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Assessment of Pre and Post Harvest Losses in Wheat and Paddy Crops in Punjab

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PREFACE

The emergence of monoculture of paddy and wheat has in a way have altered a multi commodity production system to a specialized system in the state. In the process, many traditionally cultivated crops (e.g. coarse cereals and small millets) either have lost their area or gone out of cultivation. But, these developments have entailed increased building up of pest and diseases, and consequent use of higher amount of pesticides to raise the crop productivity. The increased use of pesticides has also resulted in developing insects and disease resistance, which further led to reduction in crop yield. The estimation of crop loss due to pests and diseases is a complex subject. It is in fact, difficult to assess the loss caused by the individual pest as a particular crop may be infested by the pest complex in the farmers' field conditions. Further, extent of crop loss either physical or financial depends on the type of variety, stage of crop growth, pest population and weather conditions. Production in agriculture is seasonal and exposed to natural environment, but post-production operations play an important role in providing stability in the food supply chain.

The present study is devoted to estimate the dimension of losses occurring during the pre and post harvest stages of paddy and wheat crops. Nevertheless, an attempt has been made to estimate such losses based on the visual observations and farmers' perceptions.

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Authors

Abstract

The crop losses caused by pests and diseases are huge. But, the knowledge on the crop loss at the farm level is very much limited. In addition to losses that occur during the growth period of the crop, there is a huge quantity of grains lost during the process of harvesting, threshing, transportation and storage. Therefore, the present study makes a comprehensive attempt to estimate the dimension of losses occurring during the pre and post harvest stages of paddy and wheat crops. For the purpose, required primary data were collected from 120 wheat and paddy growing farmers of various farm size categories from Ludhiana and Ferozepur districts. The individual production loss in wheat crop due to incidence of pests (aphids), diseases (yellow rust and loose smut) and weeds *(Phalaris minor* and broad leaf weeds) was less than 5 per cent of total production with more severity of incidence of weeds. The magnitudes of crop loss due to pests, disease and weed infestation in wheat crop over actual production increased with increase in farm size with a minimum of 5.94 per cent on marginal and 8.29 per cent per acre on large farm categories. Thus, marginal farms were better managed in wheat crop due to smaller size. Total, magnitude of crop loss due to pests, diseases and weed infestation was 7.93 per cent over actual and 7.35 per cent over normal production in wheat crop. Similarly, in paddy crop also, the individual production loss due to incidence of pests (rice stem borer, leaf folder and plant hoppers), diseases (bacterial leaf blight, sheath blight and false smut) and weeds *(Echinochloa crusgalli)* was less than 5 per cent of the total production with more severity of pests. The losses due to biotic stresses in case of paddy crop also increased with increase in farm size, except on marginal farms, the loss per acre being a minimum of 6.07 per cent on small and 8.94 per cent per acre on large farm category. The total magnitudes of crop losses due to biotic stresses in paddy crop were 8.68 per cent over actual and 7.99 per cent over normal production. The loss due to major pests, diseases and weeds was low due to the efficient crop management by the farmers as well as varietal characteristics and timely application of weedicides/ pesticides/ fungicides. Harvesting loss in case of wheat crop was more in late season harvesting while in paddy both early and late season harvesting was reported as harmful resulting in higher yield loss. The post harvesting losses such as transportation, handling and rodents attack in case of stored grains was found to be negligible in case of both the crops. Total post harvest losses in wheat crop came out to be as low as 1.412 kg per quintal on marginal farms while on large farms, these losses were 1.865 kg per quintal. The total, post harvest losses in wheat crop worked out to be 1.84 kg per quintal and 35.81 kg per acre as revealed by the sample households. These losses in wheat crop increased with the increase in farm size. Similarly, total post harvest losses in case of paddy crop were calculated as 3.674 kg per quintal on medium farm category which were lowest while on marginal farm category these came out to be 6.023 kg per quintal which were highest on all the farm categories. The total post harvest losses in paddy crop worked out to be 4.43 kg per quintal and 122.38 kg per acre with major loss due to decline in weight as revealed by the sample respondents. The transportation losses were low due to easy availability of mechanized transport facility to most of sample households as well as special care accorded by putting gunny as well as plastic covers, beneath as well as on the sides of the trolley before filling it with the crop produce while transporting grains to the market. The storage losses were also found low in wheat crop due to scientific storage practices adopted by them using steel drums/silos and undertaking proper fumigation using cellphos tablets and or making it airtight by applying wet soil on openings of the steel drums. The sample farmers exclusively stored wheat crop for domestic consumption and for next year's seed purpose only. The major household suggestions to minimize pre harvest losses were the need of development of insect/pest and disease resistant varieties, availability of effective and unadulterated pesticides, and better quality seeds. To minimize post harvest losses households suggested for proper supervision of the crop at the time of harvesting particularly in case of lodged and over ripe crop, development of technologically advanced harvester combines and skilled persons required to operate them to minimize the wastage during harvesting. The major policy issues suggested were to keep a check on private input dealers to stop exploitation of the farmers due to charging of exorbitant input prices, need of new training programmes for timely and cheaper control of pests and diseases, rejuvenation of Govt. extension agencies for curtailing the dependence of farmers on private input dealers, ensuring timeliness in harvesting of wheat and paddy crops and offenders be penalized for the lapse while storage losses of foodgrains for household consumption can be further contained by imparting training to the farmers regarding control of rodents and fungus attack.

Chapter 1

Introduction

1.1 Status of agricultural economy in Punjab

Overview of state economy

Economic activities in state are showing structural changes over a period of time and primary sector is experiencing a decline in terms of share in State Domestic Product (SDP). Sectoral distribution GSDP of Punjab state at current prices and constant prices (2004-05) along with percent distribution is presented through Tables 1.1 to 1.4. Table 1.1 revealed that GSDP of Punjab at constant prices (2004-05) has increased from Rs 123223 crore in 2007-08 to Rs 148069 crore in 2010-11. Overall economy of Punjab state has witnessed a growth rate of 5.85, 6.29 and 6.81 percent during 2008-09, 2009-10 and 2010-11, respectively. At constant prices (2004-05), the contribution of primary sector consisting of agricultural and allied activities towards GSDP has increased from Rs 34107 crore in 2007-08 to Rs 35740 crore in 2010-11. This sector had shown growth of 2.05 and 3.01 percent during 2008-09 and 2010-11, respectively. However, its growth was recorded marginally negative during year 2009-10. Secondary sector mainly consisting of manufacturing, construction and power sectors has increased at rate of 4.22, 8.79 and 6.93 per cent during 2008-09, 2009-10 and 2010-11, respectively. In absolute terms, contribution of this sector in GSDP increased from Rs 37711 crore in 2007-08 to Rs 45722 crore in 2010-11. The contribution of tertiary sector of state comprising trade, transport, banking, insurance and public administration towards GSDP had increased from Rs 51405 crore in 2007-08 to Rs 66608 crore in 2010-11. Per annum increase in this sector was recorded at 9.57, 8.62 and 8.88 percent during 2008-09, 2009-10 and 2010-11, respectively. The share of agriculture in GSDP at constant prices (2004-05), which was 17.51 percent during 2007-08 declined to 15.47 percent during 2010-11. During the same period, the share of overall primary sector including livestock, forestry, and allied agricultural activities along with agriculture declined from 27.66 percent to 24.12 percent. On the other hand, over this period while the share of secondary sector in GSDP remained almost constant at 31 per cent; that of tertiary sector increased from 41.72 per cent to 44.98 percent.

At current prices the Per Capita Income in Punjab state increased from Rs 49380 in 2007-08 to Rs 68998 in 2010-11. At constant prices (2004-05) the Per Capita Income which was Rs 39567 during 2007-08 increased by 13.44 per cent to Rs 44885 in 2010-11 (Table 1.5).

Table 1.1: Gross state domestic product at factor cost by sectors in Punjab at constant (2004-05) prices

(Rs. Crore)

Sector	2007-08	2008-09	2009-10	2010-11
Agriculture and livestock	32498.88	33113.53	32924.59	33907.71
Agriculture	21575.44	22155.18	22085.01	22905.55
Livestock	10923.44	10958.35	10839.58	11002.16
Forestry and logging	1298.49	1349.44	1402.55	1451.5
Fishing	282.12	308.89	338.96	350.32
Agriculture & allied	34079.49	34771.86	34666.1	35709.53
Mining and quarrying	27.27	33.32	28.31	30.1
Sub- total (Primary)	**34106.8**	**34805.2 (2.05)**	**34694.41 (-0.32)**	**35739.63 (3.01)**
Manufacturing	24121.68	24882.89	27878.64	30067.03
Registered	12920.46	13676.38	16009.5	17844.19
Un-registered	11201.22	11206.51	11869.14	12222.84
Construction	9550.01	10284.66	10720.47	11329.68
Electricity, Gas & water supply	4039.51	4135.73	4158.86	4324.44
Sub- total (Secondary)	**37711.2**	**39303.3 (4.22)**	**42757.97 (8.79)**	**45721.55 (6.93)**
Total industry	37738.47	39336.6	42786.28	45751.25
Transport, storage & communication	8122.16	8740.52	9389.6	10219.1
Railways	1434.23	1420.85	1428.5	1535.45
Transport & other means	3907.05	4130.02	4441.4	4751.29
Storage	410.35	414.88	419.37	429.41
Communication	2370.53	2774.77	3100.33	3502.95
Trade, Hotel & restaurants	13660.29	1495.69	15552.13	16225.54
Banking & insurance	7265.47	8249.06	9549.93	11421.31
Real estate, ownership of dwelling & business services	6311.49	6626.74	6891.63	7180.87
Public administration	5335.81	6167.65	6769.77	7311.35
Other services	10710.05	11583.64	13023.52	14249.95
Sub- total (Tertiary)	**51405.3**	**56322.3 (9.57)**	**61176.58 (8.62)**	**66608.13 (8.88)**
Gross state domestic product	**123223.2**	**130430.8 (5.85)**	**138628.96 (6.29)**	**148068.9 (6.81)**

Source: Statistical Abstract, Punjab
Figures in parenthesis are percent change over the previous year

Table 1.2: Percentage distribution of gross state domestic product at factor cost by sectors in Punjab at constant (2004-05) prices

Sector	2007-08	2008-09	2009-10	2010-11
Agriculture and livestock	26.37	25.39	23.75	22.90
Agriculture	17.51	16.99	15.93	15.47
Livestock	8.86	8.40	7.82	7.43
Forestry and logging	1.05	1.03	1.01	0.98
Fishing	0.23	0.24	0.24	0.24
Agriculture & allied	27.66	26.66	25.01	24.12
Mining and quarrying	0.02	0.03	0.02	0.02
Sub- total (Primary)	27.68	26.68	25.03	24.14
Manufacturing	19.58	19.08	20.11	20.31
Registered	10.49	10.49	11.55	12.05
Un-registered	9.09	8.59	8.56	8.25
Construction	7.75	7.89	7.73	7.65
Electricity, Gas & water supply	3.28	3.17	3.00	2.92
Sub- total (Secondary)	**30.60**	**30.13**	**30.84**	**30.88**
Total industry	30.63	30.16	30.86	30.90
Transport, storage & communication	6.59	6.70	6.77	6.90
Railways	1.16	1.09	1.03	1.04
Transport & other means	3.17	3.17	3.20	3.21
Storage	0.33	0.32	0.30	0.29
Communication	1.92	2.13	2.24	2.37
Trade, Hotel & restaurants	11.09	1.15	11.22	10.96
Banking & insurance	5.90	6.32	6.89	7.71
Real estate, ownership of dwelling & business services	5.12	5.08	4.97	4.85
Public administration	4.33	4.73	4.88	4.94
Other services	8.69	8.88	9.39	9.62
Sub- total (Tertiary)	**41.72**	**43.18**	**44.13**	**44.98**
Gross state domestic product	**100.00**	**100.00**	**100.00**	**100.00**

Source: Statistical Abstract, Punjab

Table 1.3: Gross state domestic product at factor cost by sectors in Punjab at current prices

(Rs. Crore)

Sector	**2007-08**	**2008-09**	**2009-10**	**2010-11**
Agriculture and livestock	45625.84	52430.76	57429.55	63572.88
Agriculture	32041.47	37399.67	40658.06	44762.87
Livestock	13616.37	15031.09	16771.49	18810.01
Forestry and logging	1834.7	2731.02	4053.14	5547.12
Fishing	338.54	379.5	484.23	537.06
Agriculture & allied	47831.08	55541.28	61966.92	69657.06
Mining and quarrying	28.65	53.86	30.08	32.95
Sub- total (Primary)	**47859.7**	**55595.1 (16.16)**	**61997.00 (11.52)**	**69690 (12.41)**
Manufacturing	28336.15	29394.12	34383.97	37956.02
Registered	15559.96	16446.96	19702.12	22214.14
Un-registered	12776.19	13447.16	14681.85	15741.88
Construction	11615.61	13239.76	15208.15	16305.78
Electricity, Gas & water supply	3105.34	3562	4087.42	4313.05
Sub- total (Secondary)	**43057.1**	**46695.9 (8.45)**	**53679.54 (14.96)**	**58574.9 (9.12)**
Total industry	43085.8	46749.7	53709.62	58607.8
Transport, storage & communication	8846.25	9848.58	11629.19	13061.25
Railways	1635.81	1638.94	1846.56	1894.89
Transport & other means	4852.83	5513.6	6586.01	7567.79
Storage	422.1	430.27	512.86	534.64
Communication	1635.07	2265.77	2683.76	3063.93
Trade, Hotel & restaurants	18238.24	21315.25	23014.73	24797.01
Banking & insurance	6542.85	7753.36	8950.32	11607.75
Real estate, ownership of dwelling & business services	7968.16	9342.45	10907.23	12862.68
Public administration	6479.46	8146.47	9004.66	10538.33
Other services	13253.53	15342	19209.89	23842.94
Sub- total (Tertiary)	**61328.5**	**71748.1 (16.99)**	**82716.02 (15.29)**	**96710 (16.92)**
Gross state domestic product	**152245.3**	**174039.1 (14.31)**	**198392.56 (13.99)**	**224974.8 (13.40)**

Source: Statistical Abstract, Punjab
Figures in parenthesis are percent change over the previous year

Table 1.4: Percentage distribution of gross state domestic product at factor cost by sectors in Punjab at current Prices

Sector	2007-08	2008-09	2009-10	2010-11
Agriculture and livestock	29.97	30.13	28.95	28.26
Agriculture	21.05	21.49	20.49	19.89
Livestock	8.94	8.64	8.45	8.36
Forestry and logging	1.21	1.57	2.04	2.47
Fishing	0.22	0.22	0.24	0.24
Agriculture & allied	31.42	31.91	31.23	30.96
Mining and quarrying	0.02	0.03	0.02	0.01
Sub- total (Primary)	**31.44**	**31.94**	**31.25**	**30.98**
Manufacturing	18.61	16.89	17.33	16.87
Registered	10.22	9.45	9.93	9.87
Un-registered	8.39	7.73	7.40	7.00
Construction	7.63	7.61	7.67	7.25
Electricity, Gas & water supply	2.04	2.05	2.06	1.92
Sub- total (Secondary)	**28.28**	**26.83**	**27.06**	**26.04**
Total industry	28.30	26.86	27.07	26.05
Transport, storage & communication	5.81	5.66	5.86	5.81
Railways	1.07	0.94	0.93	0.84
Transport & other means	3.19	3.17	3.32	3.36
Storage	0.28	0.25	0.26	0.24
Communication	1.07	1.30	1.35	1.36
Trade, Hotel & restaurants	11.98	12.25	11.60	11.02
Banking & insurance	4.30	4.45	4.51	5.16
Real estate, ownership of dwelling & business services	5.23	5.37	5.50	5.72
Public administration	4.26	4.68	4.54	4.68
Other services	8.71	8.82	9.68	10.60
Sub- total (Tertiary)	**40.28**	**41.23**	**41.69**	**42.99**
Gross state domestic product	**100.00**	**100.00**	**100.00**	**100.00**

Source: Statistical Abstract, Punjab

Table 1.5: Per capita income in Punjab

(Rs/annum)

Year	At current prices	At constant prices (Base 2004-05)
2007-08	49380	39567
2008-09	55315	41003
2009-10 (P)	61894	42752
2010-11 (Q)	68998	44885

Source: Statistical Abstract, Punjab, P: Provisional, Q: Quick estimates

Overview of state agriculture

The total geographical area of the state is 50.36 lakh ha. During 2010-11, the net sown area was at 41.58 lakh ha which indicated that about 83 per cent of the area in state is already under cultivation. This is the highest in country and the state is virtually comparable to a farmstead where most of the area is under the cultivation leaving little land for other activities. Further, there is virtually no land left for bringing under cultivation and due to recent spurt in urbanization the net sown area declined from 41.87 lakh ha in 2007-08 to 41.58 lakh ha in 2010-11. However, during this period the increase in cropping intensity from 187.9 per cent to 190 per cent led to increase in gross cropped area in state from 78.70 lakh ha to 78.82 lakh ha. The forest wealth of state is very poor with only 5.84 per cent of the total area under the forest cover. The area under permanent barren and unculturable land has been almost found to be stable at 0.47 per cent of the state area for last many years. The total operational holdings in state during the last five years period increased by 55 thousand from 10.03 lakh to 10.58 lakh. Point worth noting is the marginalization of holdings with proportionate increase in marginal and small farmers. The proportion of marginal and small holdings which was 13.36 and 18.25 per cent in 2005-06 increased to 15.50 and 18.53 per cent, respectively during 2010-11. On the other hand, the proportion of holdings in all other categories viz. semi-medium, medium and large had been declined during this period. Over this period the average holding size in state also went down from 3.95 ha to 3.78 ha. The state has been virtually reached the saturation point in the matter of addition to the physical area horizontally; the vertical expansion of area has become increasingly limited due to already achieved higher levels of cropping intensity and some topographical and irrigational constraints in some pockets of the state. Therefore, sustainability in the growth of production per unit of land area has to come through raising the input use efficiency or upward shift in the use of technology.

Punjab holds place of pride among the Indian States for its outstanding achievements in agricultural development. The state has witnessed tremendous increase in the agricultural production during the Green Revolution period, mainly due to healthy mix of institutional and technological factors. Agrarian economy, consolidation of landholdings, reclamation of new agricultural lands, development of irrigation, use of biochemical inputs comprising high yielding variety seeds, chemical fertilizers, insecticides and mechanical inputs were among the important factors which helped Punjab agriculture in making rapid strides. Dominating rural based political power with agricultural background provided favorable environment through thrust on rural and agricultural development. In this context, extension of irrigation network, rural link roads, rural electrification, establishment of focal points and agricultural market centers, efficient delivery system of credit and other agricultural inputs along with effective implementation of agricultural price policy for wheat and paddy played significant role in agriculture and rural development of state. Consequently, the Punjab state comprising only 1.54 per cent of the total geographical area of country now contributes 13-14 per cent towards the total food grain production of the country. State has earned a name of granary of India through contributing 35-40 per cent of rice and 40 to 75 per cent of wheat to the central pool in the past two decades.

Drivers of agricultural growth

Punjab state had made remarkable progress in agriculture through taking a big leap forward in terms of irrigation facilities, use of chemical fertilizer, pesticide, high yielding varieties, mechanization etc. Backed with effective agricultural policies, the farmers of state tended their crops according to the advice of experts through well established agricultural extension network and achieved the record productivity levels. The irrigated area, which was merely 71 per cent to the net area sown in 1970-71, has reached to a level of about 98 percent by the year 2010-11. The number of tube wells has gone up from 1.92 lakh in 1970-71 to 13.82 lakh in 2010-11. The proportion of area under HYVs to gross cropped area has increased tremendously. Hundred per cent of the area of wheat and rice is under HYVs and that of maize is nearly 98 per cent. The adoption of HYVs in Punjab raised the consumption of chemical fertilizers and plant protection materials tremendously in the state. The per hectare consumption of chemical fertilizers (NPK) which was merely 37.50 kg in 1970-71 has achieved the levels of 246 kg in 2011-12. Total consumption of chemical fertilizers (nutrient) in state which was only 213 thousand tons in 1970-71 had been gone up to 1936 thousand tons in 2011-12. Consumption of insecticides and pesticides

(Technical Grade) had been increased from 3200 MT in 1980-81 to 6150 MT in 2011-12. The rapid adoption of the green revolution technology in Punjab has led to the sharp increase in farm mechanization. The number of tractors in state was only 5281 in 1970-71, which increased to more than 5 lakh in 2010-11. The Punjab state is one of the leading states for number of tractors tillers in terms of density per 1000 hectare of net sown area. Development of irrigation infrastructure along with large scale mechanization of state agriculture helped in increasing the gross copped area from 5678 thousand ha in 1970-71 to 7872 thousand ha in 2010-11. Consequently, over this period the intensity of cropping jumped from 140 per cent to 190 per cent. Effective price policy through significant increase in Minimum Support Prices (MSP), assured procurement and development of market infrastructure particularly for wheat and paddy coupled with relatively better production technology available has driven the state agriculture at remarkable rate and resulted into the emergence of paddy and wheat crops as the most secure and profitable ones in the state. Thus, rapid dissemination and adoption of new technologies and modern inputs viz. HYVs, fertilizers and pesticides, irrigation, agricultural credit, development of necessary infrastructure and setting up of institutional mechanisms for the supply of agricultural inputs and procurement of agricultural produce created an enabling environment for enhancing agricultural production in state.

The progress was spectacular in early phase due to rising agricultural productivity and expansion in gross cropped area. However, of late the progress in agricultural production has slowed down and signs of stagnation are visible. The emerging scene of Punjab agriculture is not free from some serious concerns. The state cropping pattern dominated by wheat-rice rotation is causing a serious damage to the state's natural resource base. Paddy in particular, a water-intensive crop is blamed for water-table depletion in tube-well irrigated areas and water-logging in canal irrigated areas. Increasing incidence of nutrient deficiency in the soils, including micronutrients and insect-pest attacks on the crops are also posing major threats to productivity, food grain production and sustainability of agriculture in the long run. Diversification of cropping pattern towards environment friendly high value crops with emphasis on quality output and promotion of agro-processing industry is the need of hour.

1.2 **Importance of selected crops (Paddy and wheat) in Punjab**

The green revolution brought significant changes in the cropping pattern of Punjab. The temporal analysis of cropping pattern in Punjab brings out the importance of wheat and paddy crops, selected for the present study. During 1970-71, about 40.49 per cent of the gross cropped area was under wheat which increased to 44.31 per cent in 2007-08 and since then hovered around 44.50 per cent. Rice, which occupied around 6.87 per cent of the gross cropped area in 1970-71, increased to over 33.15 per cent in 2007-08, and then rose further to around 35.85 per cent in 2010-11. The increase in wheat cultivation has been at the cost of gram, rapeseed and mustard, while that of rice has been obtained by shifting the area from maize, groundnut, millets and cotton. It can be concluded that imbalance in favour of two main cereals viz. rice and wheat in the cropping pattern has further sharpened despite all efforts on diversification of state agriculture. This happened because of better relative profitability of these crops with minimum production and marketing risk as compared to other crops (Table 1.6).

Table 1.6: Shift in cropping pattern in Punjab (1970-71 to 2010-11)

(Percent)

Crop	**1970-71**	**1980-81**	**1990-91**	**2000-01**	**2007-08**	**2008-09**	**2009-10**	**2010-11**
Rice	6.87	17.49	26.86	32.89	33.15	34.57	35.58	35.85
Wheat	40.49	41.58	43.63	42.92	44.31	44.57	44.72	44.53
Cotton	6.99	9.60	9.34	5.97	7.69	6.66	6.49	6.13
Maize	9.77	5.65	2.51	2.08	1.96	1.91	1.76	1.69
Sugarcane	2.25	1.05	1.35	1.52	1.37	1.02	0.76	0.89
Potato	0.30	0.59	0.31	0.75	1.14	1.04	1.05	0.81
Pulses	7.29	5.04	1.91	0.68	0.34	0.28	0.24	0.25
Total foodgrains	69.18	68.82	75.55	79.05	80.03	81.58	82.52	82.52
Total oilseeds	5.20	3.52	1.32	1.01	0.76	0.76	0.79	0.71

Source: Statistical Abstract, Punjab

1.3 Background of pre and post harvest losses

The emergence of monoculture of paddy and wheat has in a way have altered a multi commodity production system to a specialized system in the state. In the process, many

traditionally cultivated crops (e.g. coarse cereals and small millets) either have lost their area or gone out of cultivation. But, these developments have entailed increased building up of pest and diseases, and consequent use of higher amount of pesticides to raise the crop productivity. The increased use of pesticides has also resulted in developing insects and disease resistance, which further led to reduction in crop yield.

Pre Harvest Losses: The estimation of crop loss due to pests and diseases is a complex subject. It is in fact, difficult to assess the loss caused by the individual pest as a particular crop may be infested by the pest complex in the farmers' field conditions. Further, extent of crop loss either physical or financial depends on the type of variety, stage of crop growth, pest population and weather conditions. Nevertheless, the crop loss estimates have been made and updated regularly at global level. The worldwide yield loss due to various types of pest was estimated at as: 37.4 per cent in rice, 28.2 per cent in wheat, 31.2 per cent in maize and 26.3 per cent in soybean (Oerke, 2007). At all India level, crop loss estimates due to insect pests have been provided by Dhaliwal *et al* (2010). According to this source, the crop loss was estimated at 25 per cent in rice and maize, 5 per cent in wheat, 15 per cent in pulses and 50 per cent in cotton. The crop loss has increased during post-green revolution period when compared to pre-green revolution period. The severity of pest problems has reportedly been changing with the developments in agricultural technology and modifications of agricultural practices. The damage caused by major inspect-pests in various crops has also been compiled and reported in Reddy and Zehr (2004). Further, a number of studies have established the strong relationship between pest infestation and yield loss in various crops in India (Nair, 1975; Dhaliwal and Arora, 1994; Muralidharan, 2003; Rajeswari *et al*, 2004; Muralidharan and Pasalu, 2006; Rajeswari and Muralidharan, 2006).

