	-
4. Agro-chemicals	1579	76	407	20	-	-	-	-	-	-
5. Farm machinery	1382	66	481	23	88	4	-	-	-	-

Note: There were multiple responses for seeds. So the total % add to more than 100. For others totals did not add to 100because of no response from some farmers.

After the purchase of inputs, an assessment was made for access to different sources of information for the farmers. The information was obtained on sources of information for the farmers for seeds, seed treatment, sowing/transplanting, fertiliser use, micronutrient use, irrigation, water saving, machinery, marketing of the produce, agro-chemicals and other farm activities. The farmers were asked on the access to different sources such as their own experience, fellow farmers, shopkeepers/commission agents, PAU/Department of Agriculture, cooperative society, newspaper/TV for the above list of activities and the results are summarized in Table 7 and Table 8. Almost all the farmers make their farming decisions on the basis of their own experience or based on the advice of their fellow farmers. The proportion of farmers consulting the shopkeepers/ commission agents was also very high at 65% for seed, 100% for seed treatment, 34% for fertilizer use, 63% for micro-nutrients, 27-32% for water saving and machinery and almost all the farmers for the use of agro-chemicals and marketing of their produce. Comparing these sources with PAU/Department of Agriculture reveals a different story as the proportion of farmers reporting this source for seed and seed treatment was 34% and 44%, respectively. In all other activities, the proportion was much lower and ranged between 1-17%. Despite a large network of farmers' cooperative societies in Punjab, the proportion of farmers who reported their dependence on them as a source of information for their farming activities is almost negligible. It was just 8% for seeds and 1-2% (even nil for many activities) for the other activities.A negligible proportion of farmers reported the use of newspapers/TV as a source of their information.

As we highlight relatively lower proportion of farmers for the use of public institutions such as PAU and the Department of Agriculture and also relatively poor use of the mass media, we further explore the mechanism of such access and the results are summarized in Table 9. Almost 35% of the farmers reported to have visited PAU in the past, 46% have reported to have attended Kisan Mela/Kisan Divas organized by the PAU and 18% reported to have visited the office of the department

Table 7:Percentage of farmers have access various sources of information for use of inputs

Inputs/ Sources	Seed	Seed Treatment	Sowing/ Transplanting	Fertilizer-use	Micronutrient-use
	%	%	%	%	%
1. Own experience /Fellow farmers	100	82	100	100	100
2. Shopkeepers/commercial agents	65	100	18	34	63
3. PAU/Agricultural departments	34	44	1	13	15
4. Cooperative Society	8	-	1	2	-
5. Newspaper/TV	1	-	-	-	-

Note: The figures are %age of those farmers who responded to the questions.

Table 8: Frequency distribution of various sources for use of inputs

Inputs/ Sources	Irrigation	Water-saving	Machinery	Marketing of the produce	Agro-chemicals	Any other
	%	%	%	%	%	%
1. Own experience & Fellow farmer	100	100	100	72	100	100
2. Shopkeepers/commercial agents	10	27	32	100	96	29
3. PAU/Agricultural departments)	1	11	6	17	16	7
4. Cooperative Society	-	-	-	-	-	-
5. Newspaper/ TV	-	-	-	4	-	-

Note: The figures are %age of those farmers who responded to the questions.

Table 9: Frequency of access to the following sources of agricultural information

Frequency of access to the following sources of agriculture information		
Sources accessed	Frequency	%
Farmers visited the university, agricultural departments, kisan melas, camps, telephonic calls etc.		
1. Punjab Agricultural University	725	35
2. PAU Kisan Mela	963	46
3. Agriculture/horticulture department	367	18
4. District level agricultural camps of the DOA/DOH	445	21
5. Block level agriculture camps	787	38
6. Village level camps	1097	52
7. Telephonic calls to officials of PAU	287	14
8. Telephonic calls to officials of the department of agriculture	269	13
9. Telephonic calls to officials of the department of horticulture	25	1
10. Telephonic calls to officials of some private company	285	14
Visit of officials at the village		
11. Visit of PAU official/ADO/HDO to your village	461	22
12. Camp of some private company of the village	427	20
13. Visit of the private company official to your field	384	18
14. Visit of the PAU official/ADO/HDO to your field	218	10
Subscription of any publications		
15. Subscribed any agricultural magazine	204	10
16. If you have not subscribed, do you read somewhere	239	11
17. Bought any other publication of PAU	913	44
Membership attained		
19. Member of some Kisan Club	43	2
Other information		
20. Any other information	11	0.5

