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BARRIERS IN EFFICIENT CROP MANAGEMENT IN RICE-WHEAT CROPPING SYSTEM OF PUNJAB

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The primary aim of the present study was to portray the socio-economic and techno-physical barriers in efficient crop management in the rice-wheat farming system of Punjab and to suggest the policy options to remove them. Data from 3 main districts from rice-wheat tract of Punjab was collected during 2003-04 season using multistage sampling procedure. The major constraints faced by the farmers in crop management were diagnosed to be unhealthy and poorly treatfed seed. Continuous sequential cropping in crop management did lead to heavy infestation of weeds and resistant pest population. Shortage of irrigation water was acute and farm mechanization not up to required standards. There were institutional problems related to marketing and credit availability and there was vast scope and desirability of mechanical rice transplanter and no-tillage technology for wheat to offset difficulties of labour shortages at critical stages.
Key words: Rice-wheat farming system, sequential cropping, rotation, soil fertility, IPM.

INTRODUCTION

Rice-wheat is one of the important cropping systems of Pakistan covering an area of 2.1 million ha (MINFAL, 2003). A major portion (57%) of the rice-wheat area falls in the Punjab. The rice-wheat area of Punjab mainly covers Gujranwala, Sheikhupura and Sialkot Districts with some parts of Gujrat and Lahore Districts as well. Typically *Kallar* belt is the genuine homeland of the 'Basmati' rice, a cause of fame to Pakistan. The pleasant and sweet fragrant Basmati rice, a specialty of Pakistani Punjab, has the quality of elongation when cooked and the fluffiness that makes it unique in the world.

Farmers of the rice area are growing rice since centuries and they have continued the tradition despite emerging technical difficulties and socio-economic barriers. Basmati rice is grown for farm household consumption, domestic market and for export purposes. The bulk of the wheat, the staple food of the country's population, is also produced in the rice-wheat system of the Punjab. There exists a high gap between the potential and actual yields received by the farmers for both rice and wheat crops in the study area (Mann *et al.* 2004). The main causes of the problem are institutional, technical and socio-economic in nature, limiting the rice-wheat productivity.

The present intensive cropping of the rice-wheat system in vogue was not the tradition, instead one crop a year was cultivated. About three decades ago rice-wheat sequential cropping system began to take-off. With short duration varieties, synthetic fertilizers and tubewell installation for irrigation made it possible to grow two crops in a year.

The continuous sequential cropping has observed problem of stagnation of the rice-wheat productivity in many countries. Evidence from some long-term experiments shows that problems of stagnating yields and even yield declines are occurring in the rice-wheat system of South Asia (Regmi *et al.*, 2002; Duxbury *et al.*, 2000). Total factor productivity is declining and farmers have to apply more fertilizer to obtain the same yields (Hobbs and Morris, 1996; Murgai *et al.*, 2001). Soil organic matter is also declining; new weeds, pests, and diseases are creating more problems, whereas irrigation water is scarce. Farmers are complaining about high input costs and low prices for their produce. Marketing of excess production is a burden for farmers and storage is a problem for governments. Therefore, a huge challenge exists in the region to meet future food demand without damaging the natural resource base, producing food at a cost that is affordable by the poor and with incentives to farmers that allow them to improve their livelihoods and ultimately alleviate poverty.

The rice-wheat system of the Pakistan's Punjab, a part of the Indo-Gangantic plains, has also experienced the same trend. The agro-ecosystem of the area is deteriorating. Low soil fertility is the common problem. Insect and weed intensity is swarming. Water resources are not being identified to meet irrigation requirememt; as a result, the rice-wheat cropping system is facing some threats.

Fortunately various stakeholders, concerned with the rice-wheat productivity, have shown the anxiety over the situation and have launched the efforts to overcome the problems. The rational thinking urges to diagnose the problems of the area explaining the cause and effect scenario of the system. This study

was designed to identify problems and constraints of the study area with following specific objectives:

- To identify the socio-economic constraints to rice-wheat productivity along with a general overview of the rice-wheat farming system.
- To draw implications and suggestions for research, extension and policy makers to improve the productivity of the rice-wheat farming system of the Punjab.