Generally, crop loss is estimated as the difference between potential (attainable yield) and the actual yield. The potential yield is the yield that would have been obtained in the absence of pest under consideration. By multiplying the area with the estimated yield loss, total loss is obtained. To estimate the crop loss, most of the existing studies have adopted experimental treatment approach (with or without pest attack through artificial infestation) or fields with natural infestation wherein half of the field is protected against the pest while the other half is not. But, the results obtained from artificial infestation or natural infestation in the selected plots/fields will not be appropriate for extrapolation over a geographical area (Groote, 2002). It is for the reason that the estimated crop losses under these conditions may not represent the actual field conditions of

farmers. Alternatively, the estimates collected directly from the farmers through sample survey may be reliable and could be used for extrapolation in similar geographical settings. However, the farmers' estimates are likely to be subjective and these should be validated with expert estimates of the state department of agriculture.

Post Harvest Losses: Production in agriculture is seasonal and exposed to natural environment, but post-production operations play an important role in providing stability in the food supply chain. According to a World Bank (1999) study post harvest losses of foodgrains in India are 7-10 percent of the total production from farm to market level and 4-5 percent at market and distribution level. Given the total production of around 240 million tonnes at present, the total losses work out around 15-25 million tonnes. With the given per capita cereal consumption requirement in India, the above grains lost would be sufficient to feed more than 10 crore people. Losses in food crops occur during harvesting, threshing, drying, storage, transportation, processing and marketing. In the field and during storage, the products are threatened by insects, rodents, birds and other pests. Moreover, the product may be spoiled by infection from fungi, yeasts or bacteria. Food grain stocks suffer qualitative and quantitative losses while in storage. The quantitative losses are generally caused by factors, such as incidence of insect infestation, rodents, birds and also due to physical changes in temperature, moisture content, etc. The qualitative loss is caused by reduction in nutritive value due to factors, such as attack of insect pest, physical changes in the grain and chemical changes in the fats, carbohydrates, protein and also by contamination of myco toxins, besides, residue, etc. The storage loss/gain is a very sensitive issue as it depends upon agro climatic conditions. In order to minimize the losses during storage it is important to know the optimum environment conditions for storage of the product, as well as the conditions under which insects/pests damage the produce.

According to FAO study, about 70 percent of the farm produce is stored by farmers for their own consumption, seed, feed and other purposes in India. Farmers store grain in bulk using different types of storage structures made from locally available materials. For the better storage it is necessary to clean and dry the grain to increase its life during storage. In addition, storage structure, design and its construction also play a vital role in reducing or increasing the losses during storage. With the scientifically constructed storage, it is also essential that the grain being stored is also of good quality. At the village, generally harvesting is done at high moisture content and therefore before storing the same, it is necessary to obtain the desired moisture to obtain safe

post storage grain. There are small storage structures at the farmer level and bulk storage of foodgrains. The major construction material for storage structures in rural areas at the farmer level are mud, bamboo, stone and plant materials. Generally, they are neither rodent proof, nor secure from fungal and insect attack. On average, out of total 6 percent loss of foodgrains in such storage structures, about half is due to rodents and rest half is due to insects and fungi. The storage at the farmer level includes: coal tar drum bin, domestic Hapur bin, Chittore stone bin, double walled polyethylene lined bamboo bin, Pusa bin and so on. The bulk storage of foodgrains is done mainly by traders, cooperatives and government agencies like FCI, CWC, SWC and grain marketing cooperatives. There are many kinds of storage systems followed depending on the length of storage and the product to be stored. Some examples are cover and plinth storage, community storage structures, rural godowns and scientific warehouses.

1.4 Need for the present study

As per the available data, the crop losses caused by pests and diseases are huge. But, the knowledge on the crop loss at the farm level is very much limited. In addition to losses that occur during the growth period of the crop, there is a huge quantity of grains lost during the process of harvesting, threshing, transportation and storage. Therefore, the present study makes a comprehensive attempt to estimate the dimension of losses occurring during the pre and post harvest stages of paddy and wheat crops. For the pre harvest losses, generally animal pests (insects, mites, rodents, snails and birds), plant pathogens (bacteria, fungi, virus and nematodes) and weeds are collectively called as pests, which cause economic damage to crops. This broader definition of pests and diseases is followed in the present study. For estimating post harvest losses, there is a need to establish the extent of losses during storage under different agro climatic conditions. Causes of storage losses include sprouting, transpiration, respiration, rot due to mould and bacteria and attack by insects. Sprouting, transpiration and respiration are physiological activities that depend on the storage environment (mainly temperature and relative humidity). These physiological changes affect the internal composition of the grains and result in destruction of edible material and changes in nutritional quality. But it would be difficult to measure the loss due to physiological changes at the farm level. Nevertheless, an attempt would be made to estimate such losses based on the visual observations and according to farmers' estimates.

1.5 Objectives of the study

Keeping in view about this important subject, the objectives of the present research proposal are given below:

1. To estimate the physical and financial losses caused by pests and diseases in paddy and wheat at farm level
2. To examine the measures of pest and disease management to reduce the crop loss due to pests and diseases at farm level
3. To arrive at post harvest losses in paddy and wheat under different agro climatic conditions.
4. To identify factors responsible for such losses and suggest ways and means to reduce the extent of losses in different operations in order to increase national productivity.

1.6 Data base and methodology

The study has been based on the farm level data collected from the two major paddy and wheat growing districts namely Ludhiana and Ferozepur of Punjab state. The crop production constraints particularly infestation by pests and diseases, and losses caused by them were worked out based on the estimates provided by the farmers. As not only pests and diseases cause crop damage when their population reach beyond a threshold level, there are also other bio-economic factors like soil fertility, water scarcity, poor seed quality, high input costs and low output prices result in considerable financial loss to farmers. Thus, data on these bio-economic variables were also collected from the farmers. The post harvest losses during the process of harvesting, collection and threshing, transportation and storage were also quantified based on the estimates provided by the farmers. As storage material used by the farmers was not scientific, it was essential to identify the structure of storage at the farmers' level and enumerate the losses occurring in the process of storage at the farmer level.

To collect the primary data, a sample survey was conducted in Ludhiana and Ferozepur districts in the state for the reference period rabi 2010-11 (November to May) for wheat and kharif 2011-12 (June to October) for paddy crop. Ludhiana district represented the Central Plain region while Ferozepur district represented south – western region of the state. From each district, two villages with one nearby the market/mandi centre and one far off from the market centre were selected for canvassing the questionnaire. A random sample of 30 wheat and paddy growing

farmers were selected from each village and thus constituting a total sample of 120 farmers for each crop in the state. To ensure proportionate representation to various farm size categories in the study sample, standard national level definition of operational holdings viz., marginal (< 2.50 acres), small (2.51 to 5.00 acres), medium (5.01 to 10.00 acres) and large (> 10.01 acres) were applied. In addition to the primary data collected from the farmers, district office of the Department of Agriculture as well as experts of Punjab Agricultural University to compile the crop loss estimates (if any) for pre and post harvest losses were also consulted. Simple statistical tools were used to interpret the sample survey results.

1.7 Organization of the report

The present report has been organized into six chapters. Chapter 1 introduces the background of the report covering status of agricultural economy of the state, significance of the selected crops, backdrop of pre and post harvest losses, need for the study, objectives , data base and methodology. Trends and growth in area, production and productivity of paddy and wheat in the State, changes in costs and profitability of these crops based on CACP reports and review of secondary estimates of losses caused by pests and diseases of paddy and wheat have been presented in Chapter 2. Chapter 3 covers household characteristics, cropping pattern and production structure etc of sample holdings. Assessment of pre harvest losses of paddy and wheat crops encompassing constraints faced in cultivation of paddy and wheat, assessment of incidences of pests and disease attacks and crop losses, methods of pests and diseases control adopted and source of information received by the sample households for such controls etc are framed in Chapter 4. Chapter 5 presents the assessment of post harvest losses of paddy and wheat crops including production loss during harvest, threshing/winnowing, transportation/handling, storage etc. Concluding remarks and policy suggestion have been set out in Chapter 6.

Chapter 2

Area, Production and Productivity of Wheat and Paddy in Punjab

Owing to the introduction of HYV's in mid sixties and early seventies, there was a sharp increase in the area under wheat and paddy crops in the state and its impact was witnessed in terms of increased productivity and thereby production. This changed agricultural scenario in the state also resulted in huge investment on farm machinery and development of irrigation resources for expediting various farm operations and fulfilling the irrigation requirement of newly introduced cultivars. This chapter deals with the trends in area, production and productivity of wheat and paddy crops and the changing cost structure of these crops on the basis of CACP reports.

2.1 Trend and growth in area, production and yield of wheat and paddy crops

District wise area, production and yield of wheat crop have been depicted in Table 2.1. Area under wheat crop increased in district Hoshiarpur, Gurdaspur, Kapurthala and Sangrur districts from 1970-71 to 2009-10. On the other hand in districts namely, Jalandhar, Ludhiana, Ferozepur, Amritsar, Bathinda, Patiala, Rupnagar and Faridkot, area under wheat crop increased initially but declined during the recent two decades. On the other hand, almost twice increase in productivity under wheat crop was witnessed in all the districts during 1970-71 to 2009-10 and this also resulted in increased production over the last four decades in all the districts. New districts namely, Mansa, Fatehgarh Sahib, Moga, Muktsar and Nawanshahar were also carved out in later decades, therefore, the data for these districts were available for the last two decades only. On the whole, area under wheat crop in the state increased from 22.99 lakh hectare in 1970-71 to 35.22 lakh hectare in 2009-10. The average wheat productivity increased from 22.38 quintal per hectare in 1970-71 to 43.07 quintal per hectare in 2009-10 while the production increased from mere 51.45 lakh metric tonnes in 1970-71 to 151.69 lakh metric tonnes in 2009-10. Thus, area, production and productivity under wheat crop increased in all the districts except few ones but the increase in productivity was more pronounced as compared to increase in wheat acreage.

Table 2.1: District wise area, production and yield of wheat crop in Punjab

(1970-71 to 2009-10)

District	year	1970-71	1980-81	1990-91	2000-01	2009-10*
Hoshiarpur	**A**	131	156	163	142	153
	P	192	318	466	489	589
	Y	1468	2041	2858	3443	3849
Jalandhar	**A**	180	211	219	167	170
	P	449	518	820	773	735
	Y	2492	2456	3746	4626	4325
Ludhiana	**A**	338	265	269	258	259
	P	780	838	1148	1334	1200
	Y	3279	3163	4268	5169	4634
Ferozepur	**A**	427	332	400	378	395
	P	872	972	1512	1704	1636
	Y	2054	2928	3781	4509	4142
Amritsar	**A**	242	298	355	361	185
	P	563	809	1319	1690	753
	Y	2326	2715	3717	4682	4072
Gurdaspur	**A**	141	182	206	217	230
	P	295	398	663	924	940
	Y	2089	2186	3219	4257	4085
Kapurthala	**A**	67	96	113	111	111
	P	169	267	418	493	457
	Y	2527	2781	3700	4439	4816
Bathinda	**A**	283	248	348	243	251
	P	602	683	1153	1014	1013
	Y	2121	2753	3313	4172	4634
Patiala	**A**	255	286	330	261	235
	P	542	753	1322	1191	1063
	Y	2009	2633	4005	4564	4523
Sangrur	**A**	274	331	392	393	287
	P	587	1015	1662	1921	1302
	Y	2143	3067	4241	4889	4538
Rupnagar	**A**	-	72	82	86	65
	P	-	158	262	312	277
	Y	-	2190	3194	3631	4257
Faridkot	**A**	-	334	394	111	117
	P	-	945	1407	524	481
	Y	-	2829	3570	4721	4107
Mansa	**A**	-	-	-	163	170

	P	-	-	-	748	730
	Y	-	-	-	4591	4297
Fatehgarh Sahib	**A**	-	-	-	86	85
	P	-	-	-	434	419
	Y	-	-	-	5041	4932
Moga	**A**	-	-	-	172	177
	P	-	-	-	818	779
	Y	-	-	-	4755	4401
Muktsar	**A**	-	-	-	189	205
	P	-	-	-	869	950
	Y	-	-	-	4596	4634
Nawanshahar	**A**	-	-	-	70	74
	P	-	-	-	313	316
	Y	-	-	-	4463	4271
Punjab	**A**	2299	2812	3273	3408	3522
	P	5145	7677	12159	15551	15169
	Y	2238	2730	3715	4563	4307

A indicates Area (000, ha), P indicates Production (000, metric tonnes) and Y indicates Yield (Kg/ha)

The district wise trends in area, production and yield of wheat crop in Punjab have been depicted in Table 2.2. In Jalandhar, Ludhiana, Amritsar, Gurdaspur, Kapurthala, Patiala, Sangrur, Rupnagar and Faridkot districts there was increasing trend in area in seventies and eighties while later on this trend was reversed. In overall, significantly positive growth in area was seen in Ludhiana, Ferozepur, Gurdaspur, Kapurthala and Sangrur districts while in Jalandhar and Faridkot districts area declined significantly. On the other hand, productivity increased significantly in all the districts during various decades and at overall level except in few districts where it declined during certain periods. This enhanced productivity resulted in increased level of production in almost all the districts except in a few ones. On the whole, growth in area under wheat crop was more in 1970-71 to 1979-80 period while in later decades; growth was positive but less pronounced. Growth in productivity and production was more in 1970-71 to 1979-80 and 1980-81 to 1989-90 decades while in 1990-91 to 1999-2000 periods, growth in productivity and production was positive but less pronounced. On the other hand, productivity and production declined during 2000-01 however, this decline was not significant. Hence, there was a significant growth in area, productivity and production under wheat crop in the Punjab state.

Table 2.2: District wise trends in area, production and yield of wheat crop in Punjab

(1970-71 to 2009-10)

District		1970-71 to 1979-80	1980-81 to 1989-90	1990-91 to 1999-2000	2000-01 to 2009-10	Overall 1970-71 to 2009-10
Hoshiarpur	**A**	0.67ns	0.15ns	-1.95**	0.97***	-0.16ns
	P	3.94**	4.30***	0.10ns	1.94***	2.21***
	Y	3.24**	4.14***	2.09***	0.97**	2.37***
Jalandhar	**A**	1.83***	0.20ns	-4.46***	0.15ns	-0.69***
	P	3.02**	4.12***	-2.58ns	-0.72*	1.22***
	Y	1.16*	3.91***	1.97*	-0.87**	1.92***
Ludhiana	**A**	0.95**	-0.13ns	-0.54***	0.10ns	0.08*
	P	1.88*	2.83***	-0.59ns	-1.01*	1.46***
	Y	0.91ns	2.96***	1.14*	-1.11**	1.39***
Ferozepur	**A**	-1.47ns	1.53***	0.04ns	0.61***	0.73***
	P	2.01ns	3.95***	1.97***	0.81ns	2.68***
	Y	3.54***	2.38***	1.93***	0.21ns	1.94***
Amritsar	**A**	2.38***	1.54***	-0.12ns	-9.59***	-0.03ns
	P	4.09***	4.94***	1.80**	-10.78***	1.94***
	Y	1.69ns	3.35**	1.93**	-1.31***	1.97***
Gurdaspur	**A**	3.56***	1.01***	0.09ns	1.02***	1.07***
	P	4.75***	4.42***	2.81***	0.37ns	3.35***
	Y	1.15*	3.38**	2.72***	-0.64ns	2.25***
Kapurthala	**A**	4.96***	1.35***	-0.79ns	-0.21ns	1.10***
	P	6.27***	5.30***	0.85ns	-0.75ns	3.37***
	Y	1.25ns	3.90***	1.64ns	0.54ns	2.24***
Bathinda	**A**	-1.03ns	3.11***	-5.31***	0.41***	0.07ns
	P	1.39ns	4.96***	-2.84ns	1.21*	2.20***
	Y	2.45*	1.80ns	2.61***	.80ns	2.13***
Patiala	**A**	2.01**	0.58ns	-2.93***	-1.45***	-0.22ns
	P	7.59***	4.67***	-1.63ns	-1.43**	2.13***
	Y	5.47**	4.07***	1.34**	0.02ns	2.35***
Sangrur	**A**	1.72***	1.49***	0.12ns	-4.59***	0.47**
	P	4.57***	4.90***	1.06**	-4.96***	2.47***
	Y	2.80***	3.34***	0.94**	-0.39ns	2.00***
Rupnagar	**A**	-	0.80**	0.43**	-4.77***	-0.29ns
	P	-	4.15***	2.59***	-4.06**	1.29***
	Y	-	3.32**	2.15***	0.75ns	1.58***
Faridkot	**A**	-	1.45***	-17.42***	0.74***	-5.71***
	P	-	3.20***	-15.11***	0.27ns	-4.29***
	Y	-	1.72**	2.79***	-0.47ns	1.51***

Mansa	**A**	-	-	-	0.44**	0.72***
	P	-	-	-	0.70ns	1.24**
	Y	-	-	-	0.26ns	0.52ns
Fateh garh Sahib	**A**	-	-	-	0.07ns	-0.00ns
	P	-	-	-	-0.45ns	-0.19ns
	Y	-	-	-	-0.51ns	-0.19ns
Moga	**A**	-	-	-	0.54***	2.61***
	P	-	-	-	0.50ns	2.53***
	Y	-	-	-	-0.04ns	-0.00ns
Muktsar	**A**	-	-	-	0.81***	1.42***
	P	-	-	-	1.84**	2.73***
	Y	-	-	-	1.02ns	1.30**
Nawanshehar	**A**	-	-	-	0.66*	1.91***
	P	-	-	-	0.38ns	2.17**
	Y	-	-	-	-0.27ns	0.25ns
Punjab	**A**	2.33***	1.25***	0.26ns	0.42***	1.08***
	P	4.70***	4.29***	2.24***	0.25ns	3.07***
	Y	2.31***	3.00***	1.98***	-0.17ns	1.97***

Note: The period of analysis for Rupnagar & Faridkot is since 1980-81, for Mansa, Fatehgarh Sahib, Moga, Muktsar & Nawanshahar it is since 1996-97
*****, ** and * Significant at one, five and ten percent level of probability, respectively**

The district wise area, production and yield of rice in the Punjab have been depicted in Table 2.3. The perusal of the table reveals that there was continuous increase in area under rice crop in the state due to the introduction of high yielding varieties (HYV's) of this crop. There was a sharp jump in the area under rice crop in Jalandhar, Ludhiana, Bathinda and Sangrur districts of the state during the last four decades; however, area also increased in other districts namely Hoshiarpur, Ferozepur, Amritsar, Gurdaspur, Kapurthala, Patiala, Rupnagar and Faridkot but this increase was less prominent. There was almost three times increase in productivity of rice crop in Patiala, Sangrur and Bathinda districts while in other districts of the state the increase in productivity was nearly twice. Due to tremendous increase in area under rice crop in district Jalandhar, Ludhiana, Bathinda and Sangrur, production also increased while in other districts of the state, quantum of increase in production was less. In the state as a whole, area under rice crop increased from 3.90 lakh hectares in 1970-71 to 28.02 lakh hectares in 2009-10 while the corresponding increase in productivity in the same period was from 17.65 quintal to 40.10 quintal per hectare and that of production from 6.88 lakh metric tonnes to 112.36 lakh metric tonnes.

Table 2.3: District wise area, production and yield of rice in Punjab

(1970-71 to 2009-10)

District		1970-71	1980-81	1990-91	2000-01	2009-10*
Hoshiarpur	**A**	31	45	65	63	70
	P	49	109	186	192	248
	Y	1595	2416	2862	3047	3536
Jalandhar	**A**	14	88	158	136	161
	P	26	260	496	488	636
	Y	1850	2951	3139	3588	3948
Ludhiana	**A**	5	94	225	238	257
	P	9	356	824	939	1206
	Y	1800	3790	3662	3947	4692
Firozpur	**A**	64	162	237	248	262
	P	116	413	750	898	964
	Y	1820	2547	3165	3622	3680
Amritsar	**A**	89	197	277	319	185
	P	174	349	763	972	501
	Y	1953	1774	2755	3047	2706
Gurdaspur	**A**	80	141	173	191	204
	P	131	289	441	569	640
	Y	1647	2050	2549	2980	3135
Kapurthala	**A**	28	66	98	103	115
	P	55	197	279	358	452
	Y	1965	2984	2847	3476	3934
Bathinda	**A**	2	8	50	99	104
	P	3	28	172	350	476
	Y	1380	3542	3440	3539	4575
Patiala	**A**	61	191	280	256	240
	P	103	583	946	857	1021
	Y	1685	3054	3379	3348	4255
Sangrur	**A**	11	90	287	357	271
	P	15	336	1062	1342	1273
	Y	1365	3665	3700	3759	4696
Rupnagar	**A**	-	22	36	49	38
	P	-	72	113	163	135
	Y	-	3297	3139	3316	3559
Faridkot	**A**	-	78	138	90	98
	P	-	242	503	310	414
	Y	-	3107	3645	3446	4219
Mansa	**A**	-	-	-	84	77
	P	-	-	-	306	324

	Y	-	-	-	3636	4211
Fateh Garh Sahib	**A**	-	-	-	84	86
	P	-	-	-	350	391
	Y	-	-	-	4162	4544
Moga	**A**	-	-	-	159	172
	P	-	-	-	596	812
	Y	-	-	-	3747	4721
Muktsar	**A**	-	-	-	89	100
	P	-	-	-	309	387
	Y	-	-	-	3476	3873
Nawanshehar	**A**	-	-	-	47	104
	P	-	-	-	158	496
	Y	-	-	-	3364	4770
Punjab	**A**	390	1183	2015	2612	2802
	P	688	3233	6506	9157	11236
	Y	1765	2733	3229	3506	4010

A indicates Area (000, ha), P indicates Production (000, metric tonnes) and Y indicates Yield (Kg/ha)

The district wise trends in area, production and yield of rice crop have been depicted in Table 2.4. The results in the table reveals that there was tremendous growth in area under rice crop in Jalandhar, Ludhiana, Ferozepur, Amritsar, Gurdaspur, Kapurthala, Bathinda, Patiala and Sangrur districts during 1970-71 to 1979-80. However, during the subsequent decades, the growth in area under rice crop in almost all the districts of the state increased but at a lower rate. The productivity growth was also found to be higher during 1970-71 to 1979-80 decade in district Jalandhar, Ludhiana, Ferozepur, Amritsar, Gurdaspur, Kapurthala, Bathinda, Patiala and Sangrur. In the subsequent two decades, significant increase in productivity was observed in only Amritsar district. During 2000-01 to 2009-10 periods, there was significant increase in productivity in almost all the districts of the state. The growth in production was more pronounced in 1970-71 to 1979-80 period as compared to the subsequent decades. In overall Punjab level, there was a significant growth in area, productivity and production under rice crop in the state, however, the quantum of increase was more in 1970-71 to 1979-80 periods as compared to subsequent decades later on.

