

## Pre and post harvest losses: farm level estimates for paddy cultivation in Punjab

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### ABSTRACT

The present study makes a comprehensive attempt to estimate the dimension of losses occurring during the pre and post harvest stages of paddy crop. For the purpose, required primary data were collected from 120 paddy growing farmers of various farm size categories from Ludhiana and Ferozepur districts. The results of the study based on farmers' perceptions revealed that 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 increased with an 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 on large farm category. The total magnitudes of crop losses due to biotic stresses 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. Both early and late harvesting of paddy 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. Total post harvest losses 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 minimal due to the mechanized transport facility of tractor-trolley available with each sample respondent. The major policy issues suggested were; check on prices of various inputs used in paddy cultivation along with further subsidization to decrease cost of production, rejuvenation of govt. extension agencies for curtailing the dependence of farmers on private input dealers for expert advice to solve farm related problems and timeliness and supervision of paddy harvesting as a key to lower the harvesting losses in case of paddy crop.

**Key words:** Pest and diseases loss, pre harvest losses, post harvest losses, transportation, storage of grains

Emergence of paddy-wheat monoculture in the state during post-green revolution period has 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 worldwide yield loss due to various types of pest was estimated at as 37.4 per cent in rice (Oerke, 2007). 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. To estimate the crop loss, most of the existing studies have adopted experimental treatment approach (with or without pest attack through artificial infestation). 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 are considered more reliable for generalization/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.

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 etc. 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.

Roy and Dutta (1999) estimated paddy yield losses due to major biotic stresses as 1133.13 kilograms/ha in Haryana in which - more than 50 per cent of the total loss observed was due to biotic stresses like diseases (682 kg ha<sup>-1</sup>) followed by insect pests (265.50 kg ha<sup>-1</sup>) and weeds (185.63 kg ha<sup>-1</sup>). Janaiah and Hossain (2000) conducted a study on the farm level sustainability of intensive rice-wheat system in ten high productive rice-growing villages each from Andhra Pradesh, Karnataka, Punjab and Uttar Pradesh. Based on farmers' perceptions over the past 10 years (1990-99), the annual yield loss was estimated at 536 kg ha<sup>-1</sup> under intensive rice systems. This was equivalent to the total annual loss of about 5 million tonnes of paddy under the intensive rice system in India of which nearly 60 per cent was due to biotic stresses (insect pests and diseases) and remaining 40 per cent was due to the 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 the possible plant protection measures was only 2 per cent (125 kg ha<sup>-1</sup>) and 3 per cent (116 ha<sup>-1</sup>) 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 highlighted as the major yield-reducing insect pests while bacterial leaf blight and blast were major diseases-causing yield losses.

Although various studies have been undertaken in the past to estimate the losses incurred by either biotic or a-biotic stresses in case of paddy crop but with the passage of time due to the development of latest farm technology there has been considerable change in the incidence/ development of diseases, pests and weeds. Climate change has also taken its toll in the form of frequent changes in weather conditions which adversely affect the various crops. So, it becomes imperative to relook at the farm level losses incurred by biotic and a-biotic stresses in case of paddy crop to generate some useful coefficients.

The paper has been designed with the following specific objectives:

1. To estimate the pre and post harvest losses in paddy crop at farm level.
2. To identify the factors responsible for above losses and suggest measures to reduce the quantum of such losses at farm level.

## MATERIALS AND METHODS

The study has been based on the farm level data collected from two major paddy growing districts namely Ludhiana and Ferozepur representing central and south-western zones of Punjab state. From each district, two villages with their proximity to market, one near and one far, were selected for canvassing the schedule. To collect the required primary information, a sample survey was conducted in these two districts for reference year 2011-12.

A random sample of 30 paddy growing farmers from each village was chosen, constituting a total sample of 120 farmers representing various farm size categories viz., marginal (< 2.50 acres), small (2.50 to 5.00 acres), medium (5.00 to 10.00 acres) and large (10.00 and above acres). The sample thus constituted 22 marginal, 24 each small/medium and 50 large farmers for the survey.

To accomplish the well defined objectives of the study, the primary level required data/information related to crop production losses owing to infestation of pests and diseases etc on the sample households were collected through intensive personal survey. Besides, the post harvest losses during harvesting, collection and threshing, transportation and storage were quantified based on the estimates provided by these farmers. The data on such losses collected/estimated were cross checked in consultation with the Department of Agriculture as well as experts of State Agricultural University.