MATERIALS AND METHODS

Survey techniques and data analysis

Mainly the rice-wheat zone of the Punjab was the study area and the major focus was on three rice-growing districts of Gujranwala, Sialkot and Sheikhupura. Multistage sampling procedure was adopted and stratification of sampling was accomplished in four stages. At the first stage, three districts were chosen, Sheikhupura, Gujranwala and Sialkot. At the second stage, an area comprising of cluster of villages from each district was selected keeping in view the area where the new rice-wheat technologies were introduced. In the third stage, from each designated area 5 villages were chosen totaling to 15 villages and in fourth stage, from each village, 6-7 farmers were selected. For analysis purpose the farmers were grouped into three categories, small, medium and large. For the execution of this study, both informal and formal surveys techniques were applied. The survey scheme was exercised in two phases. In the first phase an informal survey was carried out to identify the major problems that existed in the rice-wheat farming system. The survey information was synthesized and major and minor problems and their potential alternatives from farmers' point of view were explored. A well-structured questionnaire was designed for the formal survey in the second phase.

The information collected included the personal farmers' characteristics, farm resources, cropping pattern, crop rotation, input use, pest problems and other related constraints through a pre-designed and pre-tested questionnaire. The collected data were edited, tabulated and standardized. The analysis comprised of percentiles for frequency distribution, cross tabs and averages of the information for central tendency representation.

RESULTS AND DISCUSSION

Socio-economic view of the rice-wheat areas of the Punjab

The level of input use, entrepreneurial skills, productivity level and infrastructure present in the system are determined by the socio-economic conditions in which farmers operate. The socio-economic status of the area is presented here briefly.

Table 1. Socio-economic Characteristics of the sampled farmers.

Characteristics	Farm size groups					
	<12.5 acres	12.5-25 acres	25-50 acres	50-100 acres	>100 acres	All
Personal Characteristics						
Age (years)	49	49	44	48	46	48
Education (years)	5	5	7	7	10	5
Experience (years)	27	28	19	25	14	25
Visits to Extension agent	4	2	3	5	9	4
Farm Labour						
i) Family Labour(No.)						
Full Time	1.7	2.1	2.3	2.3	2.3	2.2
Part Time	0.02	0.29	0.69	1.85	4.5	0.88
ii) Permanent Hired Labour						
Full Time (No.)	0.00	0.14	0.19	0.54	1.3	0.26
Part Time (No.)	0.4	1.2	2.7	2.0	2.4	1.5
Land Holdings						
Average farm size (acres)	7.2	19.6	34.8	68.4	172.3	39.3
Percent farmers (%)	38.8	21.4	16.3	13.3	10.2	100

Land Utilization and Cropping Patterns

Rice and wheat were the dominant crops of Kharif and Rabi seasons, respectively, covering major portion of cultivated land. The fodder crops were at second in cropped area percentage. There were also some other minor crops grown in the rice-wheat systems of the Punjab (Tables 2 & 3).

Table 2. Percent farm area under Kharif crops by farm size.

Kharif crops	Farm size groups					
	<12.5 acres	12.5-25 acres	25-50 acres	50-100 acres	>100 acres	All
	Percent area					
Rice	70.2	70.0	75.3	78.1	57.9	71.8
Kharif fodder	23.6	18.5	10.1	8.1	16.4	17.9
Vegetables	0.3	0.6	0.2	0.7	0	0.34
Sugarcane	0.01	0	0.6	1.4	0.3	0.23
Other crops	0.04	0	7.2	3.2	18.5	2.4
Kharif fallow	7.3	13.5	7.1	8.6	7.5	8.8

Kharif cropping pattern

The Kharif cropping pattern for various farm categories given in Table 2 shows that rice covered more than 70 percent of the farm area. Since farm animals are the essential component of the farming system, therefore, fodder crops have obvious importance in the farming system. Fodder was the second major crop of the area covering about 18 percent of the Kharif cropped area. Small farmers devoted more area for fodder production as compared to the large ones. Most of the farmers kept livestock to meet household consumption needs. Vegetables and sugarcane was grown on limited area. Large farmers mainly cultivated sugarcane and other high value crops. About 8.8% area remained fallow in the Kharif season.

Rabi cropping pattern

As evident from Table 3, wheat was grown on more than 70% of the farm area mainly for household consumption needs and surplus for market. Rabi fodder crops like barseem as well as oat covered about 18% of the total farm area. Remaining crops were high value crops i.e. potato (3.5%), sunflower (2%) and vegetables (2.3%). The sunflower was grown as a new crop in the rice-wheat farming system. A considerable proportion of land (about 8.5%) remained fallow in the Rabi season.