Table 2.4: District wise trends in area, production and yield of rice in Punjab

(1970-71 to 2009-10)

District		1970-71 to 1979-80	1980-81 to 1989-90	1990-91 to 1999-2000	2000-01 to 2009-10	Overall 1970-71 to 2009-10
Hoshiarpur	**A**	2.76**	3.78***	-0.23ns	0.54ns	1.56***
	P	5.86***	3.73**	-0.20ns	2.54*	3.13***
	Y	3.01***	-0.04ns	0.03ns	1.97**	1.54***
Jalandhar	**A**	18.03***	6.84***	-2.75**	2.11***	4.58***
	P	24.76***	7.34***	-2.64**	3.19***	5.73***
	Y	5.72***	0.48ns	0.11ns	1.06*	1.10***
Ludhiana	**A**	35.24***	8.29***	0.59*	0.99***	8.37***
	P	46.14***	8.04***	-0.10ns	2.68***	9.65***
	Y	8.06***	-0.23ns	-0.68ns	1.68***	1.19***
Firozpur	**A**	11.41***	3.59***	1.88**	0.86*	3.12***
	P	15.57***	4.50***	2.58***	1.95***	4.65***
	Y	3.73**	0.88ns	0.69ns	1.08*	1.48***
Amritsar	**A**	8.62***	3.82***	1.10***	-8.15***	2.27***
	P	12.09***	7.66***	2.22***	-8.47***	3.38***
	Y	3.19**	3.70**	1.11**	-0.35ns	1.09***
Gurdaspur	**A**	7.18***	2.65***	1.02***	0.58*	2.26***
	P	12.09***	3.34**	1.55**	1.65*	3.73***
	Y	4.58***	0.68ns	0.52ns	1.06***	1.44***
Kapurthala	**A**	9.94***	4.32***	-0.13ns	1.31***	3.54***
	P	13.74***	3.14ns	1.05ns	2.75***	4.74***
	Y	3.45***	-1.13ns	1.18ns	1.42**	1.15***
Bathinda	**A**	19.17*	19.10**	6.35ns	-0.07ns	12.41***
	P	27.21**	18.65**	6.24*	2.79**	14.40***
	Y	6.75***	-0.37ns	-0.10ns	2.85***	1.77***
Patiala	**A**	13.08***	3.08***	-0.99ns	-0.71**	2.56***
	P	19.97***	4.40***	-1.67ns	2.09***	4.15***
	Y	6.09***	1.28ns	-0.68ns	2.82***	1.56***
Sangrur	**A**	26.83***	11.86***	2.11***	-4.06***	8.20***
	P	38.67***	12.21***	1.89**	-1.74ns	10.11***
	Y	9.10***	0.31ns	-0.21ns	2.41***	1.77***
Rupnagar	**A**	-	4.40***	3.47***	-4.37***	2.38***
	P	-	5.58**	2.55***	-2.68**	2.72***
	Y	-	1.13ns	-0.88ns	1.78***	0.33**
Faridkot	**A**	-	5.33***	-9.46**	1.82*	-1.51ns
	P	-	7.05***	-10.85**	4.37***	-0.81ns
	Y	-	1.62**	-1.53*	2.51***	0.72***

Mansa	**A**	-	-	-	-1.84ns	0.11ns
	P	-	-	-	0.70ns	2.49**
	Y	-	-	-	2.59**	2.37***
Fateh garh Sahib	**A**	-	-	-	0.50**	0.41***
	P	-	-	-	1.58**	2.42***
	Y	-	-	-	1.08*	2.00***
Moga	**A**	-	-	-	1.46***	4.14***
	P	-	-	-	4.10***	6.32***
	Y	-	-	-	2.60***	2.10***
Muktsar	**A**	-	-	-	1.13ns	7.29**
	P	-	-	-	3.32**	9.53***
	Y	-	-	-	2.17**	2.08***
Nawanshehar	**A**	-	-	-	11.11***	6.84***
	P	-	-	-	16.31***	9.94***
	Y	-	-	-	4.68***	2.90***
Punjab	**A**	12.69***	5.34***	2.52***	0.89***	4.79***
	P	18.66***	6.70***	2.54***	2.67***	6.42***
	Y	5.29***	1.30ns	0.17ns	1.76***	1.56***

Note: The period of analysis for Rupnagar & Faridkot is since 1980-81, for Mansa, Fatehgarh Sahib, Moga, Muktsar & Nawanshahar it is since 1996-97
*****, ** and * Significant at one, five and ten percent level of probability, respectively**

2.2 Changes in costs and profitability of wheat and paddy crops

The cost of cultivation of wheat crop based on various cost concepts have been presented in Table 2.5. The perusal of data reveals that during the year 1981-82, cost C_2 in case of wheat crop was Rs. 3776.19 per hectare while cost A_2, which includes expenses incurred in cash and kind by the farmers for raising the crop and rent paid for leased in land, worked out to be Rs. 2390.94 per hectare which was 63.31 per cent of cost C_2. After one decade in the year 1991-92 the cost C_2 worked out to be Rs. 9274.96 per hectare while cost A_2 came out to be Rs. 5385.31 per hectare which was 58.06 per cent of cost C_2. Similarly, during the year 2001-02, Cost C_2 came out to be Rs.22930.99 per hectare while cost A_2 worked out to be Rs. 12368.22 per hectare which was 44.36 per cent of cost C_2. In the year 2008-09, cost C_2 worked out to be Rs. 35423.48 per hectare while Cost A_2 came out to be Rs. 14387.90 per hectare which was found to be 40.62 per cent of the Cost C_2. Thus, the share of cost A_2 in Cost C_2 had declined rapidly during the last three decades which can be due to more investment on farm machinery by the farmers and increase in the vale of owned land. The cost items wise analysis brought out that in wheat cultivation, expenses on machine labour, pesticide use as well as rental value of owned land/ rent paid for leased in land has increased rapidly from 1981-82 to 2008-09 (Appendices I(b), II(b)).

Table 2.5: Cost of cultivation of wheat based on various cost concepts, Punjab

(Rs/ha)

Year	A_1	A_2	B_1	B_2	C_1	C_2
1981-82	2204.07	2390.94	N.A.	3529.89	N.A*	3776.19
1982-83	2303.63	2632.93	2719.03	3986.41	2959.87	4227.28
1983-84	2461.74	2736.68	2833.96	4187.99	3098.54	4452.57
1984-85	2735.00	2973.88	3203.61	4786.20	3572.13	5154.72
1985-86	2854.84	3191.06	3289.88	5023.53	3654.19	5387.84
1986-87	2915.31	3216.73	3374.28	4957.07	3724.17	5306.96
1987-88	3193.04	3621.49	3682.57	5625.31	4000.69	5943.42
1988-89	3399.39	4079.69	3870.97	6367.92	4189.28	6686.22
1989-90	3545.90	4076.42	4146.53	6643.65	4494.39	6991.49
1990-91	4001.79	4632.03	4563.29	7557.42	5008.30	8002.30
1991-92	4583.73	5385.31	5248.93	8846.27	5677.61	9274.96
1992-93	5164.97	6197.56	5858.20	10201.34	6602.38	10945.52
1993-94	6018.24	6178.99	7448.22	12742.94	8254.65	13549.35
1994-95	6117.54	7004.62	7271.82	12697.13	8172.73	13598.04
1995-96	6688.57	8458.90	7613.13	13330.74	8593.55	14311.17
1996-97	7992.35	8753.68	9437.48	17141.54	10287.94	17992.01
1997-98	8109.06	9512.66	9198.96	16496.87	10035.98	17333.89
1998-99	8474.80	9944.71	9656.83	18575.44	10563.6	19479.22
1999-00	9169.35	10281.41	10791.13	20304.84	11798.42	21312.13
2000-01	9698.61	11854.13	11353.38	21545.13	12345.18	22536.93
2001-02	10172.51	12368.22	11599.8	21906.64	12624.15	22930.99
2002-03	10913.25	12484.96	12771.72	22037.03	13731.90	22997.21
2003-04	10375.14	12826.51	12325.13	21527.76	13212.41	22415.03
2004-05	11122.17	14176.52	12948.61	23465.24	13680.85	24197.48
2005-06	12252.79	13528.68	14593.08	25670.12	15622.56	26699.59
2006-07	13039.40	15303.26	15350.03	28996.56	16300.43	29946.95
2007-08	13681.81	15958.71	16217.14	31664.15	17380.22	32826.96
2008-09	14387.90	16409.84	17904.93	33887.74	19440.67	35423.48

***N.A. means not available**

Cost Concepts:

Cost A_1 = All expenses occurred in cash and kind for raising the crop

Cost A_2 = Cost A_1 + Rent paid for leased on land

Cost B_1= Cost A_1 + Interest on value of owned capital assets (Excluded land)

Cost B_2 = Cost B_1+ Rental Value of owned land (Net of land revenue) + Rent paid for leased in land

Cost C_1= Cost B_1 + Imputed vale of family labour

Cost C_2= Cost B_2+ Imputed vale of family labour

The profitability from wheat crop has been depicted in Table 2.6. The perusal of the table reveals that the yield of wheat crop was 30.75 quintal per hectare in the year 1981-82 which increased to 38.34 quintal per hectare in 1991-92, 45.72 quintal per hectare in 2001-02 and 46.47 quintal per hectare in 2007-08. Similarly, minimum support price for this crop increased from

Rs. 130 per quintal in 1981-82 to Rs. 225 in 1991-92, Rs. 610 in 2001-02 and Rs. 1080 per quintal in 2008-09. Similarly, total cost per hectare in wheat cultivation increased from Rs. 3776.19 per hectare in 1981-82 to Rs. 9274.96 in 1991-92, Rs. 22930.99 in 2001-02 and Rs. 35423.48 per

Table 2.6: Profitability indicators of wheat crop in Punjab

(Rs/Ha)

Year	Yield (q/ha)	Price (Rs/q)	By Product	Gross Returns	Variable Cost	Total Cost	Returns Over Variable Cost (ROVC)	Net Returns	
								Current Prices	Constant Prices (1981-82)
1981-82	30.75	130	685.28	4682.78	2382.53	3776.19	2300.25	906.59	906.59
1982-83	30.75	142	726.52	5093.02	2540.19	4227.28	2552.83	865.74	843.55
1983-84	29.49	151	555.09	5008.08	2645.87	4452.57	2362.21	555.51	494.51
1984-85	33.45	152	1030.11	6114.51	2998.19	5154.72	3116.32	959.79	797.84
1985-86	35.6	162	1002.34	6769.54	3102.32	5387.84	3667.22	1381.7	1086.28
1986-87	30.32	162	804.56	5716.4	3156.05	5306.96	2560.35	409.44	315.38
1987-88	34.14	166	1673.73	7340.97	3399.99	5943.42	3940.98	1397.55	994.76
1988-89	36.51	173	1946.73	8262.96	3610.31	6686.22	4652.65	1576.74	1044.60
1989-90	36.93	183	2128.51	8886.7	3753.62	6991.49	5133.08	1895.21	1169.13
1990-91	36.22	215	1653.75	9441.05	4318	8002.3	5123.05	1438.75	804.93
1991-92	38.34	225	3819.67	12446.17	4838.23	9274.96	7607.94	3171.21	1559.82
1992-93	37.08	280	4115.79	14498.19	5743.56	10945.52	8754.63	3552.67	1587.81
1993-94	43.94	330	3167.34	17667.54	6595.78	13549.35	11071.76	4118.19	1698.85
1994-95	39.41	350	2684.36	16477.86	6800	13598.04	9677.86	2879.82	1071.55
1995-96	36.6	360	2649.51	15825.51	7442.76	14311.17	8382.75	1514.34	521.78
1996-97	43.48	380	7140.99	23663.39	8526.05	17992.01	15137.34	5671.38	1868.10
1997-98	35.78	415	6604.19	21452.89	8730.13	17333.89	12722.76	4119	1299.55
1998-99	42.46	510	2031.53	23686.13	9161.23	19479.22	14524.9	4206.91	1252.81
1999-00	48.34	550	4659.68	31246.68	10000.06	21312.13	21246.62	9934.55	2864.78
2000-01	47.8	580	4079.77	31803.77	10382.09	22536.93	21421.68	9266.84	2493.79
2001-02	45.72	610	3282.74	31171.94	11045.49	22930.99	20126.45	8240.95	2140.71
2002-03	40.66	620	3990.45	29199.65	11653.15	22997.21	17546.5	6202.44	1557.95
2003-04	40	620	3232.98	28032.98	10978.14	22415.03	17054.84	5617.95	1338.13
2004-05	42.94	640	3544.63	31026.23	11673.3	24197.48	19352.93	6828.75	1527.58
2005-06	42.05	700	4177.05	33612.05	13011.41	26699.59	20600.64	6912.46	1480.72
2006-07	42.1	850	5426.53	41211.53	13734.23	29946.95	27477.3	11264.58	2288.88
2007-08	46.47	1000	4223.32	50693.32	14574.9	32826.96	36118.42	17866.36	3467.27
2008-09	39.83	1080	5110.81	48127.21	15564.23	35423.48	32562.98	12703.73	2281.24

hectare in 2008-09. In the same way, the gross returns per hectare increased from Rs. 4682.78 in 1981-82 to Rs. 12446.17 in 1991.92, Rs. 31171.94 in 2001-02 and Rs. 48127.21 per hectare in 2008-09. Net returns per hectare at current prices increased from Rs.906.59 in 1981-82 to Rs. 3171.21 in 1991-92, Rs. 8240.95 in 2001-02 and Rs. 12703.73 per hectare in 2008-09. On the other hand, the net returns at constant prices increased from Rs. 906.59 per hectare in 1981-82 to Rs. 1559.82 in 1991-92, Rs. 2140.71 in 2001-02 and Rs. 2281.24 per hectare in 2008-09. Thus, there was 2.52 times increase in the profitability from wheat crop in the Punjab state from 1981-82 to 2008-09 at constant prices. This increase in profitability can be attributed to enhanced productivity and continuous upward trend in the minimum support price announced by the Government.

The cost of cultivation of paddy on the basis of different cost concepts have been shown in Table 2.7. It can be seen from the table that during the year 1981-82 cost C_2 worked out to be Rs. 5473.89 per hectare while cost A_2 came out to be Rs. 3477.17 which was 63.52 per cent of the cost C_2. During the year 1991-92, the cost C_2 was found to be Rs. 10390.80 per hectare while cost A_2 worked out to be Rs. 6067.75 which was 58.39 per cent of the Cost C_2. Similarly, during the years 2001-02 and 2008-09, the cost C_2 was calculated at Rs. 22305.79 and Rs. 45291.24 per hectare respectively while the corresponding figures of cost A_2 for the same years worked out to be Rs. 11904.39 and Rs. 22510.13. The percent share of cost A_2 in cost C_2 was found to be 53.37 per cent during the year 2001-02 while this share further declined to 49.70 per cent during the year 2008-09. This shift in the share of cost A_2, which is the expenditure incurred on raising the crop in cash and kind and also include the rent paid for leased in land, can be attributed to the increase in the capital investment on farms in terms of new farm machinery and increase in the value of the owned lands. Therefore, during the period 1981-82 to 2008-09, there was continuous increase in the cost C_2, which is the total cost incurred per hectare in paddy crop in the Punjab state. The cost items driving the cost of production in paddy were the increase in human labour, machine labour, increased pesticide use and increase in rental value of owned land and rent paid for leased in land in relative terms from 1981-82 to 2008-09 (Appendices IV(b), V(b))

Table 2.7: Cost of cultivation of paddy based on various cost concepts, Punjab

(Rs/ha)

Year	A_1	A_2	B_1	B_2	C_1	C_2
1981-82	3311.11	3477.17	3664.49	5086.74	4051.64	5473.89
1982-83	3408.68	3682.22	3818.1	5492.7	4151.21	5805.82
1983-84	3764.60	4131.74	4189.59	6091.82	4580.18	6482.41
1984-85	4104.82	4374.65	4622.84	6501.18	5137.96	7016.31
1985-86	3820.14	4072.86	4308.00	6165.22	4782.76	6639.97
1986-87	3989.14	4353.66	4567.62	6878.57	5079.25	7390.21
1987-88	4282.6	4647.82	4794.08	7370.24	5271.66	7847.81
1988-89	5231.36	4520.22	4708.18	7303.87	5080.01	7684.71
1989-90	4347.53	5374.51	5024.71	8293.59	5516.77	8785.65
1990-91	5327.04	5912.45	6036.05	9545.31	6573.16	10082.42
1991-92	5384.14	6067.75	6026.38	9790.15	6627.03	10390.8
1992-93	5900.72	6933.03	6700.62	11784.57	7567.26	12651.21
1993-94	6660.51	6875.04	8046.24	13254.65	9385.22	14593.63
1994-95	7356.07	8035.72	8239.35	14023.95	9463.88	15248.49
1995-96	7300.11	8753.09	8151.43	1424.18	9473.45	15526.2
1996-97	9262.64	9874.94	10301.87	16864.36	11404.35	17966.82
1997-98	8610.34	10125.12	9493.98	17885.33	10601.66	18993.01
1998-99	9509.84	10599.83	10517.76	17731.89	11912.06	19126.17
1999-00	10152.81	11071.6	11332.73	19734.38	12717.79	21119.44
2000-01	10733.67	12680.9	11731.13	21878.57	13429.94	23577.39
2001-02	10488.44	11904.39	11594.68	20805.99	13094.47	22305.79
2002-03	15596.18	17452.58	17026.42	27018.78	19356.33	29348.7
2003-04	14059.5	17780.09	15528.1	27165.26	17289.09	28926.24
2004-05	14824.46	18931.54	16307.01	29697.87	18379.52	31770.38
2005-06	13932.34	15438.02	16019.31	28198.17	17826.61	30007.47
2006-07	13374.92	15056.2	15208.69	28485.12	17107.69	30384.12
2007-08	14219.24	16957.13	16368.23	32786.63	18326.8	34781.2
2008-09	18594.43	22510.13	21847.38	42646.63	24492.00	45291.24

Cost Concepts:
Cost A_1 = All expenses occurred in cash and kind for raising the crop
Cost A_2 = Cost A_1 + Rent paid for leased on land
Cost B_1= Cost A_1 + Interest on value of owned capital assets (Excluded land)
Cost B_2 = Cost B_1+ Rental Value of owned land (Net of land revenue) + Rent paid for leased in land
Cost C_1= Cost B_1 + Imputed vale of family labour
Cost C_2= Cost B_2+ Imputed vale of family labour

The profitability from paddy crop has been shown in Table 2.8. The perusal of the table reveals that the yield of paddy crop was 53.3 quintal per hectare in the year 1981-82 which declined to 49.79 quintal per hectare in 1991-92, increased to 57.5 quintal per hectare in 2001-02

Table 2.8: Profitability indicators of Paddy in Punjab

(Rs/ha)

Year	Yield (q/ha)	Price (Rs/q)	By Product	Gross Returns	Variable Cost	Total Cost	Returns Over Variable Cost (ROVC)	Net Returns	
								Current Prices	Constant Prices (1981-82)
1981-82	53.3	115	475.99	6605.49	3632.49	5473.89	2973	1131.6	1131.60
1982-83	55.66	122	362.54	7153.06	3643.23	5805.82	3509.83	1347.24	1312.71
1983-84	52.82	132	522.17	7494.41	4068.7	6482.41	3425.71	1012	900.87
1984-85	51.14	140	361.8	7521.4	4506.06	7016.31	3015.34	505.09	419.86
1985-86	52.33	142	353.85	7784.71	4190.2	6639.97	3594.51	1144.74	899.99
1986-87	56.71	146	604.89	8884.55	4400.12	7390.21	4484.43	1494.34	1151.03
1987-88	52.1	150	1793.14	9608.14	4678.91	7847.81	4929.23	1760.33	1252.99
1988-89	47.3	160	2042.36	9610.36	4503.06	7684.71	5107.3	1925.65	1275.75
1989-90	58.97	184.6	-	10885.66	4704.06	8785.65	6181.6	2100.01	1295.47
1990-91	51.3	205	833.74	11350.24	5727.63	10082.42	5622.61	1267.82	709.30
1991-92	49.79	230	1470.38	12922.08	5867.31	10390.8	7054.77	2531.28	1245.06
1992-93	56.18	270	1301.56	16470.16	6615.43	12651.21	9854.73	3818.95	1706.82
1993-94	53.98	310	2436.11	19169.91	7795.54	14593.63	11374.37	4576.28	1887.82
1994-95	51.84	340	1347.11	18972.71	8369.58	15248.49	10603.13	3724.22	1385.74
1995-96	46.03	360	1227.63	17798.43	8429.26	15526.2	9369.17	2272.23	782.92
1996-97	51.64	380	1534.54	21157.74	10194.66	17966.82	10963.08	3190.92	1051.06
1997-98	52.79	415	2055.3	23963.15	9559.43	18993.01	14403.72	4970.14	1568.08
1998-99	46.45	440	1474.7	21912.7	10729.04	19126.17	11183.66	2786.53	829.82
1999-00	54.62	490	1539.9	28303.7	11415.43	21119.44	16888.27	7184.26	2071.69
2000-01	59.48	510	3481.71	33816.51	11793.35	23577.39	22023.16	10239.12	2755.44
2001-02	57.5	523.9	-	30124.23	12325.1	22305.79	17799.13	7818.44	2030.96
2002-03	58.68	530	2645.83	33746.23	17748.61	29348.7	15997.62	4397.53	1104.59
2003-04	65.07	550	3042.06	38830.56	15599.56	28926.24	23231	9904.32	2359.09
2004-05	70.5	560	2934.24	42414.24	16763.94	31770.38	25650.3	10643.86	2381.01
2005-06	61.15	600	713.66	37403.66	15538.98	30007.47	21864.68	7396.19	1584.33
2006-07	63.08	650	1136.57	42138.57	15096.24	30384.12	27042.33	11754.45	2388.42
2007-08	68.01	775	3945.66	56653.41	16013.57	34781.2	40639.84	21872.21	4244.67
2008-09	67.41	930	4299.8	66991.1	20970.94	45291.24	46020.16	21699.86	3896.69

and 67.41 qtls per hectare in 2008-09. Also, the minimum support price for paddy increased from Rs. 115 per quintal in 1981-82 to Rs. 230 in 1991-92, Rs. 530 in 2001-02 and Rs. 930 per quintal in 2008-09. Similarly, total cost per hectare in raising paddy crop increased from Rs. 5473.89 per

hectare in 1981-82 to Rs. 10390.80 in 1991-92, Rs. 22305.79 in 2001-02 and Rs. 45291.24 per hectare in 2008-09. The gross returns per hectare from paddy increased from Rs. 6605.49 per hectare in 1981-82 to Rs. 12922.08 in 1991-92, Rs. 30124.23 in 2001-02 and Rs. 66991.10 per hectare in 2008-09. Net returns per hectare from paddy cultivation at current prices increased from Rs.1131.60 in 1981-82 to Rs. 2531.28 in 1991-92, Rs. 7818.44 in 2001-02 and Rs. 21699.86 per hectare in 2008-09. On the contrary, the net returns at constant prices increased from Rs. 1131.60 per hectare in 1981-82 to Rs. 1245.06 in 1991-92, Rs. 2030.96 in 2001-02 and Rs. 3896.69 per hectare in 2008-09. Thus, there was 3.44 times increase in the profitability from paddy crop in the Punjab state from 1981-82 to 2008-09 at constant prices. The increase in profitability from paddy crop can be attributed to introduction of new farm technology which resulted in increased productivity of paddy. Also, increase in minimum support price also gave impetus to this increase in profitability from paddy crop.

2.3 Secondary estimates of losses caused by pests and diseases of selected crops: A Review

Roy and Dutta (1999) in their study on rice-wheat crop sequence revealed the emergence of a major production system in the irrigated areas of Haryana over the last two decades prior to the study period. Concerns were being raised about the sustainability of existing high levels of rice-wheat productivity. The study was undertaken in Karnal and Kaithal districts of Haryana during 1999 to identify and prioritize production constraints that cause losses in the rice-wheat system. The study highlighted the existence of a large yield gaps in rice and wheat crops. The yield losses due to major biotic stresses were found to be 1133.13 kilograms per hectare in Paddy and 783.45 kilograms per hectare in wheat crops. In case of wheat crop, the major loss was due to weeds (258.25 kg/ha) followed by diseases (214.65 kg/ha) and insect pests (187.55 qtls/ha). On the contrary, in case of paddy crop, more than 50 per cent of the total loss due to biotic stresses was found to be due to diseases (682 kg/ ha) followed by insect pests (265.50 kg/ ha) and weeds (185.63 kg/ ha). Janaiah and Hossain (2000) conducted a study on the farm level sustainability of intensive rice-wheat system. Survey data were collected during 1999-2000 for a collaborative study of the Directorate of Rice Research (DRR) of the Indian Council of Agricultural Research (ICAR) and the International Rice Research Institute (IRRI), Philippines. Ten high productive rice-growing villages in each state of Andhra Pradesh, Karnataka, Punjab and Uttar Pradesh were selected. Ten progressive farmers were randomly selected from each village. The selected farmers had more than 10 years experience in rice cultivation. Based on farmers' perceptions over the past

10 years (1990-99), the annual yield loss was estimated at 536 kg/ha in rice crop under intensive rice systems in India. This was equivalent to the total annual loss of about 5 million tons of paddy under the intensive rice system of which nearly 60 per cent was due to biotic stresses (insect pests and diseases). The remaining 40 per cent was due to resource (soil and water) degradation. The total yield loss accounted for only 8.5 per cent of average yields obtained by farmers. Insect pests had caused more yield loss than diseases in rice system. The total yield loss due to all major insect pests, after all possible plant protection measures was only 2 per cent (125 kg/ha) and 3 per cent (116/ha) of average yields obtained by farmers in Punjab and western Uttar Pradesh respectively. Stem borer, brown plant hopper, green leaf hopper, and leaf folder were the major yield-reducing insect pests while bacterial leaf blight and blast were major disease-causing yield losses. As intensive RWS is concentrated under assured irrigation sources in Punjab and western Uttar Pradesh, the annual yield losses due to water-related stresses was minimum, i.e., less than 1 per cent of average levels. However, soil-related problems have caused yield loss of about 2 per cent (about 100 to 120 kg/ha) of average rice yields obtained by farmers under intensive RWS. Zinc deficiency, alkalinity, and iron deficiency were major yield limiting soil-related stresses under intensive RWS. Janaiah (2007) estimated the rice yield losses due to biotic and abiotic stresses at about 332 kg/ha in Punjab during 1990-99 (125 kg /ha due to insects/pests, 65 kg/ha due to diseases, 142 kg/ha due to water/soil problems. Around 57 percent losses were due to biotic stresses (insects and diseases) and remaining 43 percent accounts for pressures from resource degradation (soil and water). However, the loss accounts for 8.5 percent of farmers' average yields. Insect pests have caused more yield losses than diseases in rice. Among insects, stem borer, leaf folder and brown plant hopper were the major yield reducing pests while bacterial leaf blight; sheath blight and sheath rot were major diseases causing yield losses in Punjab.