## RESULTS AND DISCUSSION

The socio-economic characters of the sample households (Table 1) revealed that the average numbers of earners were two in all the farm size categories except in large category where there were three earners. 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. 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. The entire area on all the farm size categories was irrigated and the cropping intensity came out to be nearly 200 per cent. The cropping pattern on the sample farms revealed that paddy was the major wet season 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 wet season crops sown by sample households were maize and Bt cotton with negligible area under them. Wheat was major dry season crop which occupied 46.90 per cent of the gross

cropped area on sample farms followed by dry season fodder occupying 2.70 per cent. However, area under other dry season 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 wet season, dry season, summer and perennial crops was under HYV seeds as revealed by all the sample households.

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 section deals with various constraints faced in the production of paddy crop, assessment of incidence of pest and disease attack and crop losses, methods adopted and source of information to control pest and disease attack.

The constraints faced in cultivation of paddy crop have been depicted in Table 2. 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 and labour resulting in decline in profitability.

Major pests of paddy crop as reported by the sample households were; rice stem borer, leaf folder and plant hoppers (Table 3). The rank of severity of rice stem borer was reported by 96 per cent households

**Table 1.** Socio-economic characters and cropping details of sample farmers

Characteristics	Marginal	Small	Medium	Large	Overall	
No of HH	22	24	24	50	120	
Household size (No.)	5	6	6	8	7	
Average numbers of earners (No.)	2	2	2	3	2	
Proportion of Male/Female/Children (%)	Male >15 years	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
Annual family income (Rs)	165878	268589	516075	1259560	712161	
<b>Land holding details (acres):</b>						
Owned land (a)	2.25	4.61	5.83	13.25	8.02	
Leased-in land (b)	0.14	0.48	2.52	7.79	3.87	
Leased-out land (c)	0.23	1.15	0.31	0.36	0.48	
Net operated area (a+b-c) (NOA)	2.16	3.94	8.04	20.68	11.41	
Gross cropped area (GCA)	4.32	7.90	16.00	41.34	22.80	
Cropping intensity (%)	200.00	200.50	199.00	199.90	199.82	
<b>Cropping details (%):</b>						
<b>Wet season crops:</b>						
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	
<b>Dry season crops:</b>						
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	
<b>Summer crops:</b>						
Summer Moong	-	-	-	0.02	0.01	
Vegetables	-	-	0.26	-	0.04	
<b>Perennial crops:</b>						
Sugarcane	-	-	-	0.28	0.21	
<b>Gross cropped area (GCA)</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	

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

**Table 2.** Constraints faced in cultivation of paddy crop (% households)

Constraints	Most important	Important	Least important
Poor seed quality	-	-	98.00
Water deficiency due to erratic power supply	14.00	49.00	37.00
Pest and disease problems	7.00	33.00	60.00
High cost of inputs Including labour	73.00	14.00	13.00

**Table 3.** Incidence of major pests and diseases in paddy (% households)

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
<b>Major Pests</b>											
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	-	-	-
<b>Major Diseases</b>											
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	-	-	-	-
<b>Major Weeds</b>											
Swank( <i>Echinochloa crusgalli</i> )	-	-	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

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. 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 paddy crop have been depicted in Table 4. The actual production with pests, disease and weed infestation fluctuated between 24.93 to 26.51 q acre<sup>-1</sup> 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 q acre<sup>-1</sup>. Normal production without any pest disease and weed infestation varied between

**Table 4.** The magnitude of crop loss due to insect-pests, diseases and weed infestation in paddy

Description	Marginal	Small	Medium	Large	Total
Actual production with attack (q acre <sup>-1</sup> )	24.93	26.51	25.79	26.43	26.30
Normal production without attack (q acre <sup>-1</sup> )	26.91	28.12	27.99	28.79	28.58
Loss of output (q acre <sup>-1</sup> )	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

26.91 to 28.79 q acre<sup>-1</sup> 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 q acre<sup>-1</sup>. The loss of output varied from 1.61 to 2.36 q acre<sup>-1</sup> 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 the minimum on small farms as compared to marginal, medium and small farm categories. 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.

There are chemical and biological methods to control pest and diseases in field crops. The cost of chemical methods adopted for pests and disease control in paddy crop are given in Table 5. All the households applied chemical methods to control pests, diseases and weeds. 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 ₹ 214 to ₹ 256 acre<sup>-1</sup> 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 ₹ 646 on marginal, ₹ 579 on small, ₹ 636.20 on medium, ₹ 624 on large and ₹ 623.90acre<sup>-1</sup> 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 ₹ 181 to ₹ 211 acre<sup>-1</sup> being lowest on large and

highest on marginal farm size category while in an overall situation total cost worked out to be ₹ 185 acre<sup>-1</sup>.