of agriculture/horticulture. The proportion of farmers reporting to have participated in district level camps, block level camps and village level camps organized by the Department of agriculture and/or PAU was 38%, 52% and 14%. The proportion of farmers reporting the visit of the extension officials of PAU and Department of Agriculture was 22%. Only 10% of the farmers reported to have subscribed to the agriculture related periodicals, while 44% reported to have bought some farm related publication of PAU. Only 2% of the farmers reported to be the members of some farmers' group or club. In nutshell, while the proportion of farmers reporting to have occasionally visited the public sector extension institutions and offices is high, the proportion reflecting a regular contact in the form of telephonic contacts and regular visits is much lower. Lack of regularity in contact may have implications for faster and timely dissemination of authentic and scientific information among the farming community.

4.3 Effects of intensive agriculture: perceptions and awareness

There is no denying the fact that there has been a significant increase in agricultural production and productivity in Punjab. However, intensive agricultural practices have also led to the depletion of natural resources (Sidhu, 2002; PSFC, 2013; Johlet al., 2014). The issues of depletion of groundwater resources, depleting soil health, increasing incidences of micro-nutrient deficiency, air pollution due to straw burning and chemical residues in crops have been well documented by many studies in the past. A study by Singh (2002), shows that increase in irrigated area had led to intensive exploitation causing groundwater problems associated with declining water tables. Another study by World Bank (2004) shows that post green revolution period, soil is constantly being degraded or destroyed. The nutrient reserves of soil are being further exploited at much faster rate due to high cropping intensity and extensive adoption of rice-wheat rotation. The high profitability of rice-wheat crop production has been achieved with the excessive use of fertilizers and pesticides. The imbalanced use of these inputs has affected soil health adversely. Also, report by the ministry of environment shows that Punjab produces 23 million tons of rice straw and 17 million tons of wheat straw annually. More than 80% of the paddy straw and 50% of wheat straw is produced in the state and is being burnt in the fields every year. This affects the soil fertility as well causes air pollution due to emission of large amounts of suspended particulate matters besides gases like CH_4, CO_2, NO_x, SO_2 etc.

An attempt was made to examine the farmers' perceptions on these impacts and the results are documented in Table 10. Majority of the farmers had similar perceptions on the adverse impacts of intensive agriculture as have been reported by the above studies. More than two-third of the farmers agreed that there was a decline in the groundwater table, deterioration in the quality of air, increased incidence of chemical residues in the food and contamination of the drinking water in Punjab. While 57% of the farmers also agreed to the overall decline in the soil health, 36% reported the increase in incidence of micro-nutrient deficiency.

Farmers' knowledge was also tested on the possible causes of the adverse impacts of agricultural intensification in Punjab. Again, as was the case for farmers' perceptions on impacts of intensive agricultural production, responses of majority of the farmers regarding the causes of such adverse impacts on natural resources were in line with those evidenced in the literature and the expert opinions. For example, more than half of the farmers gave dominance of paddy and wasteful use of water in agriculture as the major reasons for decline in water table (Table 11). Increased use of fertilisers and agro-chemicals and pollution of water bodies were the most reported reasons for contamination of the drinking water sources. Intensive use of land and decline in crop and varietal diversity

Table 10: Farmers' perceptions on adverse impacts on agriculture and categorization of responses

Impacts	No.	%
1. Fall in groundwater	1654	79
2. Decline in soil fertility	1182	57
3. Increased incidence of micronutrient deficiency in the soil	754	36
4. Deterioration of air quality	1470	71
5. Increased incidence of toxic residues in food	1424	68
6. Decline in drinking water	1548	74

were reported to be two major causes of deterioration of soil health and increased incidence of micro-nutrient deficiency in the soils. Further, industrialization, urbanization and straw burning were reported to be the most dominant causes of air pollution. Excessive use of fertilizers and agro-chemicals was the major reason for increased incidence of chemical residues in food as cited by about 88% of the farmers.

While the awareness levels are very high on the possible adverse effects of agricultural intensification in Punjab along with their causes, the same is not true when farmers were asked on the possible solutions of these problems. While the detailed responses are given in Appendix, we have summarized those in Table 12 to highlight the extent of non-responses in this case.