Reasons for fallow land

The land kept fallow in Kharif season was slightly less than that of Rabi season. The major reason of Rabi fallow was the soil type. Majority of the farmers (62%) kept area fallow due to '*Shumb*' soils meaning low lying areas filled with water in rainy season. It is generally the imperfectly-drained heavy soil which is somewhat suitable for rice cultivation but not fit for wheat cultivation. The second reason was land left for cultivation of next season crops like sunflower and summer vegetables. Some of the land was kept fallow due to the unavailability of water and moisture problems.

Crop rotations

Crop rotation shows the sequence of crops cultivated during a cropping year. A variety of crop rotations were observed in the study area. Main rotations followed were rice-wheat, sunflower-rice, potato-sunflower and fodder (Rabi)-fodder (Kharif). Rice-wheat sequential cropping system was prevalent in the entire study area. Other crop rotations were localized in nature and were found in small pockets. Rice and wheat were the traditional crops to which farmers were well familiar in crop production management.

Table 3. Percent farm area under Rabi crops by farm size.

Rabi crops	Farm size groups					
	<12.5 acres	12.5-25 acres	25-50 acres	50-100 acres	>100 acres	All
	Percent area					
Wheat	74.4	58.6	62.7	65.9	51.9	62.4
Berseem	23.0	19.4	9.3	7.2	4.5	17.6
Oats	1.1	1.9	0.94	1.4	0	1.2
Potato	2.2	1.9	6.3	12.5	5.0	3.5
Sunflower	0	6.8	0.92	2.7	0	2.0
Rabi vegetables	2.1	3.4	1.7	3.0	1.7	2.3
Other Rabi crops	0.5	1.0	6.1	2.9	11.6	2.5
Rabi fallow	6.7	6.9	12.1	5.2	25.2	8.5

The farmers perceived that uninterrupted sequential cropping cause low fertility, increased weed problem, more disease and insect invasion leading to yield losses. They intend to break the rice-wheat rotation but according to them options are less although some farmers broke rotations to reduce losses. The period of rotation break averaged about 6 years. The real break crops were fodders (berseem/oats). Small farmers were the major change agents in breaking the rice-wheat sequence. They rotated their field with fodder necessary for their livestock. At few farms potato and other vegetables served as break crops (Table 4).

they avoided to experiment continuous growing of sunflower or potato on same field rather they rotated to break the sequence of rice-wheat cropping to potato-wheat, sunflower-rice and potato-sunflower (Table 4).

Seed Management

Crop management starts with seeding. Optimum potential of the crop can be achieved through the use of improved technologies and improved certified seed. Improved certified seed has an immense importance in the chain of improved technologies. The results of the study revealed that almost all farmers used the

Table 4. Crop rotations in the rice-wheat farming system of the Punjab.

Rotations	Percent crop rotations	Percent farmers	Change period (years)	Break crops
Rice-Wheat	**94**	-	-	-
Continuous		37	-	-
Change		63	6	Berseem, potato and other vegetables
Sunflower-Rice	**2**	-	-	-
Continuous		30	-	-
Change		70	2	Wheat, Berseeem and vegetables
Potato-Wheat	**1**	-	-	-
Continuous		0	-	-
Change		100	1	Rice
Potato-Sunflower	**1**	-	-	-
Continuous		0	-	-
Change		100	1	Rice and Fodder
Fodder-Fodder	**2**	-	-	-
Continuous		60	-	-
Change		40	-	Sugarcane

Small farmers followed shorter period to change a rotation whereas large farmers take longer period to change. Most of the large farmers, who followed rice-wheat rotations, were not able to break the rotation in an appropriate period even if they intended to do so. The main reason behind the short break period, as reported by the farmers, was the risk of low yields of high value crops and rice having comparative production advantage over other Kharif crops in the area. Thus its replacement was difficult for longer period.