The sources of information for pest and disease control have been given in Table 6. The perusal of the table reveals that all the sample households took advice from some specific source for control of pest and diseases in paddy crop and other farm related requirements and problems encountered. The Government extension agents were ranked as visited rarely by 92 per cent of the households followed by visited sometimes by 4 per cent and visit rarely by 4 per cent sample households. 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 was concerned, 66 per cent households ranked it as visited frequently, 24 per cent as visited sometimes and only 10 per cent households ranked it as visited rarely. 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. Therefore, fellow farmers were ranked as visited frequently for advice by 67 per cent households, visited sometimes by 21 per cent and visited rarely 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 newspaper which were ranked as followed rarely by 91 per cent of the households, followed frequently by 5 per cent and followed sometimes by 4 per cent of the sample households. State Agricultural University and KVK's were also providing extension services on pests and disease control to the farmers and these were ranked as visited rarely by 91 per cent, visited sometimes by 6 per cent

**Table 5.** Cost of chemical methods adopted for pests control in paddy

Particulars	(Rs/acre)				
	Marginal	Small	Medium	Large	Overall
<b>Weedicide</b>					
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
<b>Insecticide</b>					
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
<b>Fungicide</b>					
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

**Table 6.** Extension services on pests control management

Sources of advice	Percentage of households seeking advice		
	Visit frequently	Visit sometimes	Visit rarely
Government extension agent	4.0	4.0	92.0
Private input dealer	66.0	24.0	10.0
Fellow farmers	21.0	67.0	12.0
TV/Radio service/Newspaper	5.0	4.0	91.0
Agricultural University/KVK	3.0	6.0	91.0

and visited frequently 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 frequently visited source of advice for pest/ disease control management and other farm related issues as revealed by the sampled households.

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 section 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.

The production losses during different stages of harvesting of paddy crop have been depicted in Table 7. 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/acre in late and 38.30 kg/acre in mid season harvesting of the crop. The percentage of loss 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.

Production loss during threshing and winnowing of a crop is very important. During the course of investigation sample farmers reported that

no manual/ mechanical threshing was done in case of paddy crop and the entire area under the crop was harvested with combine harvesters leaving little scope for loss due to threshing and winnowing..

The production loss during transportation and handling is of vital importance due to involvement of different functionaries in various marketing operations. Table 8 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 q household<sup>-1</sup>. The average distance covered for transportation of the produce was 4.10 km with transportation cost of ₹1.90/q 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. The average loss during handling worked out to be 0.224 kg q<sup>-1</sup> 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 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 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 9. In case of paddy crop, 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 q household<sup>-1</sup>. 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

**Table 7.** Quantity lost at different stages of harvest of paddy crop

Particulars	Stages of harvest			
	Early	Mid	Late	
Area harvested per h (acres)	0.47	7.75	0.77	
Percentage area harvested	5.22	86.22	8.56	
Area manually harvested (%)	-	-	-	
Area mechanically harvested (%)	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

**Table 8.** Quantity lost during transportation and handling of paddy crop

Mode of transportation		Tractor/Trolley
Average quantity transported (q hh <sup>-1</sup> )		248.30
Average distance covered (Km)		4.10
Transportation cost (₹ q <sup>-1</sup> )		1.90
Rank of loss (percentage of hh)	High	-
	Medium	-
	Low	100.00
Quantity lost during transport	Average loss (kg/q of amount transported)	0.063
	% of amount transported	0.0002
Quantity lost during handling	Average loss (kg/ q of amount handled)	0.224
	% of amount handled	0.001

**Table 9.** Quantity of paddy lost during storage

Particulars		Stored in pucca house
Mode of storage (percentage of amount stored)	Open	-
	Gunny/plastic bag	100.0
	Kothi/bin kuchha, Pucca	-
	Steel drums	-
	Others	-
Quantity stored (q hh <sup>-1</sup> )	0.50	
Percentage of hh who dried before storing	100.00	
Average number of days stored hh <sup>-1</sup> )	365	
Rank of loss in storage	High	-
	Medium	-
	Low	100.00
Quantity lost during storage (kg per quintal of storage)	Due to weight loss	2.50
	Due to rodents	0.114
	Due to fungus	-
Storage cost ₹ q <sup>-1</sup>	0.60	

storage as low. The quantity lost during paddy storage was 2.50 kg q<sup>-1</sup> due to weight loss and 0.114 kg q<sup>-1</sup> due to rodents. The storage cost per quintal worked out to be ₹ 0.60q<sup>-1</sup> as revealed by the sample households.