Regarding wastage ratios, the study on foodgrains losses at farm level in Punjab conducted by Gill, et. al. highlighted the wheat losses at various harvest/post-harvest stages in 1980-81. The total wastages as percent of total wheat production have been estimated in the study as 9.06 per cent (2.63 per cent while harvesting, 1.50 per cent during threshing, 4.34 per cent during storage etc. and 0.59 percent while marketing/transportation). An unpublished thesis on foodgrains losses at farm level in Punjab brought out these losses as 1.97 per cent only (0.51 per cent while harvesting, 0.35 per cent in threshing, 0.71 per cent in storage etc. and 0.40 per cent during marketing/transportation) in 1999-2000. During 2004-05 these losses have been estimated

as 2.46 per cent (0.90 per cent while harvesting, 1.40 per cent in threshing, 0.13 per cent in storage etc. and 0.03 per cent while marketing/transportation). Gill and Johl (1966) revealed that in villages, separate godowns were available with only 6 per cent cultivators. Sixty per cent of the producers stored grains in earthen stores locally called bukharies and 30 per cent kept it in the living rooms. The remaining 4 per cent kept in other miscellaneous ways of storage. Storage practices in villages were defective and on this account alone, losses varied from 2-5 per cent. Singh and Khosla (1978) conducted a study on post-harvest foodgrains losses in India and highlighted the magnitude of foodgrains losses at various post-harvest stages. The study brought 1.03 per cent and 1.09 per cent of the value of sales during 1969-73. The total range of loss in rice at different post-harvest stages was estimated between 10 per cent and 37 per cent. Majumdar (1979) estimated losses of foodgrains in India and assessed foodgrains losses during post-harvest operation i.e. threshing, transport, processing and storage. The study highlighted the loss estimates at 12.8 per cent of total foodgrains output per year during 1951-52 to 1976-77. Author also forwarded the policy implications and suggestions to minimize these losses. Gupta and Mohan (1985) estimated the economic return in storage of foodgrains at farm level by covering the states of Maharashtra, Rajasthan and Punjab. For this purpose, three foodgrains viz., jowar in Maharashtra, bajra in Rajasthan and Bengal gram in Punjab were chose. Data were collected on various aspects such as production, retention, type of storage structures, treatment given during storage, period of storage, and loss during storage etc. for net economic return. The range of return in storage of jowar, bajra and Bengal gram was 13.10 to 31.53 per cent, 5.14 to 21.86 per cent and 5.79 to 14.15 per cent respectively. If a shift in storage at farm level started from traditional to modern scientific storage structures then the farmers would be further gainers and lot of grain would be saved from damage or lost during storage. Gill and Singh (1986) reported that wheat and paddy as the increase in market arrivals and stocks procured by the public agencies was enormous, there occurred severe losses in handling, transportation, and storage and distribution process. The total losses for foodgrains including the losses at the threshing floor have been reported at 9.33 per cent. Singh et al (1992) reported that wheat crop suffered 1.49 to 1.55 per cent loss during harvesting with sickle whereas such loss with harvest-combine ranged from 1.57 to 1.60 per cent in Punjab. Threshing loss to wheat was from 1.42 to 1.45 per cent. Losses in the traditional storage structures made of mud etc. were very alarming ranging from 6.79 to 6.84 percent. Loss during marketing of the grains was determined to be 0.80 per cent. Gill (2000) revealed that the

post-harvest losses were 7-10 per cent at the farm to market level and another 4-5 per cent from the market to distribution level. As a whole, the losses equal to 12 million metric tonnes to 16 million metric tonnes of grains per year, including 3-4 million metric tonnes to 16 million metric c tonnes of grains per year, including 3-4 million metric tonnes wheat and 5-7 million metric tonnes of rice. Storage is yet another culprit for losses, theft and damage besides leakages.

2.4 Summary

District wise area, production and yield trends of wheat crop revealed that the area under wheat crop increased in district Hoshiarpur, Gurdaspur, Kapurthala and Sangrur districts from 1970-71 to 2009-10. On the other hand in district Jalandhar, Ludhiana, Ferozepur, Amritsar, Bathinda, Patiala, Rupnagar and Faridkot area under wheat crop increased initially but declined in last two decades. Almost two time increase in productivity under wheat crop was witnessed in all the districts during 1970-71 to 2009-10 and this also resulted in increased production over the last four decades in all the districts. In overall Punjab level, area under wheat crop increased from 22.99 lakh hectare in 1970-71 to 35.22 lakh hectare in 2009-10. Wheat productivity increased from 22.38 quintal per hectare in 1970-71 to 43.07 quintal per hectare in 2009-10 while the production increased from a mere 51.45 lakh metric tonnes in 1970-71 to 151.69 lakh metric tonnes in 2009-10. The growth in area under wheat crop in Jalandhar, Ludhiana, Amritsar, Gurdaspur, Kapurthala, Patiala, Sangrur, Rupnagar and Faridkot districts showed increasing trend in area in seventies and eighties while later on this trend declined. In overall, significantly positive growth in area was seen in Ludhiana, Ferozepur, Gurdaspur, Kapurthala and Sangrur districts while in Jalandhar and Faridkot districts area declined significantly. On the other hand, productivity increased significantly in all the districts during various decades and at overall level except in a few districts where it declined in some decades. This increased productivity resulted in increased production in almost all the districts except in a few ones. At Punjab level, growth in area under wheat crop was more in 1970-71 to 1979-80 period while in later decades growth was positive but less pronounced. Growth in productivity and production was more in 1970-71 to 1979-80 and 1980-81 to 1989-90 decades while in 1990-91 to 1999-2000 periods, growth in productivity and production was positive but less pronounced. There was a sharp jump in the area under rice crop in Jalandhar, Ludhiana, Bathinda and Sangrur districts of the state during the last four decades; however, area also increased in other districts namely Hoshiarpur, Ferozepur, Amritsar, Gurdaspur, Kapurthala, Patiala, Rupnagar and Faridkot but this increase was less prominent. There was almost three times

increase in productivity of rice crop in Patiala, Sangrur and Bathinda districts while in other districts of the state the increase in productivity was nearly twice. At Punjab level, area under rice crop increased from3.90 lakh hectare in 1970-71 to 28.02 lakh hectares in 2009-10 while the corresponding increase in productivity in the same period was 17.65 quintal to 40.10 quintal per hectare and that of production from 6.88 lakh metric tonnes to 112.36 lakh metric tonnes. Growth in area was enormous under rice crop in Jalandhar, Ludhiana, Ferozepur, Amritsar, Gurdaspur, Kapurthala, Bathinda, Patiala and Sangrur districts during 1970-71 to 1979-80. However, during the subsequent decades, the growth in area under rice crop in almost all the districts of the state increased but at a lower rate. The productivity growth was also found to be higher during 1970-71 to 1979-80 decade in district Jalandhar, Ludhiana, Ferozepur, Amritsar, Gurdaspur, Kapurthala, Bathinda, Patiala and Sangrur. The growth in production was more pronounced in 1970-71 to 1979-80 periods as compared to the subsequent decades. In overall Punjab level, there was a significant growth in area, productivity and production under rice crop in the state, however, the quantum of increase was more in 1970-71 to 1979-80 period as compared to subsequent decades later on.

The cost of cultivation data for the year 1981-82 showed that cost C_2 in wheat crop was Rs. 3776.19 per hectare while cost A_2, worked out to be Rs. 2390.94 per hectare which was 63.31 per cent of cost C_2. After one decade in the year 1991-92 the cost C_2 worked out to be Rs. 9274.96 per hectare while cost A_2 came out to be Rs. 5385.31 per hectare which was 58.06 per cent of cost C_2. Similarly, during the year 2001-02, Cost C_2 came out to be Rs.22930.99 per hectare while cost A_2 worked out to be Rs. 12368.22 per hectare which was 44.36 per cent of cost C_2. In the year 2008-09, cost C_2 worked out to be Rs. 35423.48 per hectare while Cost A_1 came out to be Rs. 14387.90 per hectare which was found to be 40.62 per cent of the Cost C_2. Thus, the share of cost A_2 in Cost C_2 had declined rapidly during the last three decades. The gross returns per hectare from wheat crop increased from Rs. 4682.78 in 1981-82 to Rs. 12446.17 in 1991.92, Rs. 31171.94 in 2001-02 and Rs. 48127.21 per hectare in 2008-09. Net returns per hectare at current prices increased from Rs.906.59 in 1981-82 to Rs. 3171.21 in 1991-92, Rs. 8240.95 in 2001-02 and Rs. 12703.73 per hectare in 2008-09. On the other hand, the net returns at constant prices increased from Rs. 906.59 per hectare in 1981-82 to Rs. 1559.82 in 1991-92, Rs. 2140.71 in 2001-02 and Rs. 2281.24 per hectare in 2008-09. Thus, there was 2.52 times increase in the profitability from wheat crop in the Punjab state from 1981-82 to 2008-09 at constant prices. The cost of cultivation of paddy revealed

that during the year 1981-82, cost C_2 worked out to be Rs. 5473.89 per hectare while cost A_2 came out to be Rs. 3477.17 which was 63.52 per cent of the cost C_2. During the year 1991-92, the cost C_2 was found to be Rs. 10390.80 per hectare while cost A_2 worked out to be Rs. 6067.75 which was 58.39 per cent of the Cost C_2. Similarly, during the years 2001-02 and 2008-09, the cost C_2 was calculated at Rs. 22305.79 and Rs. 45291.24 per hectare respectively while the corresponding figures of cost A_2 for the same years worked out to be Rs. 11904.39 and Rs. 22510.13. The percent share of cost A_2 in cost C_2 was found to be 53.37 per cent during the year 2001-02 while this share further declined to 49.70 per cent during the year 2008-09. The gross returns per hectare from paddy increased from Rs. 6605.49 per hectare in 1981-82 to Rs. 12922.08 in 1991-92, Rs. 30124.23 in 2001-02 and Rs. 66991.10 per hectare in 2008-09. Net returns per hectare from paddy cultivation at current prices increased from Rs.1131.60 in 1981-82 to Rs. 2531.28 in 1991-92, Rs. 7818.44 in 2001-02 and Rs. 21699.86 per hectare in 2008-09. On the contrary, the net returns at constant prices increased from Rs. 1131.60 per hectare in 1981-82 to Rs. 1245.06 in 1991-92, Rs. 2030.96 in 2001-02 and Rs. 3896.69 per hectare in 2008-09. Thus, there was 3.44 times increase in the profitability from paddy crop in the Punjab state from 1981-82 to 2008-09 at constant prices.

Roy and Dutta (1999) in their study on rice-wheat crop sequence revealed the emergence of a major production system in the irrigated areas of Haryana over the last two decades prior to the study period. Concerns were being raised about the sustainability of existing high levels of rice-wheat productivity. The study was undertaken in Karnal and Kaithal districts of Haryana during 1999 to identify and prioritise production constraints that cause losses in the rice-wheat system. The study highlighted the existence of a large yield gaps in rice and wheat crops. The yield losses due to major biotic stresses were found to be 1133.13 kilograms per hectare in Paddy and 783.45 kilograms per hectare in wheat crops. In case of wheat crop, the major loss was due to weeds (258.25 kg/ha) followed by diseases (214.65 kg/ha) and insect pests (187.55 qtls/ha). On the contrary, in case of paddy crop, more than 50 per cent of the total loss due to biotic stresses was found to be due to diseases (682 kg/ ha) followed by insect pests (265.50 kg/ ha) and weeds (185.63 kg/ ha). Janaiah and Hossain (2000) conducted a study on the farm level sustainability of intensive rice-wheat system. Survey data were collected during 1999-2000 for a collaborative study of the Directorate of Rice Research (DRR) of the Indian Council of Agricultural Research (ICAR) and the International Rice Research Institute (IRRI), Philippines. Ten high productive rice-growing villages in each state of Andhra Pradesh, Karnataka, Punjab and Uttar Pradesh were

selected. Ten progressive farmers were randomly selected from each village. The selected farmers had more than 10 years experience in rice cultivation. Based on farmers' perceptions over the past 10 years (1990-99), the annual yield loss was estimated at 536 kg/ha in rice crop under intensive rice systems in India. This was equivalent to the total annual loss of about 5 million tons of paddy under the intensive rice system of which nearly 60 per cent was due to biotic stresses (insect pests and diseases). The remaining 40 per cent was due to resource (soil and water) degradation. The total yield loss accounted for only 8.5 per cent of average yields obtained by farmers. Insect pests had caused more yield loss than diseases in rice system. The total yield loss due to all major insect pests, after all possible plant protection measures was only 2 per cent (125 kg/ha) and 3 per cent (116/ha) of average yields obtained by farmers in Punjab and western Uttar Pradesh respectively. Janaiah (2007) estimated the rice yield losses due to biotic and abiotic stresses at about 332 kg/ha in Punjab during 1990-99 (125 kg /ha due to insects/pests, 65 kg/ha due to diseases, 142 kg/ha due to water/soil problems. Around 57 percent losses were due to biotic stresses (insects and diseases) and remaining 43 percent accounts for pressures from resource degradation (soil and water). However, the loss accounts for 8.5 percent of farmers' average yields. Insect pests have caused more yield losses than diseases in rice. Among insects, stem borer, leaf folder and brown plant hopper were the major yield reducing pests while bacterial leaf blight; sheath blight and sheath rot were major diseases causing yield losses in Punjab.

Chapter 3

Household Characteristics, Cropping Pattern and Production Structure

Since, the household characteristics play a vital role in adopting the latest farm technology, it becomes necessary to investigate the socio-economic characteristics of the farmers to know about their economic and social background. This portion of the study deals with the socio-economic characteristics of the selected farmers, their operational holding, tenancy structure, irrigation source, cropping pattern, crop productivity and marketed surplus realized on the sample farms.

3.1. Socio-economic characteristics of the selected farmers

The socio-economic characteristics of the sample farmers have been presented in Table 3.1. The perusal of the table reveals that there were 22 marginal, 24 each small and medium and 50 large farmers, making a total sample of 120 households growing both wheat and paddy crops. The average numbers of earners were two in all the farm size categories except in large category where there were three earners on an average. The household size varied from 5 to 8 members with lowest on marginal and highest on large farm category. The proportion of male family members varied between 42 to 47 per cent with least on the large farms while the percentage of female family members varied between 34 to 37 per cent with highest on the large farms. Similarly, the percentage of children varied between 17 to 21 per cent with highest on the large farm size category. The households interviewed were mostly head of the family as revealed by 80 to 83 per cent of the respondents. The average age of 71 to 79 per cent respondents was above 40 years while the age of 12 to 26 per cent respondents varied between 25 to 40 years on various farm categories. There were very few (2-17%) respondents having age less than 25 years on all the farm size categories. The education of the family members gives impetus to the adoption of new farm initiatives. Hence, it was necessary to enquire about the highest education of the family members. Majority (32 -58%) of the family members were educated up to secondary level with least on marginal farm category while 4 to 59 per cent of the members were educated up to primary level with maximum on the marginal farms. There were 20 to 21 per cent family members having education up to higher secondary level except on the marginal farms where no one was educated up to this level. There were 24 per cent family members on large farms and 17 per cent on medium

farms having education up to graduation level. However, there were very few households with illiterate family members. Majority (97%) of the respondents were from general castes with just three per cent from other backward classes. The distance of main market from the sample farms on all farm size categories varied from 3.70 to 5 kilometers. The annual family income worked out to be Rs 1.65 lakh on marginal, Rs 2.68 lakh on small, Rs 5.16 lakh on medium and Rs12.59 lakh on large farm categories with an overall average income of Rs 7.12 lakh per annum.

Table 3.1: Demographic profile of the selected wheat and paddy growing farmers (% of households)

Characteristics		Marginal	Small	Medium	Large	Overall
No of HH		22	24	24	50	120
Household size (numbers)		5	6	6	8	7
Average numbers of earners		2	2	2	3	2
Proportion of Male/Female/ Children (%)	Male >15	44	47	47	42	44
	Female >15	36	34	36	37	36
	Children <15	20	19	17	21	20
Identity of respondent (%)	Head	80	75	83	80	80
	Others	20	25	17	20	20
Average age of the respondent (% households)	Less than 25	4	17	8	2	7
	Between 25 to 40	23	12	13	26	20
	Above 40	73	71	79	72	73
Highest Education status of a family member (% households)	Illiterate	9	4	-	4	4
	Up to primary	59	25	4	10	21
	Up to secondary	32	46	58	42	44
	Higher secondary	-	21	21	20	17
	Graduate and above	-	4	17	24	4
Caste (% households)	SC	-	-	-	-	-
	ST	-	-	-	-	-
	OBC	4	8	4	-	3
	General	96	92	96	100.0	97
Distance from the main market (km)		3.70	3.90	5.0	4.0	4.10
Annual family income (Rs)		165878	268589	516075	1259560	712161

3.2. Characteristics of operational holdings

The characteristics of operational holding have been shown in Table 3.2. It has been highlighted that the marginal farms were having maximum share of owned land (2.25 acres) as

compared to leased-in and leased-out land thereby making net operated area (NOA) of 2.16 acres. On the other hand, on small farms owned land was 4.61 acres with more leased-out (1.15 acres) than leased-in (0.48 acres) land there by making net operated area (NOA) of 3.94 acres. On medium farms, 5.83 acres area was owned with more leased-in (2.52 acres) than leased-out (0.31 acres) land and hence net operated area (NOA) came out to be 8.04 acres. On large farm category, the owned land constituted 13.25 acres along with 7.79 acres leased-in land and 0.36 acres leased-out land there by making net operated area (NOA) of 20.68 acres. In an overall situation, owned land worked out to be 8.02 acres with 3.87 acres leased-in and 0.48 acres being leased-out land making net operated area (NOA) of 11.41 acres on the sample farms.

Table 3.2: Characteristics of operational holdings (acres per household)

Farm size	Owned land	Un cultivated land	Leased-in	Leased-out	NOA	Irrigated area	GCA	Cropping intensity (%)
Marginal	2.25	-	0.14	0.23	2.16	2.16	4.32	200.0
Small	4.61	-	0.48	1.15	3.94	3.94	7.90	200.50
Medium	5.83	-	2.52	0.31	8.04	8.04	16.00	199.00
Large	13.25	-	7.79	0.36	20.68	20.68	41.34	199.90
Overall	8.02	-	3.87	0.48	11.41	11.41	22.80	199.82

There was no uncultivated area on any of the farm size categories. The gross cropped area worked out to be 4.32 acres on marginal, 7.90 acres on small, 16.00 acres on medium and 41.34 acres on large farm categories. The entire area on all the farm size categories was irrigated and the cropping intensity came out to be nearly 200 per cent.

3.3 Structure of tenancy

The nature of tenancy in leasing-in and leasing-out land has been given in Table 3.3. On the selected farms, there was no agreement for crop sharing and crop and cost sharing as reported by the sample respondents from all the farm size categories. The sample farmers on all the categories opted for fixed rent in cash for leased-in or leased-out land. The per cent share of leased-in land in net operated area (NOA) was 6.50 per cent on marginal, 12.20 per cent on small, 31.30 per cent on medium, 37.70 per cent on large farms and 33.90 per cent in an overall situation. Thus, with increase in farm size, area under leased-in land increased. Similarly, the per cent share of leased-out land in net operated area (NOA) was 10.60 per cent on marginal, 29.20 per cent on small, 3.90 per cent on medium, 1.70 per cent on large farms and 4.20 per cent in an overall

situation. Therefore, per cent share of leased-out land declined with increase in farm size except in case of small farm. The rental value of leased-in land varied from Rs.30667 to 33331 per acre on all the farm categories while rent for leased out land fluctuated between Rs.31691 to 34000 per acre on various farm categories.

Table 3.3: Nature of tenancy in leasing-in/leasing-out land (% households)

Farm size	Crop sharing	Crop and cost sharing	Fixed rent in cash	Others	Total	% share of tenancy in NOA	Rent amount Rs./ acre
(Leasing-in)							
Marginal	-	-	100.0	-	100.0	6.50	30667
Small	-	-	100.0	-	100.0	12.20	32130
Medium	-	-	100.0	-	100.0	31.30	33331
Large	-	-	100.0	-	100.0	37.70	31293
Total	-	-	100.0	-	100.0	33.90	31575
(Leasing-out)							
Marginal	-	-	100.0	-	100.0	10.60	32000
Small	-	-	100.0	-	100.0	29.20	31691
Medium	-	-	100.0	-	100.0	3.90	32000
Large	-	-	100.0	-	100.0	1.70	34000
Total	-	-	100.0	-	100.0	4.20	32474

3.4 Sources of irrigation

The major factor for productivity enhancement in almost all the crops is timely and adequate application of irrigation water along with other requisite inputs. In both the selected districts for the present study, there was adequate availability of irrigation water.

Table 3.4: Source of irrigation of net irrigated area (%)

Farm size	Only canal	Canal + tube-well	Only electric tube-well	Only diesel tube-well	Tanks	Open well	Others
Marginal	-	100.00	65.00	2.00	-	-	-
Small	-	100.00	68.00	1.50	-	-	-
Medium	-	100.00	68.00	-	-	-	-
Large	-	100.00	70.00	-	-	-	-
Total	-	100.00	67.75	0.87	-	-	-

The various sources of irrigation on the sample farms have been depicted in Table 3.4. Data reveals that on marginal farms, the entire net operated area was either canal or tube-well irrigated, however, out of tube-well irrigation 65 per cent area was exclusively electric tube-well irrigated

while just 2 per cent of the area was being irrigated by diesel operated tube-well. On small farms also the similar situation was there where either the net operated area was irrigated by canal water or by the tube-wells. About 68 per cent of the area was irrigated exclusively through electric tube-wells and 1.5 per cent by the diesel operated tube-wells. On medium category farms, the major source of irrigation was also canal water and tube-wells. The entire operated area was irrigated either by the canal water or by the tube-well irrigation; however, 68 per cent of the net operated area on the sample farms was exclusively irrigated by underground water using electric tube-wells. On large category farms also, similar situation was seen where the net operated area was also either irrigated through canal water or through electric tube-well irrigation. But, the net operated area irrigated exclusively through electric tube-well was 70 per cent of the net operated area. In total also, the entire net operated area on the sample farms was irrigated either through canal water or by the tube-wells. However, 67.75 per cent of the area was irrigated exclusively by the electric tube-well and just 0.87 per cent was being irrigated using diesel tube-well. Thus, there were no tanks and open wells for irrigation on the sample farms. Thus, the major source of irrigation was under ground water using tube-wells as well as surface irrigation utilizing canal water.

3.5 Cropping pattern

It is well known that the cropping pattern on a farm gives an idea about the area covered under various crops in different seasons during the year. The cropping pattern followed on the sample farms have been depicted in Table 3.5. The perusal of table reveals that on marginal farms, paddy and wheat were the major crops comprising 35.28 and 44.11 per cent of the gross cropped area followed by kharif fodder (8.15%), rabi fodder (5.36%), basmati (4.57%), Bt cotton (1.79%) and maize (0.21%). On small farms also, paddy and wheat comprised 32.93 and 44.38 per cent of the gross cropped area followed by basmati (8.58%), kharif fodder (7.70%), rabi fodder (5.62%), Bt cotton (0.53%) and maize (0.26%). As far as medium farms are concerned, paddy and wheat shared 39.44 and 46.35 per cent of the gross cropped area on the sample farms followed by kharif fodder (4.57%), basmati (4.30%), rabi fodder (3.32%), maize (1.04%), Bt cotton (0.39%) and vegetables (0.59%). Similarly, on large farms, paddy and wheat shared 40.22 and 47.35 per cent of the gross cropped area followed by basmati (6.22%), kharif fodder (2.98%), rabi fodder (2.20%), sugarcane (0.28%), Bt cotton (0.27%), potato (0.19%) barley (0.15%), winter maize (0.05%), vegetables (0.03%) and summer moong (0.02%). Hence paddy and wheat were major crops on all the farm size categories sharing about 86 per cent of the gross cropped area on the sample farms.

Table 3.5: Cropping pattern of selected farmers (% of GCA for the whole year)

Name of the crop	Marginal	Small	Medium	Large	Overall
Kharif crops					
Paddy	35.28	32.93	39.44	40.22	39.43
Basmati	4.57	8.58	4.30	6.22	6.06
Maize	0.21	0.26	1.04	0.05	0.21
Bt cotton	1.79	0.53	0.39	0.27	0.35
Fodder	8.15	7.70	4.57	2.98	3.71
Rabi crops					
Wheat	44.11	44.38	46.35	47.35	46.90
Winter maize	0.53	-	-	0.05	0.05
Fodder	5.36	5.62	3.32	2.20	2.70
Barley	-	-	-	0.15	0.11
Potato	-	-	-	0.19	0.15
Vegetables	-	-	0.33	0.03	0.07
Summer crops					
Summer Moong	-	-	-	0.02	0.01
Vegetables	-	-	0.26	-	0.04
Perennial crops					
Sugarcane	-	-	-	0.28	0.21
Gross cropped area	100.0	100.0	100.0	100.0	100.0

3.6 Percentage of area under HYV

The introduction of high yielding varieties (HYV's) along with requisite technological factors resulted in ushering green revolution in the country. Punjab being pioneer in the adoption of new farm technology paved the way for foodgrains self sufficiency in the country. The information regarding percentage of area under high yielding seeds have been depicted in Table 3.6. The perusal of table reveals that on all farm size categories entire area was under high yielding varieties under various rabi, kharif, summer and perennial crops as reported by the sample farmers.

Table 3.6: Percentage of area under HYV seeds

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Paddy	100.0	100.0	100.0	100.0	100.0
Basmati	100.0	100.0	100.0	100.0	100.0
Maize	100.0	100.0	100.0	100.0	100.0
Bt cotton	100.0	100.0	100.0	100.0	100.0
Fodder	100.0	100.0	100.0	100.0	100.0
Rabi crops					
Wheat	100.0	100.0	100.0	100.0	100.0
Winter maize	100.0	-	-	100.0	100.0
Fodder	100.0	100.0	100.0	100.0	100.0
Barley	-	-	-	100.0	100.0
Potato	-	-	-	100.0	100.0
Vegetables	-	-	100.0	100.0	100.0
Summer crops					
Moong	-	-	-	100.0	100.0
Vegetables	-	-	100.0	-	100.0
Perennial crops					
Sugarcane	-	-	-	100.0	100.0

3.7 Crop productivity, marketed surplus and value of output by farm size

The productivity of various crops sown on the sample farms have been depicted in Table 3.7. In case of paddy crop, average yield varied from 26.30 to 27.90 quintals per acre with highest on the large farms and 27.60 quintals in an overall situation. In basmati crop, the average productivity per acre was found to be highest (17.20 qtls) on the marginal farms and lowest (15.70 qtls) on small farms with 16.70 quintal per acre in an overall situation. Productivity per acre in maize was found to be highest on medium farms (25.00 qtls), lowest on marginal farms (17.50 qtls) and 18.90 quintals per acre in an overall situation. In Bt cotton, maximum yield of 9.00 quintals per acre was observed on medium farms while minimum (4.00 qtls) yield was reported on small farm category with 6.70 quintals in an overall situation. In case of wheat crop, the yield varied between 18.40 to 19.20 quintals per acre with highest on large farms while in an overall situation 19.10 quintals per acre yield was reported. In case of winter maize, the yield reported on marginal farms was 28.00 quintals while on large farms yield obtained was 25.00 quintals per acre. In case of sugarcane crop, the yield observed on large farms was 238.30 quintals per acre.