Sunflower-rice, potato-wheat and potato-sunflower were crops of short period rotations, which were almost in negligible percentage. It indicates that almost one rotation i.e. rice-wheat was dominant as about 94 percent of the rotations consisted of rice-wheat. About 37 percent farmers followed this rotation continuously without breaking it while about 63 percent farmers broke the rotation after 6 years with berseem, potato and vegetables. Most farmers were risk averse and

improved seed of rice and wheat. However, nearly one quarter of the farmers used certified seed. Rest of the farmers used home produced seed whereas, in case of high value crops like potato and sunflower, nearly all farmers used recommended and certified seed.

In case of replacement of the seed, majority of the farmers (51.8%) replaced the rice seed after two to three years. More than one third of the farmers (38.7%) changed the seed after four to five years. Wheat seed was mainly replaced after four to five years (48.5%). A significant proportion of the farmers (43.9%) changed wheat seed after two to three years.

Almost all the farmers were using certified seed for sunflower and potato. The potato growers (62%) replaced the seed after three to four years. About 25% farmers produced two crops of potato with original seed while sunflower seed was replaced every year.

The major problems in the availability of seed were; the shortage of improved seed, adulteration and high price in case of wheat and rice. Per acre losses, as reported

by the respondent farmers, were estimated to be 7.1 mds/acre for rice and 7.5 mds/acre for wheat as a consequence of using uncertified seed. Almost all the farmers were satisfied with the performance of the seed of high value crops. About 42% of the farmers were of the view that government should intervene in the seed distribution process to solve the seed non-availability problems. Other suggestions included government monitoring of seed markets to ensure purity, low prices for certified seed, availability at near markets and release of new varieties for the rice-wheat areas.

Weed Management

Modern agriculture, being recognized as a commercial entity, cannot afford crop loss due to any reason. Weeds are one of the major yield reducing elements in the crop production. Weeds caused about 30% crop loss in the study area as reported by the respondent farmers. Severity of weed problem in the rice-wheat cropping system stems from continuous rice-wheat cropping over time. Over the years, the rice-wheat rotation has increased the weed problem in both rice and wheat crops, which has led to increased weed management costs and reduced yields.

Farmers had deep understanding of the problem. Almost all the farmers told that weed intensity had increased with such sequential cropping system. Within the rice-wheat belt of the Punjab, various areas differed in species and intensity of weeds because of changes of agro-ecological conditions at micro level.

Rice and Wheat Weeds and their Intensity

Table 5 presents various weeds and their intensity in rice and wheat crop in the study area. About 20 percent farmers reported that intensity of *Teddan* was high while about 17 percent farmers reported that its intensity was medium in rice whereas the low weed problem reported was not because of low weed infestation but they were able to control weeds. Dumbi-sitty was reported to be the most problematic weed in wheat crop (about 36% farmers reported its intensity to be high while about 28% as medium). The prevalence and higher intensity of Dumbi-sitti was also reported by Byerlee *et al* (1984).

Weed management practices

The weed management strategies followed by the farmers were (i) periodical rotation of fodders in rice-wheat fields, (ii) use of chemical technology and (iii) cultural practices like management of weeds through repeated ploughing. Most of the farmers (about 92%) employed chemical weed control while the trend of manual weeding had weakened and only some resource-poor small farmers (about 3.6 percent) were practicing this technique. Some farmers (about 5% in rice and 34% in wheat) were practicing both chemical and manual methods. The logic, given by the farmers, was that herbicides did not control all the weeds and remaining weeds were to be controlled manually (Table 6). Previous studies of rice-wheat areas suggest that widely used weed control method was crop rotation and manual weeding (Byerlee *et al.* 1984). Only a few farmers who had good extension contact were the main users of herbicides.

The trend of herbicide use in the rice-wheat farming system had emerged in the late 1980s while its wide scale use started in the mid 1990s. Table 7 shows that there was no significant difference among farm size groups in starting the use of herbicides.

Table 5. Rice and Wheat weeds and their intensity.