Though there were responses from the farmers on the possible solutions for the adverse impacts of intensive agricultural production in Punjab, a large proportion of the farmers did not respond to the questions. Even for the farmers who responded, the responses on solutions were more scattered as compared to the responses on the perceptions and the causes given earlier.Relatively less awareness on sustainable solutions may adversely affect faster and wide scale adoption of sustainable technologies and practices by the farmers.

This argument is strengthened by the extent of adoption of various resource conservation technologies and practices as given in Table 13. Only laser levelling of land has been adopted on a very large extent with 71% of the farmers reporting to have adopted it. While 13% of the farmers reported adoption of sowing crops on raised beds, 7% reported sowing their crops with the happy seeder. The adoption rate of all the other technologies and practices such as direct seeding of rice, tensiometers, leaf colour chart, net-house cultivation, drip and sprinkler irrigation was very low and ranged between 0.3-5%.

Lesserawareness and hence poor adoption of

Table 11: Farmers' perceptions on the possible reasons for adverse impacts of intensive agriculture

Reasons	Percentage of farmers
Fall in groundwater	
1. Increase in area under paddy	42
2. Wasteful use of water resources	26
3. Others	32
Decline in drinking water	
1. Increase use of chemicals and fertilizers in agriculture	68
2. Pollution of water bodies	11
3. Due to industrialization	7
4. Water logging	7
5. Decline in water table	5
6. Urbanization	2
Decline in soil fertility	
1. Mono cropping/decline in crop variety	49
2. Intensive use of land	33
3. Higher chemical use	12
4. Others	5
Deterioration of air quality	
1. Due to industrialization and urbanization	74
2. Burning of crop residue	14
3. Others	12
Increased incidence of toxic residue	
1. High fertilizer-use	100

Table 12: Farmers' responses to solutions for various impacts

Impacts	Sample responded (%)	Sample un-responded (%)
Fall in groundwater	44	56
Decline in drinking water quality	25	75
Decline in soil fertility	72	28
Deterioration in air quality	71	29
Increase incidence of toxic residue	73	27

Table13:Extent of adoption of resource saving/sustainable technologies and practices by the farmers

Technologies used	Frequency	%
Sustainable agriculture technologies/practices		
1. Organic farming	2	0.1
2. Laser levelling	1469	71
3. Direct seeding rice	68	3
4. Tensiometer	71	3
5. Leaf colour chart	98	5
6. Sowing of crop on raised bed	279	13
7. Net house cultivation	14	1
8. Drip irrigation	7	0.3
9. Sprinkler irrigation	16	1
10. Happy Seeder	148	7

conservation technologies and practices by the farmers point towards newer challenges for extension education system in Punjab agriculture. There is need to shift focus from enhancing agricultural production by maximising land productivity, which was achieved by increasing the input use. There is need to focus on optimal production, which aims at identifying the synergies between the food production and environmental sustainability. Such a strategy would require enhanced focus on reaching a large number of farmers more frequently, generating awareness on sustainable production and capacity building of the farmers and other stakeholders.

As regularity in outreach will be the key for any successful efforts towards sustainability, it is important to identify important stages of crop production and marketing, so that the efforts are prioritized and directed well in time. Table 14provides an insight into the frequency of problems being faced by the farmers during different stages of crop production and marketing.A large proportion of the farmers reported that the frequency of problems was relatively high for weed, disease and pest management, electricity supply, credit and marketing of the crops. In other operations, the frequency of problems was relatively less and hence manageable. Such information on the frequency of problems can be helpful in designing and timing the extension strategies.

Table 15 further highlights thedetails of the high frequency problems such as weed, disease and pest management, electricity, credit and marketing in agriculture. A large proportion of farmers have poor qualityof seeds, spurious weedicides and pesticides and inadequate marketing facilities and information as key problems related to weed, disease and pest management and marketing of the agricultural produce. Apart from that a considerable proportion of farmers have also reported lack of information as major problem during different stages of farm production and marketing. These responses point towards the need to develop extension strategies which should focus on information dissemination and awareness generation on key areas from time to time.