Table 3.7: Average yield of major crops grown by the selected households (quintal per acre)

Name of the crop	Marginal	Small	Medium	Large	Overall
Kharif crops					
Paddy	26.30	26.50	27.20	27.90	27.60
Basmati	17.20	15.70	17.10	16.80	16.70
Maize	17.50	18.0	25.00	20.0	18.90
Bt cotton	6.60	4.00	9.00	6.60	6.70
Rabi crops					
Wheat	18.40	18.70	18.81	19.20	19.10
Winter maize	28.00	-	-	25.00	27.30
Perennial crops					
Sugarcane	-		-	238.30	238.30

The percentages of output marketed by the selected households have been depicted in table 3.8. In case of paddy crop, 99.60 per cent of the output was marketed by the respondent households in different farm size categories with highest (99.70%) on large and least (99.20%) on marginal farm size category. The percentage of output marketed in basmati crop varied between 88.70 to 97.60 per cent with minimum on marginal farms and maximum on small farms while in an overall situation, 96.20 per cent basmati crop was marketed by the selected respondents.

Table 3.8: Percentage of output marketed by the selected households

Name of the crop	Marginal	Small	Medium	Large	Overall
Kharif crops					
Paddy	99.20	99.30	99.30	99.70	99.60
Basmati rice	88.70	97.60	97.30	96.10	96.20
Maize	85.70	88.90	97.30	95.50	95.80
Bt.cotton	99.70	99.20	99.20	99.50	99.40
Rabi crops					
Wheat	70.20	79.20	85.10	92.70	89.81
Winter maize	92.90	-	-	92.00	92.70
Barley	-	-	-	99.00	99.00
Potato	-	-	-	99.50	99.50
Vegetables					
Moong	-	-	-	90.00	90.00
Vegetables	-	-	99.50	-	99.50
Perennial crops					
Sugarcane	-	-	-	99.75	99.75

In case of maize crop, the output marketed varied between 85.70 per cent on marginal and 97.30 per cent on medium farm size category while 95.80 per cent maize produced was marketed in an

overall situation. The percentage of output marketed in Bt cotton was 99.40 per cent with minimum (99.20%) on small and medium farms and maximum (99.70%) on marginal farms. In case of wheat crop, 89.81 per cent of the output was marketed on the sample farms with a maximum of 92.70 per cent on large and minimum of 70.20 per cent on marginal farm size category. The percentage of output marketed in winter maize was 92.70 per cent. In case of barley, potato, vegetables and sugarcane nearly 99 per cent of the output was marketed on the sample farms. On the other hand, 90 per cent of the moong crop produced was marketed by the sample households.

The value of output and marketed surplus on the sample farms have been depicted in table 3.9. The value of output and marketed surplus per household on marginal farms worked out to be 1.05 and 0.89 lakh, respectively with 84.60 per cent being the output marketed. On small farms, the value of output and marketed surplus was found to be 1.99 and 1.70 lakh, respectively with 85.40 per cent being the per cent of output marketed. The value of output and marketed surplus on medium farms came out to be 4.26 lakh and 3.77 with 88.70 per cent being the per cent of output marketed. On large farms, the value of output and marketed surplus worked out to be 11.31 and 10.31 lakh respectively while the per cent of output marketed was 91.20 per cent. Thus, with increase in farm size, the per cent of output marketed increased. Also, the value of marketed surplus on marginal farms worked out to be Rs. 41358 per acre being least and Rs. 49876 per acre on large farms being highest due to larger percentage of output marketed on the large farms.

Table 3.9: Value of output and marketed surplus (aggregate of all crops)

Farm size	Value of output (main + byproduct)		Value of marketed surplus		% of output marketed
	Rs Per household	Rs Per acre	Rs Per household	Rs Per acre	
Marginal	105700	48904	89390	41358	84.60
Small	199597	50557	170504	43188	85.40
Medium	426058	53818	377798	47722	88.70
Large	1131105	54696	1031429	49876	91.20
Total	616408	54138	555836	48818	90.20

3.8 Summary

The farm size wise analysis showed that there were 22 marginal, 24 each small and medium, 50 large farmers thereby making a total sample of 120 households. The average numbers of earners were two in all the farm size categories except in large category where there were three

earners. The household size varied from 5 to 8 members with lowest on marginal and highest on large farm category. The proportion of male family members varied between 42 to 47 per cent while the percentage of female family members varied between 34 to 37 per cent. The households interviewed were mostly head of the family and the average age of 71 to 79 per cent respondents was above 40 years while the age of 12 to 26 per cent respondents varied between 25 to 40 years. Majority (32 -58%) of the family members were educated up to secondary level while 4 to 59 per cent of the members were educated up to primary level. There were 20 to 21 per cent family members having education up to higher secondary level. There were 24 per cent family members on large farms and 17 per cent on medium farms having education up to graduation level. Majority (97%) of the respondents were from general castes with just three per cent from other backward classes. The distance of main market from the sample farms on all farm size categories varied from 3.70 to 5 kilometers. The annual family income varied from 1.65 lakh to 12.60 lakh being lowest on marginal and highest on large farm category. The share of owned land was more on all the farm size categories as compared to leased in or leased out land. The net operated area was 2.16 acres on marginal, 3.94 acres on small, 8.04 acres on medium, 20.68 acres on large and 11.41 acres in an overall situation. There was no uncultivated area on any of the farm size categories. The entire area on all the farm size categories was irrigated and the cropping intensity came out to be nearly 200 per cent. There was no agreement for crop sharing and crop and cost sharing and the sample households on all the farm categories opted for fixed rent in cash for leased-in or leased-out land. The per cent share of leased-in land increased with increase in farm size while per cent share of leased out land declined with increase in farm size except on small farms. The rental value of leased-in land varied from Rs.30667 to 33331 per acre on all the farm categories while rent for leased out land fluctuated between Rs.31691 to 34000 per acre. The major source of irrigation was electric tube well as reported by 42 per cent of the households with larger area under irrigation on marginal farms. Also, there were 42 per cent respondents enjoying the facility of both electric motor and diesel engine with larger share on large farms. Canal irrigation along with tube well irrigation was availed by 10 per cent of the sample households. The cropping pattern on the sample farms revealed that Paddy was the major kharif crop sown on various farm categories occupying nearly 40 per cent of the gross cropped area followed by basmati (6.06%) and fodder crops (3.71%). Other kharif crops sown by sample households were maize and Bt cotton with negligible area under them. Wheat was major rabi crop which occupied 46.90 per cent of the gross cropped

area on sample farms followed by rabi fodder occupying 2.70 per cent. However, area under other rabi crops such as winter maize, barley, potato and other vegetables was even less than 1 per cent of the gross cropped area. Area under summer moong and sugarcane was also found to be negligible. The entire area sown under various kharif, rabi, summer and perennial crops was under HYV seeds as revealed by all the sample households.

In case of paddy crop, average yield varied from 26.30 to 27.90 quintals per acre with highest on the large farms while in basmati crop, the average productivity per acre was found to be highest (17.20 qtls) on the marginal farms and lowest (15.70 qtls) on small farms with 16.70 quintal per acre in an overall situation. Productivity per acre in maize was found to be highest on medium farms (25.00 qtls), lowest on marginal farms (17.50 qtls) while in case of Bt cotton, maximum yield of 9.00 quintals per acre was observed on medium farms while minimum (4.00 qtls) yield was recorded on small farm category. In case of wheat crop, the yield varied between 18.40 to 19.20 quintals per acre with highest on large farms while in an overall situation 19.10 quintal per acre yield was reported. In case of winter maize, the yield reported on marginal farms was 28.00 quintals while on large farms yield obtained was 25.00 quintals per acre. In case of sugarcane crop, the yield observed on large farms was 238.30 quintals per acre. In case of kharif crops, the percentage of output marketed was more than 99 per cent in case of paddy and cotton crops on all farm categories while it was nearly 96 per cent in case of basmati rice and maize. In rabi crops, percentage of output marketed in wheat crop was nearly 93 per cent on large farms while it was 70.20 per cent on marginal, 79.20 per cent on small and 85.10 per cent on medium farm size categories. Almost whole produce was marketed in case of barley, potato, vegetables and sugarcane crops while in case of summer moong and winter maize about 90 per cent produce was sold by the sample households. The value of output varied from Rs. 1.05 to 11.31 lakh with lowest on marginal and highest on large farms while in an overall situation 6.16 lakh was the value of output per farm household. Similarly, the value of output per acre was Rs. 54696 on large farms while on marginal farms it was lowest at Rs. 48904 per acre. The per cent of output marketed was nearly 91 per cent on large farms and 84.60 per cent on marginal farms which was found to be lowest due to lower level of marketed surplus available on marginal farm category.

Chapter 4

Assessment of Pre Harvest Losses of Wheat and Paddy Crops

The pre harvest losses in crops occur due to various biotic and abiotic stresses encountered in their period of growth. The severe incidence of insects, pests and diseases inhibits the crop growth which results in decline in crop productivity. Timely control measures are necessary to keep the crop losses under check. This chapter deals with various constraints faced in the production of wheat and paddy crops, assessment of incidence of pest and disease attack and crop losses, methods adopted and source of information to control pest and disease attack and household suggestions to minimize pre harvest losses.

4.1 Constraints faced in cultivation of wheat and paddy crops

The constraints faced in cultivation of wheat and paddy crops have been depicted in Table 4.1 revealing the severity of various constraints faced by selected respondents in cultivation of wheat and paddy crops. In case of wheat crop, high cost of inputs was reported as most important constraint by 76 per cent of the households while 21 per cent informed low output price as the most important constraint. Only 3 per cent households reported pest and disease problem, 2 per cent poor seed quality as most important constraints in wheat crop. On the contrary, 43 per cent households reported pest and disease problem as important constraint followed by 34 per cent informing low output price and 22 per cent revealed high cost of inputs as important constraint. On the other hand, all the households reported water deficiency , 98 per cent poor seed quality, 54 per cent pest and disease problem, 45 per cent low output price and 2 per cent high cost of inputs as least important constraint in wheat cultivation. Important constraints in wheat cultivation as reported by the sample respondents were; low quality and poor germination of seed, no permanent control of pest and diseases with occurrence in every season, high cost of inputs such as fertilizers, weedicides, pesticides, labour and decline in profitability due to low output price.

In paddy crop, high cost of inputs was reported as most important constraint by 73 per cent of the households followed by 23 per cent revealing low output price, 14 per cent water deficiency and 7 per cent pest and disease problem as most important constraint. Water deficiency was informed as important constraint by 49 per cent households followed by 33 per cent reporting pest and disease problem, 32 per cent low output price and 14 per cent high cost of inputs as important constraint. On the other hand, all the households revealed poor seed quality as least important

constraint followed by 60 per cent reporting pest and disease problem, 45 per cent low output price, 37 per cent water deficiency and 13 per cent high cost of inputs as least important constraints in paddy cultivation. Important constraints in paddy cultivation as reported by the sample respondents were; high cost on irrigation, erratic power supply, no permanent control of pest and diseases with occurrence in every season, high cost of inputs such as fertilizers, weedicides, pesticides, labour and decline in profitability due to low output price.

Table 4.1: Constraints faced in cultivation of wheat and paddy crops (percentage of households)

S. N.	Constraints	Most important	Important	Least important	Constraint faced*.	Most important	Important	Least important	Constraint faced.**
		Wheat				Paddy			
1	Poor seed quality	2.00	-	98.00	a)Low quality seed b)Poor germination	-	-	98.00	-
2	Water deficiency	-	-	100.0	Nil	14.00	49.00	37.00	a)High cost on irrigation b) Erratic power supply
3	Pest and disease problems	3.00	43.00	54.00	a). No permanent control b)Occurrence every season	7.00	33.00	60.00	a). No permanent control b) occurrence every season
4	High cost of inputs	76.00	22.00	2.00	a) High cost of inputs such as fertilizers, weedicide, pesticides etc. b) High cost of labour	73.00	14.00	13.00	a) High cost of inputs such as fertilizers, weedicides, pesticides etc. b) High cost of labour
5	Low output price	21.00	34.00	45.00	a) Decline in profitability	23.00	32.00	45.00	a) Decline in profitability

4.2 Assessment of incidences of pests and disease attacks and crop losses

The identification of pest and disease attack has been depicted in Table 4.2. The results shown in the table reveal that all the households were able to distinguish between pest and disease attack. Assessment about the severity of the attack showed that 89 per cent of the respondents in wheat and 88 per cent in paddy reported about the qualitative assessment followed by 3 per cent in

wheat and 2 per cent in paddy reported about the quantitative assessment of the severity of the attack. There were 8 per cent households in wheat and 10 per cent in paddy reporting about both qualitative and quantitative assessment followed to assess the severity of the attack. Thus, majority of the households used qualitative assessment as the major criteria for assessment of severity of the attack.

Table 4.2: Identification of pests and disease attack (percentage of households)

Description		**Wheat**	**Paddy**
HH able to distinguish pests and disease attack		100.00	100.00
Assessment about the severity of the attack	Quantitative assessment	3.00	2.00
	Qualitative assessment	89.00	88.00
	Both	8.00	10.00

The incidences of major pests and diseases in wheat crop have been shown in Table 4.3. Major pest in case of wheat crop was aphids with 97 per cent respondents reporting its severity of attack as not important with frequency of attack in every season and production loss less than 5 per cent. There were 3 per cent respondents reporting severity of aphids attack as important with production loss between 5 to 10 per cent. Major diseases affecting wheat crop were yellow or stripe rust and loose smut. The severity of yellow rust attack on wheat crop as reported by all the sample households was not important with 83 per cent revealing its frequency of attack once in three seasons, 17 per cent once in two seasons with production loss less than 5 per cent. The severity of loose smut attack on wheat crop was reported by all the respondent farmers with 32 per cent reporting its attack in every season, 40 per cent once in two seasons and 28 per cent once in three seasons with production loss less than 5 per cent. Major weeds affecting wheat productivity were broad leaf weeds and *phalaris minor*. The severity of broad leaf weeds was reported as not important by 98 per cent respondents and 2 per cent informed it as important with occurrence in every season reported by all the respondents. The production loss due to broad leaf weeds was informed by 98 per cent households as less than 5 per cent while 2 per cent revealed production loss between 5 to 10 per cent. The severity of *phlaris minor* as revealed by 82 per cent of the households was not important while 15 per cent reported its severity as important and 3 per cent as very important. The frequency of *phalaris minor* attack was reported by all the households every year with production loss less than 5 per cent revealed by 82 per cent, 5 to 10 per cent by 15 per cent and 10 to 25 per cent by 3 per cent

of the sampled households. Hence the individual production loss due to incidence of major pests, diseases and weeds was found to be less than 5 per cent as informed by majority of the respondents.

Table 4.3: Incidence of major pests and disease (percentage of households) – wheat

Name of the pest/disease/weed	Rank of severity*			Frequency of attack**			Production loss***				
	1	2	3	1	2	3	1	2	3	4	5
Major Pests											
Aphids	-	3.0	97.0	100.0	-	-	97.0	3.0	-	-	-
Major Diseases											
Yellow or stripe rust	-	-	100.0	-	17.0	83.0	100.0	-	-	-	-
Loose smut	-	-	100.0	32.0	40.0	28.0	100.0	-	-	-	-
Major Weeds											
Broad leaf weeds	-	2.0	98.0	100.0	-	-	98.0	2.0	-	-	-
Phalaris minor	3.0	15.0	82.0	100.0	-	-	82.0	15.0	3.0	-	-

Note: * very important=1; important=2; not important=3
**** Every season=1; once in two seasons=2; once in three seasons=3**
***** <5%=1; 5-10%=2; 10-25%=3; 25-50%=4; >50%=5**

The incidences of major pests and diseases in paddy crop have been shown in Table 4.4. Major pests of paddy crop as reported by the sample households were; rice stem borer, leaf folder and plant hoppers. The rank of severity of rice stem borer was reported by 96 per cent households as not important while 4 per cent reported it as important. The frequency of attack of stem borer was reported in every season by 98 per cent households while only 2 per cent informed the attack once in two seasons while production loss less than 5 per cent was reported by 96 per cent of the households and 4 per cent households informed about the production loss between 5 to 10 per cent. The severity of leaf folder attack on paddy crop was reported by all the households as not important with 92 per cent informing its attack in every season while only 8 per cent reported its attack once in two seasons. The production loss due to leaf folder attack was less than 5 per cent as revealed by all the sample households. The rank of severity of plant hoppers on paddy crop was reported as not important by 97 per cent of the households while 3 per cent informed its attack as important. The frequency of plant hoppers attack was informed in every season by 95 per cent of the households and 5 per cent reported its occurrence once in two seasons while production loss of less than 5 per cent was informed by 97 per cent of the respondents and between 5 to 10 per cent was revealed by 3 per cent of the respondents. Major diseases affecting paddy crop were; bacterial leaf blight, sheath blight and false smut. The

severity of bacterial leaf blight was reported as not important by all the respondents while only 6 per cent revealed its occurrence in every season, 35 per cent once in two seasons and 59 per cent once in three seasons. However, the production loss due to attack of bacterial leaf blight was reported less than 5 per cent by all the sample households. The severity of sheath blight attack was reported as not important by 98 per cent of the households while 2 per cent informed this attack as important.

Table 4.4: Incidence of major pests and disease (percentage of households) – Paddy

Name of the pest/disease/weed	Rank of severity*			Frequency of attack**			Production loss***				
	1	2	3	1	2	3	1	2	3	4	5
Major Pests											
Rice stem borer	-	4.0	96.0	98.0	2.0	-	96.0	4.0	-	-	-
Leaf folder	-	-	100.0	92.0	8.0	-	100.0	-	-	-	
Plant hoppers	-	3.0	97.0	95.0	5.0	-	97.0	3.0	-	-	-
Major Diseases											
Bacterial leaf blight	-	-	100.0	6.0	35.0	59.0	100.0	-	-	-	-
Sheath blight	-	2.0	98.0	58.0	34.0	8.0	98.0	2.0	-	-	-
False smut	-	-	100.0	6.0	47.0	47.0	100.0	-	-	-	-
Major Weeds											
Swank (*Echinochloa crusgalli*	-	-	100.0	100.0	-	-	100.0	-	-	-	-

Note: * very important=1; important=2; not important=3
**** Every season=1; once in two seasons=2; once in three seasons=3**
***** <5%=1; 5-10%=2; 10-25%=3; 25-50%=4; >50%=5**

The frequency of attack as reported by 58 per cent of the households was in every season while 34 per cent informed the attack as once in two seasons and 8 per cent once in three seasons. The production loss due to sheath blight was reported less than 5 per cent by 98 per cent of the respondents while only 2 per cent reported this loss between 5 to 10 per cent. The severity of false smut was informed as not important by all the households with frequency of attack in every season by 6 per cent, once in two seasons by 47 per cent and once in three seasons by 47 per cent of the households. The production loss due to false smut was reported as less than 5 per cent by all the respondents. Major weed in paddy crop was swank which was reported by all the households as not important, occurring in every season and production loss less than 5 per cent. Thus, the individual production loss in paddy crop due to major pests, diseases and weeds was reported as less than 5 per cent by majority of the households.

The magnitudes of crop loss due to pests, disease and weed infestation in wheat crop have been depicted in Table 4.5. The actual production with attack varied between 17.65 to 18.15 quintals per acre with minimum on marginal and maximum on small farm categories while in an overall situation actual production was found to be 17.79 quintals per acre. Normal production without attack fluctuated between 18.70 to 19.32 quintals per acre with lowest on marginal and highest on small farms categories while in an overall situation normal production on sample farms was found to be 19.20 quintals per acre. The loss of output varied between 1.05 to 1.47 quintals per acre with lowest on marginal and highest on large farm categories due to better management of farms by marginal and small farmers as compared to large farmers. The per cent loss over actual production also increased with increase in farm size which was a minimum of 5.94 per cent on marginal and 8.29 per cent on large farm categories. In total, magnitude of crop loss due to pests, diseases and weed infestation was 7.93 per cent over actual and 7.35 per cent over normal production. The loss due to major pests, diseases and weeds was low due to the efficient crop management by the farmers as well as varietal characteristics and timely application of weedicides/ pesticides/ fungicides.

Table 4.5: The magnitude of crop loss due to pests, disease and weed infestation- Wheat

Description	Marginal	Small	Medium	Large	Total
Actual production with attack (quintal/acre)	17.65	18.15	17.70	17.78	17.79
Normal production without attack (quintal/acre)	18.70	19.32	18.96	19.25	19.20
Loss of output (quintal/acre)	1.05	1.17	1.26	1.47	1.41
Percentage loss over actual production	5.94	6.47	7.12	8.29	7.93
Percentage loss over normal production	5.61	6.07	6.65	7.66	7.35

The magnitudes of crop loss due to pests, disease and weed infestation in paddy crop have been depicted in Table 4.6. The actual production with pests, disease and weed infestation fluctuated between 24.93 to 26.51 quintals per acre on various farm size categories with minimum on marginal and maximum on small farms while in an overall situation actual production worked out to be 26.30 quintals per acre. Normal production without any pest disease and weed infestation varied between 26.91 to 28.79 quintals per acre with lowest on marginal and highest on large farms categories while in

an overall situation normal production on sample households came out to be 28.58 quintals per acre. The loss of output varied from 1.61 to 2.36 quintals per acre with lowest on small and highest on large farm categories due to better management of farms by small farmers as compared to large farmers. The per cent loss over actual production was 7.94 per cent on marginal, 6.07 per cent on small, 8.53 per cent on medium and 8.94 per cent on large farms categories. Thus, losses were minimum on small farms as compared to marginal, medium and small farm categories.

Table 4.6: The magnitude of crop loss due to pests, disease and weed infestation- Paddy

Description	Marginal	Small	Medium	Large	Total
Actual production with attack (quintal/acre)	24.93	26.51	25.79	26.43	26.30
Normal production without attack (quintal/acre)	26.91	28.12	27.99	28.79	28.58
Loss of output (quintal/acre)	1.98	1.61	2.20	2.36	2.28
Percentage loss over actual production	7.94	6.07	8.53	8.94	8.68
Percentage loss over normal production	7.36	5.72	7.86	8.20	7.99

Losses were more on marginal farms due to their involvement in other occupations along with farming. In total, magnitude of crop loss due to pests, diseases and weed infestation in paddy crop was 8.68 per cent over actual and 7.99 per cent over normal production. The loss due to major pests, diseases and weeds was low due to the efficient crop management by the farmers as well as varietal characteristics and timely application of weedicides/ pesticides/ fungicides.

4.3 Methods of pests and diseases control adopted by the selected sample households

There are chemical and biological methods to control pest and diseases in field crops. Table 4.7 gives an idea about the cost of chemical methods adopted for pests and disease control. In order to control weeds in wheat crop, majority of the farmers on various farm categories applied up to two or more sprays. The total cost of weedicides spray along with labour charges ranged between Rs. 476.60 to Rs.630.30 per acre being lowest on marginal and highest on large farm category. In order to control various pests, at least one insecticide spray was applied on all the farm size categories. The total cost of chemical used and labour charges worked out to be Rs. 135.30 on marginal, Rs.207.80 on small, Rs.181 on medium, Rs.151.10 on large and Rs.158.50 per acre in an overall situation. One spray of fungicide was applied by more than half of the sampled households

to control diseases. The total cost of fungicide spray varied between Rs.130 to Rs.178.70 per acre being lowest on medium and highest on small farm category while in an overall situation total cost worked out to be Rs. 166.10 per acre.

Table 4.7: Cost of Chemical methods adopted for pests and disease control (Rs/acre) - Wheat

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted control measures	100.0	100.0	100.0	100.0	100.0
Weedicide					
No. of sprays/acre	1.75	2.20	2.10	2.30	2.25
Cost of chemicals	394.10	486.40	454.20	536.20	514.25
Labour charges	82.50	78.70	70.40	94.10	89.40
Total Cost	476.60	565.10	524.60	630.30	603.65
Insecticide					
No. of sprays/acre	0.90	1.20	1.10	1.0	1.0
Cost of chemicals	97.50	153.30	126.20	111.40	115.80
Labour charges	37.80	54.50	54.80	39.70	42.70
Total Cost	135.30	207.80	181.0	151.10	158.50
Fungicide					
No. of sprays/acre	0.70	0.70	0.60	0.80	0.75
Cost of chemicals	145.10	149.30	110.90	146.10	141.40
Labour charges	24.0	29.40	19.10	25.40	24.70
Total Cost	169.10	178.70	130.0	171.50	166.10

Table 4.8: Cost of Chemical methods adopted for pests and disease control (Rs/acre)- Paddy

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted control measures	100.0	100.0	100.0	100.0	100.0
Weedicide					
No. of sprays/acre	0.90	1.0	1.0	1.0	1.0
Cost of chemical	183.30	205.70	205.30	193.30	195.40
Labour charges	48.20	49.70	50.80	46.20	47.10
Total Cost	213.50	255.40	256.10	239.50	242.50
Insecticide					
No. of sprays/acre	2.80	2.80	2.70	2.60	2.65
Cost of chemical	500.0	452.70	516.30	496.0	496.50
Labour charges	146.0	126.40	119.90	128.0	127.40
Total Cost	646.0	579.10	636.20	624.0	623.90
Fungicide					
No. of sprays/acre	0.90	0.80	0.80	0.85	0.85
Cost of chemical	176.0	166.60	168.80	152.60	156.40
Labour charges	34.80	30.40	28.30	28.0	28.40
Total Cost	210.80	197.0	197.10	180.60	184.80

The cost of chemical methods adopted for pests and disease control in paddy crop are given in Table 4.8.All the households applied chemical methods to control pests, diseases and weeds in paddy crop. Majority of the farmers on various farm categories applied up to one spray to control weeds. The total cost of weedicides spray along with labour charges varied between Rs. 213.50 to Rs.256.10 per acre being lowest on marginal and highest on medium farm category. More than two insecticide sprays were applied on all the farm size categories in order to control various pests in paddy crop. The total cost of chemical used and labour charges worked out to be Rs. 646 on marginal, Rs.579.10 on small, Rs.636.20 on medium, Rs. 624 on large and Rs.623.90 per acre in an overall situation. To control various diseases one spray of fungicide was applied by more than half of the sampled households. The total cost of fungicide spray including labour charges varied between Rs.180.60 to Rs.210.80 per acre being lowest on large and highest on marginal farm category while in an overall situation total cost worked out to be Rs. 184.80 per acre.