Rice Weeds	Weed Intensity (% farmers)			
	No weeds	Low weeds	Medium weeds	High weeds
Merchbooti (*sphenoclea zeylanica*)	84.7	5.1	4.1	6.1
Dela (*Cyperus rotundus*)	73.5	8.2	7.1	11.2
Teddan (*Echinochloa crusagilli*)	54.1	8.2	17.3	20.4
Khoein (*Cyperus iria*)	55.1	15.3	14.3	15.3
Swank (*Echinochloa colona*)	86.7	5.1	2.0	6.1
Settal	98.0	0	1.0	1.0
Wheat Weeds				
Mena (*Medicago denticulate*)	73.5	9.2	9.2	8.2
Dumbi-sitti (*Phalaris minor*)	22.4	14.3	27.6	35.7
Jangli javi/wild oats (*Avena fatuva*)	82.7	7.1	8.2	2.0
Bathu (*Chenopodium al bum*)	81.6	11.2	5.1	2.0
Sanji (*Melilotus alba*)	95.5	0	2.0	2.0
Other weeds (*broad leaf*)	95.9	2.0	1.0	1.0

Table 6. Effective and practiced weed control techniques for rice and wheat.

Control techniques	Farm size groups			
	Small	**Medium**	**Large**	**All**
Rice				
Effective techniques	Percent farmers			
Manual	20.6	15.0	11.1	16.0
Chemical	73.5	85.0	85.2	80.2
Others/both	5.8	-	3.7	3.8
Practiced techniques				
Manual	7.9	-	-	3.6
Chemical	84.2	95.0	100	91.7
Others/both	7.9	5.0	-	4.8
Wheat				
Effective techniques				
Manual	17.6	16.7	7.7	14.1
Chemical	76.5	72.2	92.3	80.8
Others/both	5.9	11.1	-	5.1
Practiced techniques				
Manual	8.4	-	-	3.6
Chemical	86.1	95.0	100	92.7
Others/both	5.6	5.0	-	33.7

Table 7. Beginning of Herbicide use by the sample farmers in rice and wheat.

Crop and time since started	Farm size groups			
	Small	**Medium**	**Large**	**All**
Rice	Percent farmers			
<10 years	48.4	57.9	41.7	48.6
10-15 years	41.9	31.6	33.3	36.5
>15 years	9.7	10.5	25.0	14.9
Wheat	Percent farmers			
<10 years	47.1	66.7	50.0	52.6
10-15 years	47.1	27.8	26.9	35.9
>15 years	5.9	5.6	23.1	11.5

Plant Protection Management

Continuous mono-cropping and sequential cropping systems have led to heavy infestation of insects, pests and diseases. Cyclical epidemics toll heavily on crop yields. In diversified cropping system, some insect pests may not be problem but with outrageous quantum of a crop in a pattern provide food for insects to flourish on it.

The pesticide use in the study area was started in the early 1980s. Wheat crop was found free from serious pest insects and disease attacks except for some minor fungal and bacterial disease attack at very low rates. Rice received heavy infestations of insets and fungal and viral diseases. Table 8 depicts that rice leaf folder was the most common insect in rice as about 67 percent farmers reported its presence either in low, medium or high intensity while about 37 percent farmers did not face any problem of rice leaf folder. The similar intensity of leaf folder was also reported by Azeem *et al.* (1994). The major disease of rice was found to be *Bakainae* but it had been controlled for the past few years.

In insect pest management chemical insect pest control had gained popularity among most of the farmers (about 96%) of the study area while a minor proportion of the farmers also used combination of chemical and cultural control. Application of the insecticide was the only technique available to the farmers and they had little choice in finding alternative techniques. About 80% farmers were of the view that insecticides minimize the crop losses and increase productivity while about 14% farmers regarded it as ineffective. About 6 percent farmers were of the view that insecticides caused loss to natural enemies and had food chain effects, environmental problems and effects on animal health. The cause of ineffectiveness may be due to the adulteration and lower quality insecticides.

Table 8. Insect pests and disease problem and its intensity in rice.

	Intensity of the problem			
Insects of rice	No problem	Low	Medium	High
Leaf folder	37.0	13.3	26.5	22.4
Stem borer	67.0	12.2	11.2	9.2
Taila/Aphid (GLH)	79.6	6.1	6.1	8.2
Parwana (White-back plant-hopper)	84.7	2.0	2.0	9.2
Disease: *Bakainae*	93.9	5.1	0	1.0

Irrigation management

Availability of sufficient irrigation water is prerequisite for crop production especially rice and wheat. The rice-wheat areas fall in sub-humid zone where monsoon drizzles moderately. Water resources are depleting overtime as a result of increased cropping intensity to meet the needs of growing populations and increased use of water for human consumption.