The total post harvest losses per quintal by farm size have been depicted in Table 10. In case of paddy crop, quantity lost during harvesting of the crop worked out to be a minimum of 1.19 kg q<sup>-1</sup> on marginal farms while on medium farms it was 1.64 kg q<sup>-1</sup> which were highest in all the farm categories. In total, quantity lost in paddy harvest worked out to be 1.54 kg q<sup>-1</sup>. Meager quantity of 0.05 kg q<sup>-1</sup> lost during transportation on medium farms while a maximum of 0.09 kg q<sup>-1</sup> was the loss on marginal and small farms. In total, transportation losses in paddy crop worked out to be 0.06 kg q<sup>-1</sup>. Quantity lost in handling varied from 0.20 kg to 0.22 kg q<sup>-1</sup> with lowest on small farms and highest on medium and large farm categories while in total this 0.22 kg q<sup>-1</sup>

were the handling losses. Storage losses due to weight loss varied from 4.30 kg to 1.70 kg q<sup>-1</sup> with highest on marginal farms and lowest on medium farm category while in total, 2.50 q<sup>-1</sup> was the storage loss due to decline in weight. Storage losses due to other factors came out to be the minimum of 0.053 kgq<sup>-1</sup> on medium and 0.193 kg q<sup>-1</sup> on marginal farms which was also highest on all farm categories while in total the storage loss worked out to be 0.114 kg q<sup>-1</sup> in case of paddy crop. Total post harvest losses in case of paddy crop were calculated as 3.674 q<sup>-1</sup> on medium farm category which were lowest while on marginal farm category these came out to be 6.023 kg q<sup>-1</sup> which were highest on all the farm categories. The total post harvest losses in paddy crop worked out to be 4.43 q and 122.38 kg q<sup>-1</sup> as revealed by the sample respondents.

Another study has estimated the losses of paddy at different stages of handling accounted for 2.47

**Table 10.** Total post harvest losses per quintal by farm size in paddy crop

Particulars	Farm size category				Overall
	Marginal	Small	Medium	Large	
Quantity lost in harvest(kg q <sup>-1</sup> )	1.19	1.66	1.64	1.52	1.54
Quantity lost in threshing(kg q <sup>-1</sup> )	-	-	-	-	-
Quantity lost in winnowing(kg q <sup>-1</sup> )	-	-	-	-	-
Quantity lost in transport(kg q <sup>-1</sup> )	0.09	0.09	0.05	0.06	0.06
Quantity lost in handling(kg q <sup>-1</sup> )	0.25	0.20	0.22	0.22	0.22
Quantity lost in storage (kg q <sup>-1</sup> )	4.30	2.30	1.70	2.60	2.50
a) Due to weight loss b) Storing loss	0.193	0.053	0.064	0.132	0.114
Total post harvest loss(kg q <sup>-1</sup> )	6.023	4.303	3.674	4.532	4.434
Total post harvest loss ((kg q <sup>-1</sup> )	158.40	114.03	99.93	127.28	122.38

per cent of the total production. Harvesting stage accounted for the major proportion of losses followed by transportation while marginal losses were observed during farm level storage of paddy (Grover *et al*, 2012). Thus, this study also authenticated the results of the study i.e. major post harvest losses were at the time of harvesting.

Owing to specialized farming of paddy, the incidence of biotic and a-biotic stresses had multiplied over the years, resulting in decreasing the crop productivity. The study highlighted that high cost of inputs such as fertilizers, insecticides, fungicides, labour etc. was the major constraint at farm level. The individual paddy 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. 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 on large farms. On small farms, the management of biotic stresses in paddy crop was better than other farms. Majority of the farmers took advice from private input dealers to solve their crop related problems. 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. The quantity lost in paddy storage due to rodents was minimal and it was stored in plastic bags. Total post harvest losses in case of paddy crop were calculated as 3.674 kg quintals<sup>-1</sup> on medium farm category which were lowest while on marginal farm category these came out to be 6.023 kg q<sup>-1</sup> which were highest among all the farm categories.

Majority of the farmers reported the high cost of inputs including labour as most important constraint in production of paddy. There is a need to check the rising prices of certified seeds, fertilizers, weedicides, fungicides, pesticides etc. along with providing higher subsidies for these inputs in order to reduce the cost of production of paddy and supply of inputs through co-operatives should be further promoted to minimize the exploitation of farmers at the hands of private input dealers. Further, to curtail the dependence of farmers on private input dealers for taking advice regarding farm related problems, there is a need to rejuvenate the govt. extension agencies for approaching the farming community frequently to solve their problems. Farmers should be emphasized to ensure timeliness and supervision of paddy harvesting to minimize the harvesting losses.

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