Table 4.9: Details of biological methods adopted for pests and disease control

Item		Wheat		Paddy	
		Percentage of HH adopted this method	Details about the method	Percentage of HH adopted this method	Details about the method
Biological methods		-	-	-	-
Other Control measures	1	100.0	Chemical control	100.0	Chemical control
	2	-	-	-	-

The sampled households in wheat and paddy crops did not use any biological method to control pests and diseases. On the other hand, all the sampled households adopted chemical control measures to check incidence of pests and diseases.

4.4 Sources of information for pests and disease control by the selected households

The sources of information for pest and disease control have been given in table 4.10. The perusal of the table reveals that all the sample households took advice from some specific source for control of pest and diseases in wheat and paddy crops and other farm related requirements and problems encountered. The Government extension agents were ranked as least important by 92 per cent of the households followed by important by 4 per cent and most important by 4 per cent in case of both paddy and wheat crops. A detail of the advice taken from Government extension

agents was regarding new varieties, disease incidence and crop diversification. As far as advice from private input dealers is concerned, 66 per cent households ranked it as most important, 24 per cent as important and only 10 per cent households ranked it as least important. The major advice taken by sampled households from private dealers was regarding use of insecticide and pesticide for control of various pests and diseases. Fellow farmers were also an important source of advice for discussing various farm related problems in paddy and wheat crops. Therefore, fellow farmers were ranked as important source of advice by 67 per cent households, most important by 21 per cent and least important by 9 per cent of the households. The advice taken was mostly regarding insecticide/ pesticide use for control of pests and diseases. Another important source of advice for sample households regarding pest and disease control management was television, radio and

Table 4.10: Extension services on pests and disease control management (percentage of hh)

Percentage of HH seeking advice	**Wheat**				**Paddy**			
	100.0				**100.0**			
Sources of advice								
Rank of sources	Most imp	Impor-tant	Least imp	Details of advice	Most imp	Impor-tant	Least imp	Details of advice
Government extension agent	4.0	4.0	92.0	a) New varieties b) Disease incidence c) Crop diversification	4.0	4.0	92.0	a) New varieties b) Disease incidence c) Crop diversification
Private input dealer	66.0	24.0	10.0	a) Use of insecticide & pesticide for pest/disease control	66.0	24.0	10.0	a) Use of insecticide & pesticide for pest/disease control
Fellow farmers	21.0	67.0	12.0	a)Insecticides & pesticides use b) Disease/pest incidence	21.0	67.0	12.0	a)Insecticides & pesticides use b) Disease/pest incidence
TV/Radio service/Newspaper	5.0	4.0	91.0	a) New varieties b) Diseases c)Regarding state Govt agril. priorities d) Current farm problems	5.0	4.0	91.0	a) New varieties b) Diseases c) Regarding state Govt agril. priorities d) Current farm problems
Agricultural University/KVK	3.0	6.0	91.0	a) New varieties b) New farm machinery	3.0	6.0	91.0	a) New varieties b) New farm machinery
Any other	-	-	-	-	-	-	-	-

newspaper which were ranked as least important by 91 per cent of the households, most important by 5 per cent and important by 4 per cent of the sample households. Agricultural university and KVK's were also providing extension services on pests and disease control to the
farmers and these were ranked as least important by 91 per cent, important by 6 per cent and most important by 3 per cent of the sample households. The type of advice taken was about new varieties and newly developed farm machinery. Thus, private input dealers and fellow farmers were the most important source of advice for pest/ disease control management and other farm related issues as revealed by the sampled households.

4.5 Households' suggestions on how to minimize pre harvest losses

The major household suggestions to minimize pre harvest losses were as follows:

i) There is a need of development of insect/pest and disease resistant varieties least affected by insect/ pest and disease attack thereby minimizing the pre harvest losses.

ii) As revealed by the sample households, most of the insecticides and fungicides available in the market were not controlling pests and diseases properly, thereby increasing the pre harvest losses.

iii) Households suggested requirement of better quality seeds and chemicals to minimize the pre harvest losses.

iv) Training to farmers on latest farm technology developed can also result in controlling weeds, pests and diseases timely and adequately thus minimizing the losses.

4.6 Summary

In case of wheat cultivation, high cost of inputs was reported as most important constraint by 76 per cent of the households while 21 per cent informed low output price as most important constraint. On the contrary, 43 per cent households reported pest and disease problem as important constraint followed by 34 per cent informing low output price as important constraint. On the other hand, all the households reported water deficiency and 98 per cent revealed poor seed quality as least important constraint in wheat cultivation. In paddy crop, high cost of inputs was reported as most important constraint by 73 per cent of the households and 23 per cent revealing low output price as most important constraint. Water deficiency was informed as important constraint by 49 per cent households followed by 33 per cent reporting pest and disease problem, 32 per cent low output price as important constraint. On the other hand, all the households revealed poor seed quality as least

important constraint followed by 60 per cent reporting pest and disease problem, 45 per cent low output price and 37 per cent water deficiency as least important constraints in paddy cultivation. All the households were able to distinguish between pest and disease attack. Assessment about the severity of the attack showed that 89 per cent of the respondents in wheat and 88 per cent in paddy reported about the qualitative assessment followed by 3 per cent in wheat and 2 per cent in paddy reported about the quantitative assessment of the severity of the attack. Major pest of wheat crop was aphids with 97 per cent respondents reporting its severity of attack as not important with frequency of attack in every season and production loss less than 5 per cent. Major diseases affecting wheat crop were yellow or stripe rust and loose smut. The severity of yellow rust attack on wheat crop as reported by all the sample households was not important with 83 per cent revealing its frequency of attack once in three seasons with production loss less than 5 per cent. The severity of loose smut attack on wheat crop was reported by all the respondent farmers with 32 per cent reporting its attack in every season, 40 per cent once in two seasons and 28 per cent once in three seasons with production loss less than 5 per cent. Major weeds affecting wheat productivity were broad leaf weeds and *phalaris minor*. The severity of broad leaf weeds was reported not important by 98 per cent respondents with occurrence in every season and production loss less than 5 per cent. The severity of *phlaris minor* as revealed by 82 per cent of the households was not important with frequency of attack every year and production loss less than 5 per cent. Major pests of paddy crop as reported by the sample households were; rice stem borer, leaf folder and plant hoppers. The rank of severity of rice stem borer was reported by 96 per cent households as not important with frequency of attack in every season by 98 per cent households and production loss less than 5 per cent was reported by 96 per cent of the households. The severity of leaf folder attack on paddy crop was reported by all the households as not important with 92 per cent informing its attack in every season and production loss less than 5 per cent as revealed by all the sample households. The rank of severity of plant hoppers was reported as not important by 97 per cent of the households with the frequency of attack in every season by 95 per cent of the households and while production loss of less than 5 per cent. Major diseases affecting paddy crop were; bacterial leaf blight, sheath blight and false smut. The severity of bacterial leaf blight was reported as not important by all the respondents with 59 per cent reporting its occurrence once in three seasons and production loss less than 5 per cent. The severity of sheath blight attack was reported as not important by 98 per cent of the households with frequency of attack in every season as reported by 58 per cent of the households and production loss less than 5 per cent. Similarly, the severity of false smut was informed

as not important by all the households with frequency of attack in three seasons by 47 per cent of the households and production loss less than 5 per cent by all the respondents. Major weed in paddy crop was swank which was reported by all the households as not important, occurring in every season and production loss less than 5 per cent. Thus, the individual production loss in paddy and wheat crops due to major pests, diseases and weeds was reported as less than 5 per cent by majority of the households.

The magnitudes of crop loss due to pests, disease and weed infestation in wheat crop showed that the actual production with attack varied between 17.65 to 18.15 quintals per acre with minimum on marginal and maximum on small farm categories. Normal production without attack fluctuated between 18.70 to 19.32 quintals per acre with lowest on marginal and highest on small farms categories. The loss of output varied between 1.05 to 1.47 quintals per acre with lowest on marginal and highest on large farm categories due to better management of farms by marginal and small farmers as compared to large farmers. The per cent loss over actual production also increased with increase in farm size. In total, magnitude of crop loss due to pests, diseases and weed infestation in wheat crop was 7.93 per cent over actual and 7.35 per cent over normal production. The magnitudes of crop loss due to pests, disease and weed infestation in paddy crop showed that the actual production with pests, disease and weed infestation fluctuated between 24.93 to 26.51 quintals per acre on various farm size categories with minimum on marginal and maximum on small farms Normal production without any pest disease and weed infestation varied between 26.91 to 28.79 quintals per acre with lowest on marginal and highest on large farms categories. The loss of output varied from 1.61 to 2.36 quintals per acre with lowest on small and highest on large farm categories due to better management of farms by small farmers as compared to large farmers. The per cent loss over actual production increased with increase in farm size except on marginal farms. In total, magnitude of crop loss due to pests, diseases and weed infestation in paddy crop was 8.68 per cent over actual and 7.99 per cent over normal production. In order to control weeds in wheat crop, majority of the farmers on various farm categories applied up to two or more sprays. The total cost of weedicides spray along with labour charges ranged between Rs. 476.60 to Rs.630.30 per acre being lowest on marginal and highest on large farm category. In order to control various pests, the total cost of chemical used and labour charges ranged from Rs. 135.30 to Rs. 207.80 on various farm categories. Similarly, the total cost of fungicide spray varied between Rs.130 to Rs.178.70 per acre being lowest on medium and highest on small farm category. The total cost of weedicides spray along with labour charges to control weeds in paddy crop varied between Rs. 213.50 to Rs.256.10 per acre being lowest on marginal and highest on medium

farm category. The total cost of chemical used and labour charges to control pests varied from Rs. 646 on marginal and Rs.579.10 on small farm categories. Similarly, the total cost of fungicide spray for control of diseases varied between Rs.180.60 to Rs.210.80 per acre being lowest on large and highest on marginal farm category. The loss due to major pests, diseases and weeds was low due to the efficient crop management by the farmers as well as varietal characteristics and timely application of weedicides/ pesticides/ fungicides.

All the sample households took advice from some specific source for control of pest and diseases in wheat and paddy crops. The Government extension agents were ranked as least important by 92 per cent of the households in case of both paddy and wheat crops. As far as advice regarding pest and diseases from private input dealers is concerned, 66 per cent households ranked it as most important and 24 per cent as important. Fellow farmers were also an important source of advice for discussing various farm related problems in paddy and wheat crops and they were ranked as important source of advice by 67 per cent households and most important by 21 per cent households. Another important source of advice for sample households regarding pest and disease control management was television, radio and newspaper which were ranked as least important by 91 per cent of the households. Agricultural university and KVK's were also providing extension services on pests and disease control to the farmers and these were ranked as least important by 91 per cent households. Major suggestion by the sample households was the development of insect/pest and disease resistant varieties, better quality seeds and availability of unadulterated chemicals to minimize pre harvest losses. Training to farmers on latest farm technology developed can also result in controlling weeds, pests and diseases properly.

Chapter 5

Assessment of Post Harvest Losses of Wheat and Paddy Crops

The post harvest losses in crops occur at the time of harvesting, threshing transportation and storage. Precious foodgrains are lost at different stages of various farm operations. These losses can be minimized by taking various precautionary measures at different stages of crop handling. This chapter deals with assessment of production losses during harvesting, threshing and winnowing, transportation, handling, storage, quantitative assessment of storage and pest control measures adopted by the selected households.

5.1. Production loss during harvest

The production losses during different stages of wheat harvest have been depicted in Table 5.1. The perusal of table shows that area harvested per household during early stage was 0.21 acres followed by 8.85 acres in mid and 1.62 acres during late harvesting of the crop. Thus, 82.87 per cent area was harvested in mid season followed by 15.16 per cent in late and 1.97 per cent in early season by the sample households. The area harvested mechanically in early stage was 2.45 per cent while in mid stage 79.14 per cent and 18.41 per cent in the late stage was harvested mechanically.

Table 5.1: Quantity lost at different stages of harvest – Wheat crop

Stages of harvest and variety		Early		Mid		Late	
		Local	HYV	Local	HYV	Local	HYV
Area harvested per hh (acres)		-	0.21	-	8.85	-	1.62
Percentage area harvested (early, mid and late)		-	1.97	-	82.87	-	15.16
Area manually harvested (percentage)		-	-	-	98.10	-	1.90
Area mechanically harvested (percentage)		-	2.45	-	79.14	-	18.41
Rank of loss (percentage of households)	High	-	-	-	-	-	-
	Medium	-	-	-	-	-	-
	Low	-	2.0	-	86.00	-	12.00
Quantity lost during harvest	Kg per acre of harvest	-	20.40	-	26.70	-	47.20
	Kg per quintal of harvest	-	1.10	-	1.40	-	2.50
	Loss % of harvest amount	-	1.10	-	1.40	-	2.50

The area harvested in the mid stage was 98.10 per cent of the manually harvested area while in the late stage just 1.90 per cent area was harvested. The ranking of loss during different stages of crop harvest was reported as low by 2 per cent households during early, 86 per cent during mid and 12

per cent during the late stage of harvesting. Quantity lost during early stage was 20.40 kg. per acre followed by 26.70 kg. in mid and 47.20 kg. in late harvesting stage of wheat crop. Therefore, the loss percentage of harvest amount was 1.10 per cent in early, 1.40 per cent in mid and 2.50 per cent in late harvesting stage of wheat crop on the sample households. The percent loss was more in late stage of harvesting due to shattering of grains as reported by the sample households.

The production losses during different stages of harvesting of paddy crop have been depicted in Table 5.2. Area harvested in early harvesting stage of crop was 0.47 acres, 7.75 acres in mid season and 0.77 acres in late harvesting of the crop on the sample households. In early stage, 5.22 per cent area was harvested while 86.22 per cent in mid season and 8.56 per cent in late season by the sample households. The entire area was harvested mechanically by the sample households. The ranking of loss during different stages of crop harvest was reported as low by 3 per cent households during early, 92 per cent during mid and 5 per cent during the late stage of harvesting in paddy crop. Quantity lost in early harvested crop was 93.70 kg. per acre of harvest followed by 53.60 kg. per acre in late and 38.30 kg. per acre in mid season harvesting of the crop.

Table 5.2: Quantity lost at different stages of harvest – Paddy crop

Stages of harvest and variety		**Early**		**Mid**		**Late**	
		Local	**HYV**	**Local**	**HYV**	**Local**	**HYV**
Area harvested per hh (acres)		-	0.47	-	7.75	-	0.77
Area harvested per hh (percentage harvested early, mid and late)		-	5.22	-	86.22	-	8.56
Area manually harvested (percentage)		-	-	-	-	-	-
Area mechanically harvested (percentage)		-	100.0	-	100.0	-	100.0
Rank of loss (percentage of households)	High	-	-	-	-	-	-
	Medium	-	-	-	-	-	-
	Low	-	3.00	-	92.00	-	5.00
Quantity lost during harvest	Kg per acre of harvest	-	93.70	-	38.30	-	53.60
	Kg per quintal of harvest	-	3.40	-	1.40	-	1.90
	Loss % of harvest amount	-	3.40	-	1.40	-	1.90

The loss per cent of harvest amount was maximum in early harvesting (3.40%) followed by late (1.90%) and mid (1.40%) season harvesting. The loss during early stage was more due to immature grains while in late season there was more shattering of the grains as reported by sample households.

5.2. Production loss during threshing and winnowing

Production loss during threshing and winnowing is very important. As reported by 35 per cent of the sample farmers, threshing was done mechanically with the thresher and no winnowing was done due to the facility of fan in the threshing operation itself. The average loss was just 3.95 kg. per acre which came out to be just 0.20 kg. per quintal on the 35 per cent of the sample respondent farms only. Respondents ranked this loss also low.

Table 5.3: Quantity lost during threshing and winnowing

Stages of harvest and variety		**Wheat**		**Paddy**	
		Local	**HYV**	**Local**	**HYV**
Area/quantity mechanically threshed (percentage of hh)		-	35.00	-	-
Rank of loss (percentage of households)	High	-	-	-	-
	Medium	-	-	-	-
	Low	-	35.00	-	-
Quantity lost during threshing	Average loss (Kg per acre)	-	3.95	-	-
	Average loss (Kg per qtl)	-	0.20	-	-
	Loss % of threshed amount	-	0.20	-	-
Area/quantity manually winnowed (percentage of hh)		-	-	-	-
Rank of loss (percentage of households)	High	-	-	-	-
	Medium	-	-	-	-
	Low	-	-	-	-
Quantity lost during winnowing	Average loss (Kg per acre)	-	-	-	-
	Average loss (Kg per qtl)	-	-	-	-
	Loss % of winnowed amount	-	-	-	-

5.3 Production loss during transportation and handling

The production loss during transportation and handling is of vital importance due to involvement of different functionaries in various marketing operations. Quantity of wheat lost during transportation and handling has been depicted in Table 5.4. Tractor-trolley was the only mode of transportation used by the sample households to transport their produce to the market. The average quantity transported per household was 183.50 quintal while average distance covered was 4.10 kms with transportation cost of Rs.3.60 per quintal.

Table 5.4: Quantity lost during transportation and handling – Wheat crop

Mode of transportation		Head load	Bullock cart	Trolley	Tempo	Truck	Others	Total
Average quantity transported (qtls per hh)		-	-	183.50	-	-	-	183.50
Average distance covered (kms)		-	-	4.10	-	-	-	4.10
Transportation cost (Rs per quintal)		-	-	3.60	-	-	-	3.60
Rank of loss (percentage of hh)	High	-	-	-	-	-	-	-
	Medium	-	-	-	-	-	-	-
	Low	-	-	100.00	-	-	-	100.00
Quantity lost during transport	Average loss (Kg per qtl of amount transported)	-	-	0.059	-	-	-	0.059
	% of amount transported	-		0.0003	-	-	-	0.0003
Quantity lost during handling	Average loss (Kg per qtl of amount handled)	-		0.204	-	-	-	0.204
	% of amount handled	-		0.001	-	-	-	0.001

The loss during transportation was ranked low by all the sample households. The average loss per quintal of amount transported came out to be 0.059 kilogram which was just 0.0003 per cent of the quantity transported. Similarly, the average quantity lost per quintal of amount handled calculated as 0.204 kilogram which was a meager 0.001 per cent of the handled quantity as reported by the sample households. Thus, the loss during transportation and handling worked out to be just negligible in case of wheat crop.

Table 5.5 shows the quantity of paddy lost during transportation and handling as reported by the sample households. The mode of transportation was tractor-trolley as revealed by the all the sample households. The average quantity transported was 248.30 quintals per household. The average distance covered for the transportation of the produce was 4.10 kms with transportation cost of Rs.1.90 per quintal as reported by the sample households. The rank of loss was reported low by all the respondents. The average loss per quintal of amount transported came out to be 0.063 kg which was just 0.0002 per cent of the transported quantity.

Table 5.5: Quantity lost during transportation and handling – Paddy crop

Mode of transportation		Head load	Bullock cart	Trolley	Tempo	Truck	Others	Total
Average quantity transported (qtls per hh)		-	-	248.30	-	-	-	248.30
Average distance covered (kms)		-	-	4.10	-	-	-	4.10
Transportation cost (Rs per quintal)		-	-	1.90	-	-	-	1.90
Rank of loss (percentage of hh)	High	-	-	-	-	-	-	-
	Medium	-	-	-	-	-	-	-
	Low	-	-	100.00	-	-	-	100.00
Quantity lost during transport	Average loss (Kg per qtl of amount transported)	-	-	0.063	-	-	-	0.063
	% of amount transported	-	-	0.0002	-	-	-	0.0002
Quantity lost during handling	Average loss (Kg per qtl of amount handled)	-	-	0.224	-	-	-	0.224
	% of amount handled	-	-	0.001	-	-	-	0.001

The average loss during handling worked out to be 0.224 kg per quintal of amount handled which was a meager 0.001 per cent of the handled quantity. Therefore, the loss during transportation and handling of paddy crop was found to be very less as revealed by the sample households.

The transportation losses were so low due to the facility of tractor- trolley to each sample respondent and also special care was taken by putting gunny as well as plastic covers, beneath as well as on the sides of the trolley before filling it with the crop produce to be sold in the market.

5.4 Production loss during storage

The agricultural produce is affected by pests, rodents and fungus during storage if proper precautions are not taken at the household level. The quantity lost during storage has been given in Table 5.6. In case of wheat crop, the place of storage was pucca house as revealed by the sample households. The mode of storage in case of wheat crop was steel drums and the average wheat stored was 19.5 quintal per household. All the households dried their produce before storage. This stored produce was gradually withdrawn from the storage drums as per requirement for

consumption purpose by the sample households and, therefore, was stored for the whole year. The rank of losses was low as reported by all the sample households. The average quantity lost during wheat storage was found to be 0.012 kg per quintal of storage due to rodents and 0.008 kg per quintal due to fungus. The storage cost per quintal worked out to be Rs. 3.35 per quintal of stored quantity.

Table 5.6: Quantity lost during storage

Place of storage*		**Wheat**				**Paddy**			
		1	2	3	4	1	2	3	4
Mode of storage (percentage of amount stored	Open	-	-	-	-	-	-	-	-
	Gunny/plastic bag	-	-	-	-	-	100.0	-	-
	Kothi/bin kuchha, Pucca	-	-	-	-	-	-	-	-
	Steel drums	-	100.0	-	-	-	-	-	-
	Others	-	-	-	-	-	-	-	-
Amount stored (Qtls per hh)		-	19.5	-	-	-	0.50	-	-
Percentage of hh who dried before storing		-	100.00	-	-	-	100.00	-	-
Average number of days stored (per hh)		-	365	-	-	-	365	-	-
Rank of loss in storage	High	-	-	-	-	-	-	-	-
	Medium	-	-	-	-	-	-	-	-
	Low	-	100.00	-	-	-	100.00	-	-
Quantity lost during storage (kgs per quintal of storage)	Due to weight loss	-	-	-	-	-	2.50	-	-
	Due to rodents	-	0.012	-	-	-	0.114	-	-
	Due to fungus	-	0.008	-	-	-	-	-	-
Storage cost Rs. per quintal		-	3.35	-	-	-	0.60	-	-

Note: * Kutcha house =1; Pucca house =2; Scientific godown/warehouse =3; Others =4

In case of paddy crop also, the place of storage was pucca house as revealed by all the sample households. The mode of storage of paddy crop was gunny/ plastic bag as reported by all the sampled households and the average amount stored was 0.50 quintals per household. All the households dried their produce before storing it for consumption purpose for the whole year. All the households storing the produce ranked the loss due to storage as low. The quantity lost during paddy storage was 2.50 kg per quintal due to weight loss and 0.114 kg per quintal due to rodents. The storage cost per quintal worked out to be Rs.0.60 per quintal as revealed by the sample households.

The storage losses were low in wheat crop due to the scientific storage adopted by the sample farmers using steel drums and undertaking proper fumigation using cellphos tablets and also making it airtight by applying wet soil on openings of the steel drums. The sample farmers exclusively stored wheat crop for domestic consumption and for next years seed purpose only.

5.5 Capacity utilization of storage by the selected households

The capacity utilization of storage by the selected households has been depicted in Table 5.7. As discussed earlier, the mode of storage for wheat crop was steel drums with average storage capacity of 20.60 quintals. The actual wheat storage was 19.50 quintal with capacity utilization of 94.70 per cent. In case of paddy crop, the capacity of the storage was 0.50 quintal and actual storage was also 0.50 quintal with hundred per cent capacity utilization on the sample households.

Table 5.7: Capacity utilization of storage by the households

Mode of storage	**Wheat**			**Paddy**		
	Capacity (qtls)	Actual storage (qtls)	Capacity utilization (%)	Capacity (qtls)	Actual storage (qtls)	Capacity utilization (%)
Open	-	-	-	-	-	-
Gunny Plastic bag	-	-	-	0.50	0.50	100.00
Kothi/bukhari/bin kachha	-	-	-	-	-	-
Kothi/bukhari/bin made of cement	-	-	-	-	-	-
Steel drums	20.60	19.50	94.70	-	-	-
Others	-	-	-	-	-	-

The total post harvest losses per quintal by farm size have been depicted in Table 5.8. The perusal of the table reveals that the quantity lost in harvesting of wheat crop varied from 0.93 to 1.57 kg per quintal with minimum on marginal and maximum on medium farm size category with total loss of 1.52 kg per quintal and in threshing just 0.04 kg./qtl. Quantity lost in transport varied from a meager 0.05 kg per quintal on medium and a maximum of 0.10 kg per quintal on marginal farms while in total 0.06 kg per quintal was the loss of wheat during transportation. Quantity lost in handling of wheat crop varied from a minimum of 0.17 kg per quintal on medium farms to a maximum of 0.29 kg per quintal on marginal farms while total loss during handling reported on the sample farms was 0.20 kg per quintal. Storage losses of wheat varied from a minimum of 0.015 kg per quintal on large farms to a maximum of 0.042 kg per quintal on marginal farms while in total the storage losses worked out to be 0.02 kg per quintal as reported by the sample households.