The farmers in the study area used canal and tubewell water for irrigation purposes. Only 2% farmers completely relied on canal irrigation water while about 17% farmers only used tubewell water for irrigation. Although tubewell irrigation is costly but majority of the farmers were using tubewells for irrigation purposes. Almost similar sort of results have been reported by many researchers (Ahmad *et al.* 1996 and Azeem *et al.* 1994). About 90% farmers were having their own tubewells. Average number of irrigations applied to rice was 30 and 3 to wheat crop.

Farmers had a general consensus that the shortage of canal water was hampering the output profoundly. Table 9 shows that the availability of canal water was not compatible to the requirements of the farmers. The farmers at the tails of the canal distributary were in real problem. They needed extra time for irrigating their fields. The flow of the canal was seasonal and allocated time was very short. Some resourceful and influential farmers had more irrigation time at the cost of small farmers' share cutback. It is clear from Table 9 that average time per acre for the small farms with an average area of 7.2 acres was about 0.28 hors in which area irrigated was 1.3 acres only. On the average, for an average farm area of 39.3 acres in the study area, hours per turn of canal water were 10.3 hours, which could irrigate only 5.8 acres.

About 78% farmers used diesel operated tubewells out of which 50% were operated with peter engines while about 16% farmers used electric engines to run their tubewells. About 7% farmers used tractor driven tubewells, 14% used diesel engine driven tubewells while 8.5% used combination of diesel engine, peter engine and tractor driven tubewells. Many farmers switched from diesel engine to electric power for tubewell operations in the past but the hike in electric charges in the recent past forced farmers to switch again to diesel operated tubewells. It had doubled the cost of investment in electric and diesel engines. The farmers preferred electric tubewell over diesel tubewells but they were afraid of the tariff policy of the government. About 45% farmers also complained about the load shedding at the critical stages of the crops.

Farm Mechanization Constraint

Rice-wheat areas of the Punjab fall in one of the big industrialized zone of the country. As a result farm labour has become scarce and expensive. The scope and need of farm mechanization is becoming more crucial in agricultural production to increase land and labour productivity. The survey results showed that about half of the sampled farmers had their own tractors while half of the farmers did not and they had to rely on custom hire services from resourceful

Table 9. Canal irrigation time by farm size in the study area.

Farm categories	Average farm area	Hours per turn	Hours per acre	Area irrigated per turn (acre)
<12.5 acres (small farm)	7.2	2.0	0.28	1.3
12.5-25 acres (medium farm)	19.6	8.3	0.42	3.3
25-50 acres (large farm)	34.8	11.1	0.32	7.4
50-100 acres (large farm)	68.4	13.6	0.23	5.3
>100 acres (large farm)	172.3	31.2	0.18	19.5
Average	39.3	10.3	0.26	5.8

farmers who owned farm machinery. The owners of the farm machinery first completed farm operations at their own fields and then hired out. This caused delay in the field operations of the small farmers ultimately causing reduction in the yield. The use of mechanical rice transplanter was gaining some popularity among the farmers to speed up the nursery transplanting operations as about 3 percent farmers partially employed this technology on their fields. Similarly the application of no-tillage technology had the scope but it was not being exercised on large scale (only 4% farmers used it partly). Other tillage implements owned by the farmers are listed in Table 10.

Table 10. Farm machinery ownership status in the rice wheat areas of Punjab.

Farm machines/implements	Percent farmers (owners)
Tractor	52
Disc plough	17
Deep plough	12
Rotavator	8
Trolley	41
Fodder chopper	81
Potato planter	6
Spray pump	26
Reaper	6
Combine harvestor	2
Thresher	14

Marketing Imperfections

Production entails in produce disposal which can be segregated into two parts, i) keeping for household consumption needs and seed and ii) marketing of the surplus produce, the most problematic part of produce disposal. Farmers mainly sold their grain produce in near town markets (65%), central market of the city (14%), village '*Beoparies*', traders (15%) and input dealers and shellers (6%). In case of vegetables, about 64% farmers sold them in the main markets in expectation of good price while rest of them sold their produce in the near town markets.

Problems faced in the marketing of farm produce by the farmers were under weighing (13% farmers responded positively), unfair weight discount (15%), high commission (7%) and delayed payments (21%). About 35% farmers were of the view that under-pricing was at the peak in good production years as farmers received lower price than the support price as in the absence of efficient marketing system, a good production year brings crash down of crop prices and major portion of reward is snatched by the market intermediaries (Gulati and Narayanan, 2002).