5. Policy pathways and strategies

The present study has revealed that a large proportion

Table 14: Frequency of problems faced by farmers during different stages of agricultural production and marketing

Problems	Less frequent	Regular	Highly frequent
1. Seed related	61	10	9
2. Method of sowing	71	5	0.5
3. Fertilizer related	66	7	6
4. Weeds related	30	16	34
5. Disease and pest related	26	11	44
6. Machinery related	54	8	3
7. Irrigation related	44	11	11
8. Electricity related	13	13	57
9. Crop harvesting related	47	8	13
10. Marketing related	29	13	37
11. Transport related	52	4	2
12. Credit related	41	11	23

Table 15:Reasons listed by the farmers for facing agricultural problems

Particular	Percentage
Seed related problems	**%**
1. Poor quality seed	49
2. Inadequate availability of seeds	24
3. Others	23
Sowing related problems	
1. Lack of innovation in sowing	43
2. Lack of information/knowledge on new methods	47
3. Others	10
Fertilizer related problems	
1. Inadequate availability in the peak period	43
2. Higher cost of fertilizers	37
3. Others	19
Weed related problems	
1. Spurious weedicides	70
2. Excessive growth of weeds	29
3. Others	1
Disease and pest related problems	
1. Spurious chemicals	34
2. Lack of knowledge	21
3. Others	45

Machinery related problems	
1. Not easily available on rent	48
2. High rent for machinery	29
3. Others	24
Irrigation related problems	
1. Power supply is less/limited	41
2. Rainfall is declining and is usually less	33
3. Others	25
Electricity related problems	
1. Power supply is less	95
2. Irregular Power supply	5
Marketing related problems	
1. Inadequate marketing facilities and information	36
2. Less remunerative crops	38
3. Others	26
Transport related problems	
1. Inadequate availability of transportation facilities	90
2. Others	10
Credit related problems	
1. High rate of interest	51
2. Others	49

of farmers lack awareness on recommended inputs, technologies and practices for agriculture. A large proportion of the farmers were unable to name even three recommended varieties of major crops. Also, majority of the farmers are not following the recommended levels of seed rate and fertilizer use. Sub-optimal use of the inputs may lead to increase in the input costs and decline in profitability due to less than optimal yields. Relatively poor access to the public sources of information and extension education such as PAU and the Department of Agriculture of the state may be an important reason for such a sub-optimal use. Farmers largely reach their fellow farmers and also to the shopkeepers and commission agents for their information needs. Apart from that, the access to the public sector extension agencies is also not regular. Owing to the depletion of natural resources, stagnating productivity and impending crisis of climate change, the extension education system faces a different set of challenges.Ensuring agricultural growth with sustainability requires larger and more frequent outreach of the programs and interventions. Reaching a large number of farmers timely and more frequently will require more resources, new approaches which may include more use of information technology.

Further, majority the farmers are aware about the implications of intensive agricultural production system in Punjab. The awareness is also high even about the major reasons for degradation of natural resource. However, same is not true for the possible solutions as majority of the farmers were unable to respond to such questions asking for the solutions. It is natural that adaptations are less likely to occur in such a situation. The fact of very low level of adoption of conservation technologies and practices such as direct seeding of rice, tensiometers, leaf colour chart etc., also points to the need for large scale efforts to reach the farmers, generate awareness and build their capacity in the use of such technologies and practices. Weed, disease and pest management, use of fertilisers and agro-chemicals and marketing of the produce are the major activities where there is a need for awareness generation and capacity building of the farmers. Another point to be emphasised is that majority of the above operations involve decision making by the farmers for more than one time during the production cycle of a particular crop.

To ensure optimal decisions at each step will require the public sector extension agencies to ensure information delivery to the farmers more frequently and timely, which is a big challenge.

The government of India in its XIIth plan period proposed national mission for reviving extension system within the country. The National Mission on Agriculture extension lay emphasizes on restructuring and strengthening of extension system through a judicious mix of extensive physical outreach of personal, enhancement in quality through domain experts, regular capacity building, interactive methods of information dissemination, public private partnerships and pervasive and innovative use of ICT/mass media. It has identified 12 mini-missions or themes to address the different challenges. These are as follows:

1. Technology Solutions and Innovations
2. Extension Policy and Systems
3. Convergence, Programme Delivery, Governance and Innovations
4. Manpower Planning, HRD and Accreditation
5 Leveraging ICT, Mass Media and e-Governance 4
6. Partnerships for Agri-preneurship and Business Development
7. National and International Linkages and Partnerships
8. Mobilisation for Farmers Empowerment
9. Women Empowerment, Household Food and Nutritional Security
10. Leveraging Youth for Agriculture
11. Extension strategies for Difficult Area, Dis-advantaged Farmers and Farm Workers