Table 5.8: Total post harvest losses per quintal by farm size

Particulars	Wheat					Paddy				
	Marginal	**Small**	**Medium**	**Large**	**Total**	**Marginal**	**Small**	**Medium**	**Large**	**Total**
Quantity lost in harvest (kg per qtl)	0.93	1.42	1.57	1.54	1.52	1.19	1.66	1.64	1.52	1.54
Quantity lost in threshing (kg per qtl)	0.05	0.09	0.02	0.04	0.04	-	-	-	-	-
Quantity lost in winnowing (kg per qtl)	-	-	-	-	-	-	-	-	-	-
Quantity lost in transport (kg per qtl)	0.10	0.08	0.05	0.06	0.06	0.09	0.09	0.05	0.06	0.06
Quantity lost in handling (kg per qtl)	0.29	0.22	0.17	0.21	0.20	0.25	0.20	0.22	0.22	0.22
Quantity lost in storage (kg per qtl) a) Due to weight loss	-	-	-	-	-	4.30	2.30	1.70	2.60	2.50
b)Storing loss	0.042	0.018	0.029	0.015	0.02	0.193	0.053	0.064	0.132	0.114
Total post harvest loss (kg per qtl)	1.412	1.828	1.839	1.865	1.84	6.023	4.303	3.674	4.532	4.434
Total post harvest loss (kg per acre)*	25.99	34.18	34.57	35.81	35.14	158.40	114.03	99.93	127.28	122.38

Note: Post harvest loss per acre is calculated by multiplying losses in kg per quintal by the productivity per acre.

Total post harvest losses in wheat crop came out to be a minimum of 1.412 kg per quintal on marginal farms while on large farms these losses were 1.865 kg per quintal which was also maximum. In total, post harvest losses in wheat crop worked out to be 1.84 kg per quintal and 35.81 kg per acre as revealed by the sample households. These losses in wheat crop increased with the increase in farm size.

In case of paddy crop, quantity lost during harvesting of the crop worked out to be a minimum of 1.19 kg per quintal on marginal farms while on medium farms it was 1.64 kg per quintal which was highest in all the farm categories. In total, quantity lost in paddy harvest worked out to be 1.54 kg per quintal. Meager quantity of 0.05 kg per quintal lost during transportation on medium farms while a maximum of 0.09 kg per quintal was the loss on marginal and small farms. In total, transportation losses in paddy crop worked out to be 0.06 kg per quintal. Quantity lost in handling varied from 0.20 kg to 0.22 kg per quintal with lowest on small farms and highest on medium and large farm categories while in total this 0.22 kg per quintal were the handling losses. Storage losses due to weight loss varied from 4.30 kg to 1.70 kg per quintal with highest on marginal farms and lowest on medium farm category while in total, 2.50 kg per quintal was the storage loss due to decline in weight. Storage losses due to other factors came out to be a minimum of 0.053 kg per quintal on medium and 0.193 kg per quintal on marginal farms which was also highest on all farm categories while in total the storage loss worked out to be 0.114 kg per quintal in case of paddy crop. Total post harvest losses in case of paddy crop were calculated as 3.674 kg per quintal on medium farm category which were lowest while on marginal farm category these came out to be 6.023 kg per quintal which were highest on all the farm categories. The total post harvest losses in paddy crop worked out to be 4.43 kg per quintal and 122.38 kg per acre as revealed by the sample respondents.

5.6 Quantitative aspects of storage and their pests control measures adopted by the selected households

The quantitative aspects of storage and their pest control measures adopted by the selected households have been depicted in table 5.9. The study brought out that the nature of the storage structure used by all the sample households was metallic drum for storing wheat grains. The walls and floors of this metallic drum for storage were made of metal as revealed by all the sample households. The platform on which metallic drums were kept was of 6-12 inches height as

reported by 45 per cent of the respondents. Physical condition of the storage structure as revealed by all the respondents was having good roof, good condition walls and the floor on which these were kept was cemented and was in a good condition.

Table 5.9: Some quantitative aspects of storage (percentage of households)

Description		**Wheat**	**Paddy**
1. Nature of storage structure		-	-
Roof made of	Grass thatched	-	
	Crop by product	-	
	Plastic cover	-	
	Metal/cemented	100.0	
	Asbestos sheet	-	
	Others	-	
Walls made of	Burnt bricks/cemented	-	
	Woven basket	-	
	Mud	-	
	Crib	-	
	Open wall	-	
	Others (metal)	100.0	
Floor made of	Concrete		
	Earth		
	Woven basket		
	Wooden		
	Others (metal)	100.0	
Percentage of households having platform			
Height of the platform	Less than 6 inches		
	6-12 inches	45.00	
	Above 12 inches		
	Others		
2. Physical condition of storage			
Roof	Leaking root		
	Good roof	100.0	
Walls	Damaged wall		
	Good condition walls	100.0	
Guards	Rat guard installed	-	
	No rat guards	100.0	
Floor	Cemented good condition roof	100.0	
	Broken floor, mud coming out		

Contd…….

Table 5.9: Some quantitative aspects of storage (percentage of households) – Contd

Description		**Wheat**	**Paddy**
3.Cost of storage(per household) Rs		65.40	0.30
The average age of the storage structure (years per household)		7.60	0.60
Cost of permanent storage, e.g., steel drums, gunny/plastic bag etc. (Rs per household)		2243.0	8.60
Cost of kutcha or cemented house for storage (Rs. Per household)		-	-
Maintenance status – Frequency of repair of grain storage			
Roof	Every year	-	-
	Every two years	6.0	-
	2-5 Years	71.0	-
	No maintenance required	23.0	-
Walls	Every year	-	-
	Every two years	6.0	-
	2-5 Years	71.0	-
	No maintenance required	23.0	-
Rat guards	Every year	-	-
	Every two years	-	-
	2-5 Years	-	-
	No maintenance required	-	-
Storage pests control measures			
Sun drying	Monthly	30.0	-
	Quarterly	70.0	-
	By-annual	-	100.0
	Annual	-	-
	Never	-	-
Removal of infested grain from storage and destroying it	Monthly	30.0	-
	Quarterly	70.0	-
	By-annual	-	100.0
	Annual	-	-
	Never	-	-
Admixing with ash and other plant materials	Monthly	-	-
	Quarterly	-	-
	By-annual	-	-
	Annual	8.0	-
	Never	92.0	-
Smoking	Monthly	-	-
	Quarterly	-	-
	By-annual	-	-
	Annual	-	-
	Never	100.0	-
Others	Monthly	-	-
	Quarterly	-	-
	By-annual	-	-
	Annual	-	-
	Never	-	-

The cost of storage of wheat grains worked out to be Rs.65.40 per household with average age of storage structure being 7.60 years. The cost of permanent structures such as metallic drums worked out to be Rs.2243 per household for storing wheat grains. Maintenance status of the storage structure reveals that 71 per cent of the households maintained its roof and walls with in 2-5 years, 6 per cent in every two years and 23 per cent did not maintain it. The major storage pest control measure for wheat grains was quarterly sun drying and removal of infested grain from storage and destroying it as revealed by 70 per cent of the households while monthly drying and removal of infested grain was reported by 30 per cent of the respondents. Another annual pest controlling measure was admixing the storage drum with plant material which was reported by 8 per cent of the respondents. Practice of smoking as a pest control measure was not followed by any of the sample households.

Paddy crop was stored in gunny/ plastic bags and its expenses on pest control measures was just Rs.0.30 per household. The cost of gunny/ plastic bag worked out to be Rs. 8.60 per household while its average age was 0.60 years as revealed by the sample households. The storage pest control measures included a by-annual sun drying and removal of grain from storage and drying it as revealed by all the respondents.

5.7 Households suggestions how to minimize post harvest losses

The major household suggestions to minimize post harvest losses were as follows:

i) Proper supervision of the crop at the time of harvesting particularly in case of lodged and over ripe crop.

ii) There is a need of development of technologically advanced harvester combines and skilled persons required to operate them to minimize the wastage during harvesting.

iii) Another major point reported by the sample households was timely harvesting of the crop to minimize the losses due to shattering of the grains.

iv) Marginal farmers preferred manual harvesting particularly in wheat to minimize the harvesting losses.

5.8 Summary

The production losses during different stages of wheat harvest showed that area harvested per household during early stage was 0.21 acres followed by 8.85 acres in mid and 1.62 acres during late harvesting of the crop. The entire area in early stage was harvested manually while in late

stage, per cent area mechanically harvested was 97.30 per cent followed by 76.30 per cent in mid season. The ranking of loss during different stages of crop harvest was reported as low by 2 per cent households during early, 86 per cent during mid and 12 per cent during the late stage of harvesting. Quantity lost during early stage was 20.40 kg per acre followed by 26.70 kg in mid and 47.20 kg in late harvesting stage of wheat crop. Therefore, the loss percentage of harvest amount was 1.10 per cent in early, 1.40 per cent in mid and 2.50 per cent in late harvesting stage of wheat crop on the sample households. The percent loss was more in late stage of harvesting due to shattering of grains as reported by the sample households. The production losses during different stages of harvesting of paddy crop revealed that the area harvested per household in early harvesting stage of the crop was 0.47 acres, 7.75 acres in mid season and 0.77 acres in late harvesting of the crop on the sample households. The entire area was harvested mechanically by the sample households. The ranking of loss during different stages of crop harvest was reported as low by 3 per cent households during early, 92 per cent during mid and 5 per cent during the late stage of harvesting in paddy crop. Quantity lost in early harvested crop was 93.70 kg per acre of harvest followed by 53.60 kg per acre in late and 38.30 kg per acre in mid season harvesting of the crop. The loss per cent of harvest amount was maximum in early harvesting followed by late and mid season harvesting. The loss during early stage was more due to immature grains while in late season there was more shattering of the grains as reported by sample households. As revealed by the sample households no area/quantity was manually threshed. Tractor-trolley was the only mode of transportation used by the sample households to transport their produce to the market. The average quantity of wheat transported per households was 183.50 quintal while average distance covered was 4.10 kms with transportation cost of Rs.3.60 per quintal. The loss during transportation was ranked low by all the sample households. The average loss per quintal of amount transported came out to be 0.059 kilogram which was just 0.0003 per cent of the quantity transported. Similarly, the average quantity lost per quintal of amount handled calculated as 0.204 kilogram which was a meager 0.001 per cent of the handled quantity as reported by the sample households. The transportation losses were so low due to the facility of tractor- trolley to each sample respondent and also special care was taken by putting gunny as well as plastic covers, beneath as well as on the sides of the trolley before filling it with the crop produce to be sold in the market.

The average quantity of paddy transported was 248.30 quintals with transportation distance of 4.10 kms and transportation cost incurred was Rs.1.90 per household. The rank of loss was reported low by all the respondents. The average loss per quintal of amount transported came out to be 0.063 kg which was just 0.0002 per cent of the transported quantity. The average loss during handling worked out to be 0.224 kg per quintal of amount handled which was a meager 0.001 per cent of the handled quantity. In case of wheat crop, the place of storage was pucca house as revealed by the sample households. The mode of storage was steel drums and the average wheat stored was 19.5 quintal per household. All the households dried their produce before storage and this stored produce was gradually withdrawn from the storage drums as per requirement for consumption purpose by the sample households and, therefore, was stored for the whole year. The average quantity lost during wheat storage was found to be 0.012 kg per quintal of storage due to rodents and 0.008 kg per quintal due to fungus. The storage cost per quintal worked out to be Rs. 3.35 per quintal of stored quantity. In case of paddy crop also, the place of storage was pucca house and the mode of storage of paddy crop was gunny/ plastic bag and the average amount stored was 0.50 quintals per household. All the households dried their produce before storing it for consumption purpose for the whole year and also ranked the loss due to storage as low. The quantity lost during paddy storage was 2.50 kg per quintal due to weight loss and 0.114 kg per quintal due to rodents. The storage cost per quintal worked out to be Rs.0.60 per quintal as revealed by the sample households. The capacity utilization of storage by the selected households revealed that the mode of storage for wheat crop was steel drums with average storage capacity of 20.60 quintals. The actual wheat storage was 19.50 quintal with capacity utilization of 94.70 per cent. In case of paddy crop, the capacity of the storage was 0.50 quintal and actual storage was also 0.50 quintal with hundred per cent capacity utilization on the sample households. The storage losses were so low in wheat crop due to the scientific storage adopted by the sample farmers using steel drums and undertaking proper fumigation using cellphos tablets and also making it airtight by applying wet soil on openings of the steel drums. The sample farmers exclusively stored wheat crop for domestic consumption and for next years seed purpose only.

The total post harvest losses per quintal by farm size revealed that the quantity lost in harvesting of wheat crop varied from 0.93 to 1.57 kg per quintal with minimum on marginal and maximum on medium farm size category. Quantity lost in threshing was as low as 0.04 kg. per quintal. Quantity lost in transport varied from a meager 0.05 kg per quintal on medium and a

maximum of 0.10 kg per quintal on marginal farms. Quantity lost in handling of wheat crop varied from a minimum of 0.17 kg per quintal on medium farms to a maximum of 0.29 kg per quintal on marginal farms. Storage losses of wheat varied from a minimum of 0.015 kg per quintal on large farms to a maximum of 0.042 kg per quintal on marginal farms. Total post harvest losses in wheat crop came out to be a minimum of 1.412 kg per quintal on marginal farms while on large farms these losses were 1.865 kg per quintal which was also maximum. In total, post harvest losses in wheat crop worked out to be 1.84 kg per quintal and 35.81 kg per acre as revealed by the sample households. These losses in wheat crop increased with the increase in farm size. In case of paddy crop, quantity lost during harvesting of the crop worked out to be a minimum of 1.19 kg per quintal on marginal farms while on medium farms it was 1.64 kg per quintal which was highest in all the farm categories. Meager quantity of 0.05 kg per quintal lost during transportation on medium farms while a maximum of 0.09 kg per quintal was the loss on marginal and small farms. Quantity lost in handling varied from 0.20 kg to 0.22 kg per quintal with lowest on small farms and highest on medium and large farm categories. Storage losses due to weight loss varied from 4.30 kg to 1.70 kg per quintal with highest on marginal farms and lowest on medium farm category. Storage losses due to other factors came out to be a minimum of 0.053 kg per quintal on medium and 0.193 kg per quintal on marginal farms which was also highest on all farm categories Total post harvest losses in case of paddy crop were calculated as 3.674 kg per quintal on medium farm category which were lowest while on marginal farm category these came out to be 6.023 kg per quintal which were highest on all the farm categories. The total post harvest losses in paddy crop worked out to be 4.43 kg per quintal and 122.38 kg per acre as revealed by the sample respondents. The study brought out that the nature of the storage structure used by all the sample households was metallic drum for storing wheat grains. The platform on which metallic drums were kept was of 6-12 inches height. The storage structure was having good roof, good condition walls and the floor on which these were kept was cemented. The cost of storage of wheat grains worked out to be Rs.65.40 per household with average age of storage structure being 7.60 years. The cost of permanent structures such as metallic drums worked out to be Rs.2243 per household for storing wheat grains. Maintenance status of the storage structure reveals that 71 per cent of the households maintained its roof and walls with in 2-5 years. The major storage pest control measure for wheat grains was quarterly sun drying and removal of infested grain from storage and destroying it. Another annual pest controlling measure was admixing the storage drum with plant

material which was reported by 8 per cent of the respondents. Practice of smoking as a pest control measure was not followed by any of the sample households. Paddy crop was stored in gunny/ plastic bags and its expenses on pest control measures was just Rs.0.30 per household. The cost of gunny/ plastic bag worked out to be Rs. 8.60 per household while its average age was 0.60 years. The storage pest control measures included a by-annual sun drying and removal of grain from storage and drying it as revealed by all the respondents. The major household suggestions to minimize post harvest losses were the proper supervision of the crop at the time of harvesting particularly in case of lodged and over ripe crop, development of technologically advanced harvester combines, timely harvesting of the crop to minimize the losses due to shattering of the grains.

Chapter 6

Concluding Remarks and Policy Suggestion

Punjab being a pioneer state in ushering an era of green revolution resulted in making India self sufficient in foodgrains production particularly in case of wheat and rice. However, this paddy- wheat cropping system, especially paddy cultivation has resulted in sharp decline in underground water table and environmental degradation. Besides, there was increase in the capital investment on various farm size categories in Punjab due to huge expenditure in farm machinery and requirement of allied implements which resulted in enhancing the total cost due to increase in the non-recurring cost component. However, the profitability from wheat and paddy crops also increased due to continuous price support by the union Government and efficient marketing mechanism for these crops. Owing to specialized farming in case of wheat and paddy crops, the incidence of biotic and a-biotic stresses had multiplied over the years. These constraints are taking their toll by decreasing the productivity due to the severe incidence of insect- pest, diseases and weeds. It becomes necessary to investigate the pre and post harvest losses of these crops to bring out some suitable policy measures to restrict these losses to a reasonable level. Keeping the above cited reasons into account, the various conclusions from the study can be drawn as under:

i) High cost of inputs such as fertilizers, insecticides, fungicides, labour etc. was the major constraint reported by the sample households.

ii) The individual production loss in wheat crop due to incidence of pests (aphids), diseases (yellow rust and loose smut) and weeds *(Phlaris minor* and broad leaf weeds) was less than 5 per cent of total production.

iii) In paddy crop also, the individual production loss due to incidence of pests (rice stem borer, leaf folder and plant hoppers), diseases (bacterial leaf blight, sheath blight and false smut) and weeds *(Echinochloa crusgalli)* was less than 5 per cent of the total production.

iv) The per cent loss due to biotic stresses over actual production in wheat crop increased with increase in farm size with a minimum of 5.94 per cent on marginal and 8.29 per cent per acre on large farms. Thus, there was better management of marginal farms due to comparative smaller size.

v) The per cent loss due to biotic stresses over actual production in paddy crop increased with increase in farm size except on marginal farms with a minimum of 6.07 per cent on small and 8.94 per cent per acre on large farms. On small farms, the management of biotic stresses in paddy crop was better than other farms.

vi) Majority of the farmers took advice from private input dealers to solve their crop related problems.

vii) The loss during wheat harvesting was high in case of late harvesting of the crop due to shattering of grains as reported by the sample households.

viii) In case of paddy harvesting, loss during early stage was more due to immature grains while in late season harvesting there was more shattering of the grains as reported by sample households.

ix) The quantity lost during wheat storage was minimal due to rodents and fungus attack and all the respondents stored wheat in steel drums for future domestic consumption.

x) The quantity lost in paddy storage due to rodents was minimal and it was stored in plastic bags.

xi) Total post harvest losses in wheat crop came out to be a minimum of 1.412 kg per quintal on marginal farms while on large farms these losses were 1.865 kg per quintal which was also found to be maximum among various farm categories.

xii) Total post harvest losses in case of paddy crop were calculated as 3.674 kg per quintal on medium farm category which were lowest while on marginal farm category these came out to be 6.023 kg per quintal which were highest among all the farm categories.

Policy Suggestions

Keeping the above cited conclusions into consideration the following policy issues can be drawn:

i) Ever increasing prices of farm inputs especially pesticides and fungicides should be curtailed by keeping a check on the prices being charged by the private pesticide dealers to stop exploitation of the farmers.

ii) There is a need of imparting new training programmes to farmers for timely and cheaper control of insect-pest and disease attack to minimize the production losses due to these constraints.

iii) There is a need of rejuvenation of the Govt. extension agencies for approaching the farming community and making themselves indispensable to curtail the dependence of farmers on private input dealers for taking advice regarding farm related problems.

iv) Timeliness in harvesting of wheat and paddy crops should be ensured for minimizing the harvesting losses and untimely harvesting by the farmers should be discouraged by penalizing for the lapse.

v) Post harvest losses can be further minimized by imparting training to farmers on control of rodents and fungus for storage of wheat grains.

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Appendix I(a): Trends in operational cost of wheat cultivation (CACP) in Punjab, 1981-82 to 2008-09

(Rs/ha)

Year	Human Labour	Bullock Labour	Machine Labour	Seed	Fertilizers	Insecticide	Irrigation	Misc. expenses	Interest on working capital	Operational Cost
1981-82	590.61	135.46	474.24	168.16	830.56	22.51	88.13	8.13	64.73	2382.53
1982-83	604.26	111.49	532.1	207.04	834.95	59.8	114.44	6.43	69.68	2540.19
1983-84	628.58	130.08	535.72	195.88	791.74	111.01	173.88	6.82	72.16	2645.87
1984-85	825.56	158.86	600.89	203.72	834.92	69.17	212.96	12.42	79.69	2998.19
1985-86	882.14	147.26	667.22	217.43	817.12	62.7	209.64	15.84	82.97	3102.32
1986-87	847.59	111.91	675.67	227.12	910.93	104.7	182.77	10.32	85.04	3156.05
1987-88	984.69	107.78	665.49	259.79	958.94	116.45	198.27	15.19	93.39	3399.99
1988-89	958.82	97.67	825.12	306.76	942.46	160.76	206.3	12.66	99.76	3610.31
1989-90	1038.54	104.59	826.63	276.48	1002.19	190.37	189.88	21.74	103.2	3753.62
1990-91	1288.59	103.57	974.34	325.38	1085.35	183.2	219.29	20.92	117.36	4318
1991-92	1349.88	112.64	1093.65	374.4	1357.36	191.83	203.05	133.62	21.8	4838.23
1992-93	1910.91	78.39	1157.62	403.13	1571.8	208.16	242.85	19.2	151.5	5743.56
1993-94	2146.26	4.6	1028.74	495.9	2028.16	176.22	455.5	87.63	172.77	6595.78
1994-95	2354.99	51.53	1182.02	463.95	1919.94	294.26	335.93	19.18	178.2	6800
1995-96	2480.58	37.37	1384.68	500.57	2164.03	314.32	341.87	23.51	195.83	7442.76
1996-97	2892.53	44.34	1586.41	647.31	2346.96	388.4	341.7	45.81	232.59	8526.05
1997-98	3048.47	59.04	1692.07	691.19	2331.72	428.83	215.12	24.5	239.19	8730.13
1998-99	3013.77	59.03	2068.72	789.39	2172.62	618.22	155.16	34.09	250.23	9161.23
1999-00	3006.72	23.83	2621.4	740.02	2346.29	668.65	266.55	54.09	272.51	10000.06
2000-01	2675.37	99.23	2875.94	643.37	2556.83	813.91	377.76	55.13	284.55	10382.09
2001-02	2679.91	46	3324.7	726.56	2532.79	1047.11	338.04	46.71	303.67	11045.49
2002-03	2482.25	153.8	3449.01	781.1	2729.23	1085.79	615.81	32.13	324.03	11653.15
2003-04	2037.66	93.15	3226.11	836.38	2755.49	1202.3	504.35	16.92	305.78	10978.14
2004-05	1952.42	75.17	3866.03	865.35	2903.17	1180.98	461.72	36.91	331.55	11673.3
2005-06	2914.9	60.62	4131.66	931.04	2879.5	1077.6	576.04	76.96	363.09	13011.41
2006-07	3309.21	86.35	4458.15	1078.48	2851.33	970.8	488	104.52	387.39	13734.23
2007-08	3058.13	67.72	5347.84	1210.29	2929.59	1004.23	472.86	77.81	406.43	14574.9
2008-09	4034.63	78.01	5271.94	1371.12	2924.12	1038.07	296.75	124.48	425.11	15564.23

Appendix I(b): Trends in per cent share in operational cost of wheat cultivation (CACP) in Punjab, 1981-82 to 2008-09

Year	Human Labour	Bullock Labour	Machine Labour	Seed	Fertilizers	Insecticide	Irrigation	Misc. expenses	Interest on working capital	Operational Cost
1981-82	24.79	5.69	19.90	7.06	34.86	0.94	3.70	0.34	2.72	100.00
1982-83	23.79	4.39	20.95	8.15	32.87	2.35	4.51	0.25	2.74	100.00
1983-84	23.76	4.92	20.25	7.40	29.92	4.20	6.57	0.26	2.73	100.00
1984-85	27.54	5.30	20.04	6.79	27.85	2.31	7.10	0.41	2.66	100.00
1985-86	28.43	4.75	21.51	7.01	26.34	2.02	6.76	0.51	2.67	100.00
1986-87	26.86	3.55	21.41	7.20	28.86	3.32	5.79	0.33	2.69	100.00
1987-88	28.96	3.17	19.57	7.64	28.20	3.43	5.83	0.45	2.75	100.00
1988-89	26.56	2.71	22.85	8.50	26.10	4.45	5.71	0.35	2.76	100.00
1989-90	27.67	2.79	22.02	7.37	26.70	5.07	5.06	0.58	2.75	100.00
1990-91	29.84	2.40	22.56	7.54	25.14	4.24	5.08	0.48	2.72	100.00
1991-92	27.90	2.33	22.60	7.74	28.05	3.96	4.20	2.76	0.45	100.00
1992-93	33.27	1.36	20.16	7.02	27.37	3.62	4.23	0.33	2.64	100.00
1993-94	32.54	0.07	15.60	7.52	30.75	2.67	6.91	1.33	2.62	100.00
1994-95	34.63	0.76	17.38	6.82	28.23	4.33	4.94	0.28	2.62	100.00
1995-96	33.33	0.50	18.60	6.73	29.08	4.22	4.59	0.32	2.63	100.00
1996-97	33.93	0.52	18.61	7.59	27.53	4.56	4.01	0.54	2.73	100.00
1997-98	34.92	0.68	19.38	7.92	26.71	4.91	2.46	0.28	2.74	100.00
1998-99	32.90	0.64	22.58	8.62	23.72	6.75	1.69	0.37	2.73	100.00
1999-00	30.07	0.24	26.21	7.40	23.46	6.69	2.67	0.54	2.73	100.00
2000-01	25.77	0.96	27.70	6.20	24.63	7.84	3.64	0.53	2.74	100.00
2001-02	24.26	0.42	30.10	6.58	22.93	9.48	3.06	0.42	2.75	100.00
2002-03	21.30	1.32	29.60	6.70	23.42	9.32	5.28	0.28	2.78	100.00
2003-04	18.56	0.85	29.39	7.62	25.10	10.95	4.59	0.15	2.79	100.00
2004-05	16.73	0.64	33.12	7.41	24.87	10.12	3.96	0.32	2.84	100.00
2005-06	22.40	0.47	31.75	7.16	22.13	8.28	4.43	0.59	2.79	100.00
2006-07	24.09	0.63	32.46	7.85	20.76	7.07	3.55	0.76	2.82	100.00
2007-08	20.98	0.46	36.69	8.30	20.10	6.89	3.24	0.53	2.79	100.00
2008-09	25.92	0.50	33.87	8.81	18.79	6.67	1.91	0.80	2.73	100.00