Credit Constraint

A major stratum of the farmers lacked in required cash flow for crop production. They relied on loans till the harvest of crops. They were in search of money loans even to meet their livelihood. About 73% farmers fulfilled their credit needs from informal sources while only 27% farmers had access to formal institutional credit facility mainly for tractor (56%), inputs (22%) and livestock purchase (22%). Majority of the farmers of the area got loans in kind like seed, fertilizer and pesticide from informal credit facilitators like *arhtie*s, input dealers, friend/relatives and village *beoparies*. Some farmers (18%) preferd to get loans from their friends and relatives to avoid exploitations of market intermediaries. Formal credit sources were mostly used by the large farmers. These sources were mainly commercial banks and ZTBL.

The less use of formal credit facility in the area was due to the lengthy procedures, paper work and corruption in loan advancement. The banking staff charged 5-10 percent commission from non-resourceful small farmers, as most of them were illiterate and unable to fulfill the official requirements by their own. They were unable to provide personal bank guarantee or pledging of land ownership due to certain reasons. Ultimately they preferred to get small and short-term loans from informal sources.

Although easy to avail, there were certain disadvantages associated to informal credit as well. Most farmers (about 55%) thought it as an interest free loan facility but they were charged higher input prices, less and delayed payment of output prices. In fact, in obtaining informal loans from *arhtie*s and village dealers, the farmers had to pay the cost in other forms. There was a moral binding on the farmer to sell his produce to the *arhti* from whom he had obtained the loan. In case of formal credit, its procedural complexities and favoritism to resourceful farmers had made it general refusal to the small resource-poor farming community.

CONCLUSIONS AND RECOMMENDATIONS

The primary aim of the present study was to portray the socio-economic and techno-physical barriers in efficient crop management in the rice-whet farming system of Punjab. Rice-wheat, as the major crop rotation, was followed by Rabi and Kharif fodders. Sunflower, potato and other seasonal vegetables were also cultivated in some areas. The continuous sequential cropping pattern overtime had resulted diminished soil fertility and heavy infestation of weeds and insect pests. Use of improved and certified seed

was mainly hindered due to high prices and adulteration. Irrigation water shortage was acute due to unjustified time allocation and higher investment costs of tubewells and electric motors. Lack of proper farm machinery, attributable to lack of finance, did lead to delayed farm operations causing decreased yields. There was increased scope of mechanical rice transplanter and no-tillage technology for wheat to facilitate timely farm operations. Last but not least, marketing activities had led to inefficiency by exploitation of the farmers by various market functionaries along with the imperfections in agricultural credit advancement. To overcome these barriers, following suggestions may prove helpful to enhance the productivity of the rice-wheat farming system of Punjab.

- Intervention of short duration green manure crops in rice-wheat rotation has the potential for the restoration of soil fertility. Similarly developing schedules to break continuous rice-wheat rotation at proper intervals by various break crops is necessary. In this regard, detailed on-farm experimentation on break crops to restore the soil fertility is required.
- Provision of tested and certified seed at affordable prices will be helpful in realizing good returns. Involvement of more seed companies in the private sector may create competition in the seed market resulting in low prices and better quality.
- Insect, pest and weed control can be achieved successfully through Integrated Pest Management (IPM). A well-planned campaign is necessary to familiarize the farmers about IPM techniques. However, monitoring of pesticides for quality control is necessary to save the farmers from being deceived and looted.
- Various on-farm agronomic trails for water conservation and increasing water use efficiency for different crops are necessary to save this scarce resource. Time allocation schedule may be revised to accommodate the farms at the tails.
- Transfer of knowledge-based technologies can remove the weak linkages in the present extension system through the promotion of participatory approaches and expanded partnerships of the stakeholders. Similarly, use of mechanical rice planter and no-tillage technology for wheat needs proper consideration to offset the labour shortage problems during peak labour requirements.
- There is an impressing need that the poor farmers be provided institutional credit facilities with easy access, less paper work and affordable interest rates. Exploitation of the farmers by various market intermediaries needs to be checked so that farmers are protected against their unlawful practices. This necessitates the implementation of support price policy in its true letter and spirit to save the farming community from unfair profiteering intermediaries.

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