12. Agrarian distress, conflicts and farm studies.

An effective extension education strategy for the state must ensure large scale outreach on recommended package of practices, capacity building of the farmers on more efficient use of inputs and natural resources. Furthermore, there is a need to have a special focus on reaching the small holders as they are highly vulnerable due to adverse impacts on agriculture. This could be achieved by moving beyond from traditional extension approaches and finding ways of promoting innovation and enhancing capacity for innovation.The following strategies can help in reinvigorating the extension education system for achieving more frequent and large scale outreach in Punjab.

5.1 Shifting focus on resource use efficiency and natural resource sustainability

It is pertinent to shift the focus of extension activities towards enhancing the resource-use efficiency and ensuring long-term sustainability of natural resources. In other words, the extension education strategies should focus on optimizing production rather than maximizing it. It would require a lot of effort on generating awareness on the importance of resource-use efficiency and natural resource sustainability. A larger share of resources is still being diverted to delivering material inputs to the farmers in the subsidized form. However, there is need for educating and skill building of the farmers and other stakeholders (including the extension agents) on the use and benefits of conservation technologies and practices. The government of India is launching a National Agricultural Education Project (NAEP) which aims at bringing systematic reforms and innovative institutional development i.e. building capacities of the State Agricultural Universities on tackling the issues such as declining productivity & profitability, degradation & depletion of natural resources, risks under changing climate etc.

5.2 Aiming at more regular and large scale outreach strategies

As discussed earlier the extension education system in the state should aim at reaching a relatively larger section of farmers with increased frequency of contacts with the farmers. Although this is already happening but the pace is quite slow as the study has highlighted very large gaps in frequency and number of farmers. There are efforts towards developing some interface between the farmers and the extension agencies through identifying some local extension intermediaries such as KhetiDootsand village scouts but some more innovative approaches are needed. It is, however, obvious that larger and more frequent outreach is resource intensive and needs serious prioritization of activities. For this, the primary agricultural cooperative societies (PACS) in Punjab should be developed as information hubs for agriculture. There are more than 3000 PACS in Punjab serving more than 12000 villages with easy access to even marginal and small farmers for credit and input delivery. A large number of PACS have successfully demonstrated the economic viability of Agro-Machinery Service Centers (AMSCs) in Punjab. The AMSCs have brought down the cost of production and also reduced the fixed costs in farming by custom hiring of heavy and expensive agro-machinery (Sidhu and Vatta, 2012). The

PACS have the potential to serve as information hubs by disseminating timely and more authentic farming related information from the PAU and Department of Agriculture. Developing PACS as information hubs for agriculture will provide a larger multiplier in outreach for achieving sustainable agricultural production in Punjab.

5.3 Promoting the use of ICT in agriculture

There are about one million holdings in Punjab with more than one family member working on the land. Reaching such a large number with relatively larger frequency than has been achieved in the past is a huge challenge. It is not only resource intensive but also seems infeasible with traditional methods of extension education. It is therefore, almost necessary to promote the large scale use of information and communication technology for generating awareness, capacity building and promoting more efficient use of inputs, sustainable technologies and practices. Even in the present study, it came out that more than 85% of the farmers in Punjab owned a mobile phone with majority of them being android based but their use for agriculture and related purposes was very limited. We suggest three important ICT based interventions which can ensure faster and large scale outreach in the long run. These are i) developing farmer friendly web portal for information on important inputs and package of practices, ii) developing mobile applications for the same information which do not require internet connections and iii) bulk mobile messages. The capacity building on these tools and promoting it through information hubs in the PACS can ensure information dissemination on a much wider scale.

6. Conclusions

This paper has presented the farmers awareness and access to information on agricultural inputs, conservation technologies and practices in Punjab. Farmers' access to public sources of extension education appears to be much less than the access to informal sources such as fellow farmers and commercial sources such as shopkeepers/commission agents. Despite large awareness on the adverse impacts of intensive agriculture on natural resource sustainability along with their possible causes, farmers were unable to identify potential solutions for such problems. The agricultural extension system in the state should aim at reaching a much larger proportion of farmers more frequently by shifting focus on improving resource-use efficiency and promoting natural resource sustainability, aiming at more regular and large scale outreach strategies and by promoting the use of ICT in agriculture. This will require a substantial increase in the resources for agricultural extension. Developing PACS as information hubs for agricultural production and marketing and promoting information dissemination with extensive use of web-portals, mobile applications and bulk messages to provide more authentic and timely knowledge and skills in agriculture will help to strengthen the agricultural extension system in the state.