Appendix II(a): Trends in fixed cost of wheat cultivation (CACP) in Punjab, 1981-82 to 2008-09

(Rs/ha)

Year	Rental value of Owned	Land revenue and taxes	Rent paid for leased in land	Depreciation on implements & buildings	Interest on fixed capital	Fixed Cost
1981-82	812.28	3.15	186.87	64.69	326.67	1393.66
1982-83	1018.09	3.72	249.31	80.59	335.38	1687.09
1983-84	1079.1	3.2	274.94	77.25	372.21	1806.7
1984-85	1343.7	3.95	238.89	101.38	468.61	2156.53
1985-86	1397.43	3.94	336.21	112.9	435.04	2285.52
1986-87	1281.37	3.9	301.42	105.25	458.97	2150.91
1987-88	1514.28	3.49	428.45	107.68	489.53	2543.43
1988-89	1816.6	3.33	680.34	104.05	471.58	3075.9
1989-90	1966.61	3.15	530.52	137.03	600.63	3237.94
1990-91	2363.88	3.55	630.24	125.25	561.51	3684.43
1991-92	2795.76	3.96	801.58	170.24	665.19	4436.73
1992-93	3350.55	3.68	992.59	161.92	693.22	5201.96
1993-94	5133.97	3.01	160.75	225.88	1429.98	6953.59
1994-95	4538.22	3.5	887.08	214.94	1194.28	6798.03
1995-96	3947.29	3.21	1770.33	223.03	924.55	6868.41
1996-97	6942.73	4.14	761.34	312.62	1445.13	9465.95
1997-98	5894.3	0	1403.6	215.95	1089.91	8603.76
1998-99	7445.7	0	1469.91	217.34	1185.04	10317.9
1999-00	8401.65	0	1112.06	176.58	1621.78	11312.07
2000-01	8036.23	0	2155.52	308.32	1654.77	12154.84
2001-02	8111	0	2195.7	151.38	1427.29	11885.5
2002-03	7693.6	0	1571.71	220.28	1858.47	11344.06
2003-04	6751.25	0	2451.38	284.26	1950	11436.89
2004-05	7462.28	0	3054.35	181.11	1826.44	12524.18
2005-06	9801.15	0	1275.89	270.85	2340.29	13688.18
2006-07	11382.66	0	2263.87	255.56	2310.63	16212.72
2007-08	13169.85	0	2276.89	269.73	2535.59	18252.06
2008-09	13960.87	0	2021.94	359.42	3517.02	19859.25

Appendix II(b): Trends in per cent share in fixed cost of wheat cultivation (CACP) in Punjab, 1981-82 to 2008-09

Year	Rental value of Owned land	Land revenue and taxes	Rent paid for leased in land	Depreciation on implements & buildings	Interest on fixed capital	Fixed Cost
1981-82	58.28	0.23	13.41	4.64	23.44	100.00
1982-83	60.35	0.22	14.78	4.78	19.88	100.00
1983-84	59.73	0.18	15.22	4.28	20.60	100.00
1984-85	62.31	0.18	11.08	4.70	21.73	100.00
1985-86	61.14	0.17	14.71	4.94	19.03	100.00
1986-87	59.57	0.18	14.01	4.89	21.34	100.00
1987-88	59.54	0.14	16.85	4.23	19.25	100.00
1988-89	59.06	0.11	22.12	3.38	15.33	100.00
1989-90	60.74	0.10	16.38	4.23	18.55	100.00
1990-91	64.16	0.10	17.11	3.40	15.24	100.00
1991-92	63.01	0.09	18.07	3.84	14.99	100.00
1992-93	64.41	0.07	19.08	3.11	13.33	100.00
1993-94	73.83	0.04	2.31	3.25	20.56	100.00
1994-95	66.76	0.05	13.05	3.16	17.57	100.00
1995-96	57.47	0.05	25.77	3.25	13.46	100.00
1996-97	73.34	0.04	8.04	3.30	15.27	100.00
1997-98	68.51	0.00	16.31	2.51	12.67	100.00
1998-99	72.16	0.00	14.25	2.11	11.49	100.00
1999-00	74.27	0.00	9.83	1.56	14.34	100.00
2000-01	66.12	0.00	17.73	2.54	13.61	100.00
2001-02	68.24	0.00	18.47	1.27	12.01	100.00
2002-03	67.82	0.00	13.85	1.94	16.38	100.00
2003-04	59.03	0.00	21.43	2.49	17.05	100.00
2004-05	59.58	0.00	24.39	1.45	14.58	100.00
2005-06	71.60	0.00	9.32	1.98	17.10	100.00
2006-07	70.21	0.00	13.96	1.58	14.25	100.00
2007-08	72.16	0.00	12.47	1.48	13.89	100.00
2008-09	70.30	0.00	10.18	1.81	17.71	100.00

Appendix III: Trends in total cost (operational+ fixed) of wheat cultivation (CACP) in Punjab, 1981-82 to 2008-09

(Rs/ha)

Year	Operational cost	Fixed Cost	Total Cost	Operational cost	Fixed Cost	Total Cost
				Per cent share		
1981-82	2382.53	1393.66	3775.19	63.11	36.92	100.00
1982-83	2540.19	1687.09	4227.28	60.09	39.91	100.00
1983-84	2645.87	1806.7	4452.57	59.42	40.58	100.00
1984-85	2998.19	2156.53	5154.72	58.16	41.84	100.00
1985-86	3102.32	2285.52	5387.84	57.58	42.42	100.00
1986-87	3156.05	2150.91	5306.96	59.47	40.53	100.00
1987-88	3399.99	2543.43	5943.42	57.21	42.79	100.00
1988-89	3610.31	3075.9	6686.22	54.00	46.00	100.00
1989-90	3753.62	3237.94	6991.52	53.69	46.31	100.00
1990-91	4318	3684.43	8002.43	53.96	46.04	100.00
1991-92	4838.23	4436.73	9274.96	52.16	47.84	100.00
1992-93	5743.56	5201.96	10945.52	52.47	47.53	100.00
1993-94	6595.78	6953.59	13549.37	48.68	51.32	100.00
1994-95	6800	6798.03	13598.04	50.01	49.99	100.00
1995-96	7442.76	6868.41	14311.17	52.01	47.99	100.00
1996-97	8526.05	9465.95	17992.01	47.39	52.61	100.00
1997-98	8730.13	8603.76	17333.89	50.36	49.64	100.00
1998-99	9161.23	10317.9	19479.22	47.03	52.97	100.00
1999-00	10000.06	11312.07	21312.13	46.92	53.08	100.00
2000-01	10382.09	12154.84	22537	46.07	53.93	100.00
2001-02	11045.49	11885.5	22930.9	48.17	51.83	100.00
2002-03	11653.15	11344.06	22997.21	50.67	49.33	100.00
2003-04	10978.14	11436.89	22415	48.98	51.02	100.00
2004-05	11673.3	12524.18	24197.48	48.24	51.76	100.00
2005-06	13011.41	13688.18	26699.59	48.73	51.27	100.00
2006-07	13734.23	16212.72	29946.95	45.86	54.14	100.00
2007-08	14574.9	18252.06	32826.96	44.40	55.60	100.00
2008-09	15564.23	19859.25	35423.48	43.94	56.06	100.00

Appendix IV(a): Trends in operational cost of paddy cultivation (CACP) in Punjab, 1981-82 to 2008-09

(Rs/ha)

Year	Human Labour	Bullock Labour	Machine Labour	Seed	Fertilizers	Insecticide	Irrigation	Misc. expenses	Interest on working capital	Operational Cost
1981-82	1196.07	149.89	310.21	134.78	916.6	119.36	707.24	0	98.34	3632.49
1982-83	1106.49	120.25	426.66	124.27	928.36	109.39	727.5	0	100.31	3643.23
1983-84	1266.05	130.79	447.99	129.73	1153.06	142.54	687.08	0	111.46	4068.7
1984-85	1531.72	216.72	463.81	140.72	1091.54	168.64	771.94	0.03	120.94	4506.06
1985-86	1446.45	184.92	460.89	130.12	949.34	146.15	759.74	0	112.59	4190.2
1986-87	1607.59	159.99	445.44	126.54	1007.89	170.42	764.25	0.17	117.83	4400.12
1987-88	1558.03	121.95	685.14	152.38	1043.49	169.64	821.17	0	127.31	4678.91
1988-89	1529.75	102.49	583.25	153.89	1002.92	172.82	833.04	0	124.92	4503.06
1989-90	1482.21	202.71	772.12	155.64	989.79	220.13	755.44	0	126.03	4704.06
1990-91	1851.09	70.52	998.8	174.45	1241.52	262.05	979.92	0	157.29	5727.63
1991-92	1946.76	110.46	925.49	189.9	1107.48	323.27	1104.37	0	159.6	5867.31
1992-93	2216.88	66.33	1087.17	183.94	1452.81	380.83	1053.32	0	174.21	6615.43
1993-94	3072.22	89.61	966.85	218.57	1403.13	490.84	1344.12	0	195.2	7795.54
1994-95	2999.51	51.78	1053.54	293.87	1621.81	650.44	1481.89	0	216.51	8369.58
1995-96	3088.88	70.46	1259.76	281.21	1419.79	609.27	1479.66	1.96	215.28	8429.26
1996-97	3407.69	34	1789.07	354.81	1959.53	825.04	1549	0	275.52	10194.66
1997-98	3342.09	25.06	1816.41	397.09	1702.31	767.52	1552.76	0.08	256.11	9559.43
1998-99	3716.7	23.71	2164.17	467.06	1880.3	860.08	1334.15		282.87	10729.04
1999-00	3635.16	11.37	2432.86	529.63	2205.07	922.18	1365.7	9.53	303.95	11415.43
2000-01	3857.42	16.98	2435.45	512.69	1956.55	1139.37	1543.88	19.08	311.93	11793.35
2001-02	4124.68	32.15	2670.31	557.25	1974.26	1179.39	1455.71	19.34	322.01	12325.1
2002-03	5199.93	117.16	3398.72	554.39	2678.62	1179.12	4149.34	4.1	467.23	17748.61
2003-04	4525.82	35.03	3068.12	569.48	2507.63	1603.78	2861.02	9.33	419.35	15599.56
2004-05	4794.34	89.82	3653.01	595.04	2535.92	1298.26	3335.01	17.35	445.19	16763.94
2005-06	4981.22	26.16	2969.02	658.9	2446.74	1439.51	2571.18	30.24	415.99	15538.98
2006-07	5161.77	89.83	3029.11	651.28	2466.9	1251.89	2015.9	29.64	399.92	15096.24
2007-08	5472.15	90.43	3630.81	725.97	2518	1486.25	1636.38	28.76	424.82	16013.57
2008-09	8369.91	162.19	4510.37	901.84	3063.67	1977.14	1406.3	24.17	555.34	20970.94

Appendix IV(b): Trends in per cent share in operational cost of paddy cultivation (CACP) in Punjab, 1981-82 to 2008-09

Year	Human Labour	Bullock Labour	Machine Labour	Seed	Fertilizers	Insecticide	Irrigation	Misc. expenses	Interest on working capital	Operational Cost
1981-82	32.93	4.13	8.54	3.71	25.23	3.29	19.47	0.00	2.71	100.00
1982-83	30.37	3.30	11.71	3.41	25.48	3.00	19.97	0.00	2.75	100.00
1983-84	31.12	3.21	11.01	3.19	28.34	3.50	16.89	0.00	2.74	100.00
1984-85	33.99	4.81	10.29	3.12	24.22	3.74	17.13	0.00	2.68	100.00
1985-86	34.52	4.41	11.00	3.11	22.66	3.49	18.13	0.00	2.69	100.00
1986-87	36.54	3.64	10.12	2.88	22.91	3.87	17.37	0.00	2.68	100.00
1987-88	33.30	2.61	14.64	3.26	22.30	3.63	17.55	0.00	2.72	100.00
1988-89	33.97	2.28	12.95	3.42	22.27	3.84	18.50	0.00	2.77	100.00
1989-90	31.51	4.31	16.41	3.31	21.04	4.68	16.06	0.00	2.68	100.00
1990-91	32.32	1.23	17.44	3.05	21.68	4.58	17.11	0.00	2.75	100.00
1991-92	33.18	1.88	15.77	3.24	18.88	5.51	18.82	0.00	2.72	100.00
1992-93	33.51	1.00	16.43	2.78	21.96	5.76	15.92	0.00	2.63	100.00
1993-94	39.41	1.15	12.40	2.80	18.00	6.30	17.24	0.00	2.50	100.00
1994-95	35.84	0.62	12.59	3.51	19.38	7.77	17.71	0.00	2.59	100.00
1995-96	36.64	0.84	14.95	3.34	16.84	7.23	17.55	0.02	2.55	100.00
1996-97	33.43	0.33	17.55	3.48	19.22	8.09	15.19	0.00	2.70	100.00
1997-98	34.96	0.26	19.00	4.15	17.81	8.03	16.24	0.00	2.68	100.00
1998-99	34.64	0.22	20.17	4.35	17.53	8.02	12.43	0.00	2.64	100.00
1999-00	31.84	0.10	21.31	4.64	19.32	8.08	11.96	0.08	2.66	100.00
2000-01	32.71	0.14	20.65	4.35	16.59	9.66	13.09	0.16	2.64	100.00
2001-02	33.47	0.26	21.67	4.52	16.02	9.57	11.81	0.16	2.61	100.00
2002-03	29.30	0.66	19.15	3.12	15.09	6.64	23.38	0.02	2.63	100.00
2003-04	29.01	0.22	19.67	3.65	16.08	10.28	18.34	0.06	2.69	100.00
2004-05	28.60	0.54	21.79	3.55	15.13	7.74	19.89	0.10	2.66	100.00
2005-06	32.06	0.17	19.11	4.24	15.75	9.26	16.55	0.19	2.68	100.00
2006-07	34.19	0.60	20.07	4.31	16.34	8.29	13.35	0.20	2.65	100.00
2007-08	34.17	0.56	22.67	4.53	15.72	9.28	10.22	0.18	2.65	100.00
2008-09	39.91	0.77	21.51	4.30	14.61	9.43	6.71	0.12	2.65	100.00

Appendix V(a): Trends in fixed cost of paddy cultivation (CACP) in Punjab, 1981-82 to 2008-09

(Rs/ha)

Year	Rental value of Owned land	Land revenue and taxes	Rent paid for leased in land	Depreciation on implements & buildings	Interest on fixed capital	Fixed Cost
1981-82	1255.69	3.6	166.56	62.17	353.38	1841.4
1982-83	1371.06	3.7	283.54	94.87	409.42	2162.59
1983-84	1535.09	3.11	367.14	83.38	424.99	2413.71
1984-85	1608.51	3.89	269.83	110	518.02	2510.25
1985-86	1604.49	3.94	252.72	100.76	487.87	2449.78
1986-87	1946.84	4.5	364.11	96.56	578.08	2990.09
1987-88	2210.94	3.68	365.22	77.58	511.48	3168.9
1988-89	2306.83	3.37	288.86	105.77	476.82	3181.65
1989-90	2241.9	3.01	1026.98	132.52	677.18	4081.59
1990-91	2923.86	4.05	585.41	132.47	709	4354.79
1991-92	3071.16	4.55	692.61	112.93	642.24	4523.49
1992-93	4051.64	4.73	1032.31	147.2	799.9	6053.78
1993-94	4993.88	12.66	1214.53	191.29	1385.73	6798.09
1994-95	5104.96	3.15	679.65	207.87	883.28	6878.91
1995-96	4599.77	3.11	1452.98	192.76	851.31	7099.94
1996-97	5948.2	3.42	614.29	165.06	1041.22	7772.19
1997-98	6877.07	0	1514.28	159.09	883.14	9433.58
1998-99	6124.14	0	1089.99	175.08	1007.92	8397.13
1999-00	7482.86	0	918.79	122.44	1179.92	9704.01
2000-01	7795.36	0	1415.95	194.89	1106.24	10512.44
2001-02	8200.22	0	1947.23	107.38	997.46	11252.29
2002-03	8135.96	0	1856.41	177.48	1430.24	11600.09
2003-04	7916.57	0	3720.59	220.92	1468.6	13326.68
2004-05	9283.77	0	4107.09	133.03	1482.55	15006.44
2005-06	10873.18	0	1505.69	204.66	2086.98	14470.51
2006-07	11595.15	0	1681.28	177.69	1833.76	15287.88
2007-08	13680.51	0	2737.9	200.23	2148.99	18767.63
2008-09	16883.54	0	3915.7	268.11	3552.95	24320.3

Appendix V(b): Trends in per cent share in fixed cost of paddy cultivation (CACP) in Punjab, 1981-82 to 2008-09

Year	Rental value of Owned land	Land revenue and taxes	Rent paid for leased in land	Depreciation on implements & buildings	Interest on fixed capital	Fixed Cost
1981-82	68.19	0.20	9.05	3.38	19.19	100.00
1982-83	63.40	0.17	13.11	4.39	18.93	100.00
1983-84	63.60	0.13	15.21	3.45	17.61	100.00
1984-85	64.08	0.15	10.75	4.38	20.64	100.00
1985-86	65.50	0.16	10.32	4.11	19.91	100.00
1986-87	65.11	0.15	12.18	3.23	19.33	100.00
1987-88	69.77	0.12	11.53	2.45	16.14	100.00
1988-89	72.50	0.11	9.08	3.32	14.99	100.00
1989-90	54.93	0.07	25.16	3.25	16.59	100.00
1990-91	67.14	0.09	13.44	3.04	16.28	100.00
1991-92	67.89	0.10	15.31	2.50	14.20	100.00
1992-93	66.93	0.08	17.05	2.43	13.21	100.00
1993-94	73.46	0.19	17.87	2.81	20.38	100.00
1994-95	74.21	0.05	9.88	3.02	12.84	100.00
1995-96	64.79	0.04	20.46	2.71	11.99	100.00
1996-97	76.53	0.04	7.90	2.12	13.40	100.00
1997-98	72.90	0.00	16.05	1.69	9.36	100.00
1998-99	72.93	0.00	12.98	2.08	12.00	100.00
1999-00	77.11	0.00	9.47	1.26	12.16	100.00
2000-01	74.15	0.00	13.47	1.85	10.52	100.00
2001-02	72.88	0.00	17.31	0.95	8.86	100.00
2002-03	70.14	0.00	16.00	1.53	12.33	100.00
2003-04	59.40	0.00	27.92	1.66	11.02	100.00
2004-05	61.87	0.00	27.37	0.89	9.88	100.00
2005-06	75.14	0.00	10.41	1.41	14.42	100.00
2006-07	75.85	0.00	11.00	1.16	11.99	100.00
2007-08	72.89	0.00	14.59	1.07	11.45	100.00
2008-09	69.42	0.00	16.10	1.10	14.61	100.00

Appendix VI: Trends in total cost (operational+ fixed) of paddy cultivation (CACP) in Punjab, 1981-82 to 2008-09

(Rs/ha)

Year	Operational cost	Fixed Cost	Total Cost	Operational cost	Fixed Cost	Total Cost
				Per cent share		
1981-82	3632.49	1841.4	5473.89	66.36	33.64	100.00
1982-83	3643.23	2162.59	5805.82	62.75	37.25	100.00
1983-84	4068.7	2413.71	6482.41	62.77	37.23	100.00
1984-85	4506.06	2510.25	7016.31	64.22	35.78	100.00
1985-86	4190.2	2449.78	6639.98	63.11	36.89	100.00
1986-87	4400.12	2990.09	7390.21	59.54	40.46	100.00
1987-88	4678.91	3168.9	7847.81	59.62	40.38	100.00
1988-89	4503.06	3181.65	7684.71	58.60	41.40	100.00
1989-90	4704.06	4081.59	8785.65	53.54	46.46	100.00
1990-91	5727.63	4354.79	10082.42	56.81	43.19	100.00
1991-92	5867.31	4523.49	10390.8	56.47	43.53	100.00
1992-93	6615.43	6053.78	12651.21	52.29	47.85	100.00
1993-94	7795.54	6798.09	14593.63	53.42	46.58	100.00
1994-95	8369.58	6878.91	14248.49	58.74	48.28	100.00
1995-96	8429.26	7099.94	15526.6	54.29	45.73	100.00
1996-97	10194.66	7772.19	17966.85	56.74	43.26	100.00
1997-98	9559.43	9433.58	18993.01	50.33	49.67	100.00
1998-99	10729.04	8397.13	19126.17	56.10	43.90	100.00
1999-00	11415.43	9704.01	21119.44	54.05	45.95	100.00
2000-01	11793.35	10512.44	22305.79	52.87	47.13	100.00
2001-02	12325.1	11252.29	23577.39	52.28	47.72	100.00
2002-03	17748.61	11600.09	29348.7	60.47	39.53	100.00
2003-04	15599.56	13326.68	28926.24	53.93	46.07	100.00
2004-05	16763.94	15006.44	31770.38	52.77	47.23	100.00
2005-06	15538.98	14470.51	30009.49	51.78	48.22	100.00
2006-07	15096.24	15287.88	30384.12	49.68	50.32	100.00
2007-08	16013.57	18767.63	34781.2	46.04	53.96	100.00
2008-09	20970.94	24320.3	45291.24	46.30	53.70	100.00

Appendix VII

Coordinator's Comments on the Draft Report

1. **Title of the draft report examined:**

   Assessment of Pre and Post Harvest Losses in Wheat and Paddy Crops in Punjab

2. **Date of receipt of the Draft report:** 8 November 2012

3. **Date of dispatch of the comments:** 11 December 2012

4. **Comments on the Objectives of the study:**

   All the objectives of the study have been addressed

5. **Comments on the methodology**

   Common methodology proposed for the collection of field data and tabulation of results has been followed. However, some changes are required to be made in a few tables.

6. **Comments on analysis, organization, presentation etc.**

(i) Since the composition of the state economy is presented in percentage terms in Table 1.2, the Table 1.1 containing absolute number is redundant and hence it may be removed. Similarly, Table 1.3 and Table 1.4 provide absolute value of GSDP in current prices and their per cent distribution, respectively are not required.

(ii) Chapter 2, Section 2.2 deals with changes in costs and profitability of wheat and paddy. Analysis of the changes in costs based on the CACP cost items is quite interesting. But, these costs are given in aggregate terms. A mere interpretation of these items does not throw much light on the changes in individual cost items. Therefore, it would be useful to present the per cent share of individual cost items (like land, labour, fertilizers, pesticides etc.) in order to better understand which cost items are driving the cost of production in the state of Punjab over time.

(iii) In Chapter 3, Table 3.4 provides data on source of irrigation by percentage of households having access to irrigation. However, it is better to provide these figures in terms of percentage of net operated area.

(iv) It appears from the Table 4.1, Table 4.3, Table 4.4 and Table 4.5 provided in the Chapter 4 that incidence of pests and diseases on wheat and paddy is low and hence low reported loss. It therefore, needs to be emphasized in the report that whether low incidence is due to efficient crop management through agronomic practices by the farmers, varietal characteristics or any other factors.

(v) Table 4.5 and Table 4.6 reports magnitude of crop loss. But, in both the tables actual production with attack does not match with yield data presented in Table 3.7. Yield data need to be checked and corrected accordingly. This will also lead to making changes in loss estimates.

(vi) In Table 5.1 (Chapter 5), for manually and mechanically harvested, work out the percentages across stages of harvest by each type of harvesting methods. That is, 100 should add up to manual harvesting separately. So is the case for the mechanical harvesting.

(vii) Section 5.2, p.64 and also Table 5.3 should be modified to incorporate loss during threshing and winnowing by mechanical methods. It is clear from the discussion that no manual threshing has been reported by the sample farmers. However, there might be cases of mechanical threshing and winnowing of paddy and wheat. Therefore, instead of reporting of no manual threshing in the Section 5.2, information on mechanical threshing and winnowing should be provided.

(viii) The reported loss of grains during transportation and handling (Table 5.4, Table 5.5 and Table 5.8) is very low (59g/qtl of wheat and 63g/qtl of paddy). Authors may provide possible reasons for such efficient transportation and handling of wheat and paddy by the farmers in the study. Authors are also requested to relook at the data and calculate the loss for further confirmation. Similarly, estimates of grain loss during storage should also be recalculated.

7. Overall view on acceptability of report

Authors are requested to incorporate all the comments and submit the final report for consolidation.

Appendix VIII

ACTION TAKEN ON THE COMMENTS BY AERC, LUDHIANA

'Assessment of Pre and Post Harvest Losses in Wheat and Paddy Crops in Punjab

The report has been revised in the light of comments/observations/ suggestions received from the coordinating centre. Point wise reply is as under:

(i) The additional information presented in chapter 1 over and above the coordinator's requirements has been incorporated keeping in view its relevance for readers of the state. Hence tables 1.1 to 1.4 have been retained in the report.

(ii) Discussion regarding individual cost items of wheat and paddy cultivation (CACP) has been incorporated as desired and detailed cost break up has been appended (Appendix I-VI).

(iii) Suggestion incorporated

(iv)) Suggestion incorporated

(v) The yield data presented in Table 3.7 have been calculated by dividing the total production on the selected farms by operational area under the crop. On the contrary, the data on actual and normal production in Tables 4.5 and 4.6 have been estimated on the perception of the sample farmers in case there was no major productivity loss due to insect, pest, diseases and weeds incidence and vice versa. Therefore, the figures in these tables may not exactly match but are almost at par.

(vi) Suggestion incorporated

(vii) Suggestion incorporated

(viii) Estimated transportation and storage losses checked and found correct.

(D.K. Grover)

AERC, Ludhiana