REFERENCES

ADB, 2011. "Lower Sutlej Sub Basin" Published as a Part of the Final Report- TA 7417- IND: Support for the National Water Mission - National Action Plan on Climate Change. Prepared for Govt. of India and state govt. of Punjab by Asian Development Bank.

Gulati, 2002."Challenges to Punjab agriculture in Globalizing World". IFPRI Report, Washington DC, USA

Johl S.S., R.S. Sidhu and Kamal Vatta, 2014 "Natural Resource Management in Punjab agriculture: Challenges and Way forward". New Delhi: India: Centers for International Project Trust (Working paper)

Joshi, A. 2004.Punjab: "Farm Household Income, Investment and Consumption", Economic and Political Weekly, 31: 321-23.

Kumar M.D., 2003. "Food Security and sustainable agriculture in India: The water management challenge", Colombo: Sri Lanka: International Water Management Institute (Working paper 60).

Mishra .N.,D.Khare., K.K.Gupta., and R.Shukla., 2013. "Impact of land use change on groundwater- A Review". Advances in Water Resource and Protection.

Punjab Agricultural University, 2015. "Statistics of Punjab Agriculture": In Punjab Agricultural University, Ludhiana

PSFC Report, 2013."Agricultural Policy for Punjab". Punjab State Farmers Commission: Mohali: Punjab.

World Bank, 2004.World Bank Report."Resuming Punjab's Prosperity; The Opportunities and Challenges Ahead", Poverty Reduction and Economic Management Sector Unit, South Asia Region, p. 4.

Sombilla.M., Rosegrant MW, and Meijers S. 2002. A long-term outlook of rice supply and demand balances in South, Southeast, and East Asia. In: Sombilla M, Hossain M, Hardy B, editors. Developments in the Asian rice economy. Los Baños (Philippines): International Rice Research Institute.

Singh, K. 2009."Act to Save Groundwater in Punjab: Its Impact on Water Table, Electricity Subsidy and Environment", Agricultural Economics Research Association, 22: 365-86.

Singh, S. 2002. "Contracting Out Solutions: Political Economy of Contract Farming in the Indian Punjab", World Development, 30(9), September, 1621-38.

Singh, S. 2004. "Crises and Diversification in Punjab agriculture", Economic & Political Weekly, 39(52), December,

Singh, K and S Kalra. 2002. 'Rice Production in Punjab: Systems, Varietal Diversity, Growth and Sustainability', Economic and Political Weekly, 37 (30) July 27, 3139-48

Sidhu, H. S. 2002. 'Crisis in Agrarian Economy in Punjab – Some Urgent Steps', Economic and Political Weekly, 37 (30) July 27, 3132-38

Sidhu, R.S. and A.S. Bhullar 2005. Pattern and Determinants of Agricultural Growth in two Punjabs, Economic and Political Weekly, 40: 5620-27.

Sidhu, R.S. and Vatta Kamal 2012.Improving Economic Viability of Farming: A Study of Cooperative Agro Machinery Service Centres in Punjab, Agricultural EconomicsResearch Review, 25: 427-34.

Swaminathan, M.S. 1999. "Green Revolution: The challenges ahead", The Hindu Survey of Indian agriculture, Chennai-11,9-16.

Vatta, K., Sidhu, M.S. and Amanpreet Kaur. 2013."Pattern of Growth and Emerging Challenges for Punjab Agriculture", Report submitted to the United Nations Environment Programme (UNEP), Punjab Agricultural University, Ludhiana, India.

About the Authors

Kamal Vatta is Director, Centers for International Projects Trust, New Delhi, email: kamal@cipt.in

Garima Taneja is Senior Research Associate, Centers for International Projects Trust, New Delhi, email: garima@cipt.in

Photo credit: Centers for International Projects Trust and Columbia Water Center

Contact Us

Centers for International Projects Trust
910-911, Pragati Towers, Rajendra Place
New Delhi - 110008
T: +91-11-4056 5989
W: www.cipt.in