Research Report: IX/ADRTC/153A

ASSESSMENT OF PRE AND POST HARVEST LOSSES OF IMPORTANT CROPS IN INDIA

ELUMALAI KANNAN

Agricultural Development and Rural Transformation Centre
Institute for Social and Economic Change
Bangalore- 560 072

September 2014

CONTENTS

LIST OF TABLES

ACKNOWLEDGEMENTS

The present study was entrusted by the Plant Protection Division, Ministry of Agriculture to Agro-Economic Research Centres/Units to estimate crop losses caused by the pest and diseases through farmers' field survey. The reference crops included were paddy, wheat, tur and soybean. This report provides the estimates of pre and post harvest physical loss of these four crops in 10 major states. The study received immense support from the officials of the Ministry of Agriculture, Government of India and State Departments of Agriculture. I sincerely thank all of them for their kind support and cooperation. Sincere thanks are due to all the researchers involved in the preparation of state level reports at the AERCs. I would also like to thank Dr. Parmod Kumar, Professor and Head, ADRTC and Director, ISEC for unstinted support and encouragement for carrying out this study.

Author

CHAPTER I
INTRODUCTION

1.1. Background

Indian agriculture has undergone considerable transformations over time. These transformations are seen in the form of changes in agrarian structure, technological interventions, cropping pattern, enterprise mix and marketing system. During 1960s and 1970s, much emphasis was placed on increasing agricultural production through adoption of high yielding varieties along with use of chemical fertilisers and pesticides. This had led to intensive use of land and agricultural inputs particularly in the regions endowed with irrigation facilities. The periods of 1980s and 1990s had witnessed crop diversification and emergence of allied enterprises like dairying and animal husbandry. The commodity specific programmes like technology mission on oilseeds were launched during the mid-1980s to enhance the production of oilseeds and reduce dependence on imports. The mission was later expanded to include pulses, oil palm and maize. The domestic economic reforms and border trade reforms were introduced in 1990s. These reforms emphasised on reorientation of domestic production for generation of surplus to meet the export demand for agricultural products.

During 2000s, the nature of demand for agricultural commodities has changed for both the domestic and foreign requirements. The food consumption pattern has shifted from cereals to high value commodities like fruits, vegetables and livestock products. Trade liberalisation has led to production of such commodities which have export demand in the world market. These developments in a way have altered a multi commodity production system to a specialised system in different parts of the country. 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 productivity of crops. The increased use of pesticides has also resulted in developing resistance by insects and pathogens, which further led to reduction in crop yield. The indiscriminate and excess use of pesticides combined with chemical fertilisers is partly responsible for environmental degradation. Further, this has led to destruction of habitat of beneficial insects and also increase in the cost of cultivation of crops. The rise in cost of cultivation results in low farm business income and tend to cause distress among the farmers.

1.2. Pre and Post Harvest Losses

1.2.1. 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, crop loss estimates have been made and updated regularly at global level. The worldwide yield loss due to various types of pest was estimated 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 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, loss estimates collected directly from the farmers through sample survey may be reliable and could be used for extrapolation in similar geographical settings. However, farmers' estimates are likely to be subjective and these

should be validated with expert estimates of the state department of agriculture and agricultural research stations.

1.2.2. Post Harvest Losses

Agricultural production 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 damaged by insects, rodents, birds and other pests. Moreover, products may be spoiled by the infestation of 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, 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 shelf-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 structures, it is also essential that the grain being stored is of good quality. At the village level, generally harvesting is done at high moisture content and therefore before storing the same, it is necessary to obtain the desired moisture for safe post storage of grains. There are small storage structures at the farmer level and also 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 is due to insects and fungi. The bulk storage of foodgrains is done mainly by traders, cooperatives and government agencies like food corporation of India, central warehousing corporation and state warehousing corporation 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.

1.3. Need for the Study

As per the available data (Oerke, 2006; Dhaliwal et al, 2010), crop losses caused by pests and diseases are substantially higher. But, the knowledge on the subject of 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 the selected 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 significant 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 was made to estimate such losses based on the farmers' estimates.

1.4. Objectives of the Study

Keeping in view of importance of the subject, the present study focuses on the following objectives.

1. To estimate the physical losses caused by pests and diseases in rice, wheat, tur and soybean 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 rice, wheat, tur and soybean 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

1.5. Database and Methodology

The present study was based on the farm level data collected from the major states growing four reference crops viz., rice, wheat, tur and soybean. 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 sample 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 quantification of yield loss was estimated by asking the farmers to identify the pests and diseases by name, frequency of attack and crop loss by individual pests. Farmers were also asked to mention actual production with attack of all pests and normal production in the absence of pests.

The post harvest losses encountered during the process of harvesting, threshing, transportation and storage were quantified based on the estimates provided by the sample farmers. Storage material used by the farmers is generally mud, bamboo, stone, plant materials etc. The study also attempted to identify the structure of storage at the farmers' level and enumerate the losses occurring during storage at the farmer level for the reference crops. The control measures adopted by the farmers to minimise the post harvest losses were also captured through field survey.

Table 1.1. Distribution of Sample Households

State	Crop	Districts	Sample Size
Assam	Paddy	Golaghat	60
		Sonitpur	60
	Wheat	Morigaon	60
		Borpeta	60
Gujarat	Tur	Bharuch	60
		Vadodara	60
Karnataka	Paddy	Mysore	80
		Shimoga	80
	Tur	Bidar	80
		Gulbarga	80
Madhya Pradesh	Wheat	Hoshangabad	80
		Vidisha	80
	Soybean	Ujjain	80
		Raisen	80
Maharashtra	Tur	Yavatmal	60
		Latur	60
	Soybean	Nanded	60
		Nagpur	60
Punjab	Wheat	Ludhiana	60
		Ferozepur	60
	Paddy	Ludhiana	60
		Ferozepur	60
Rajasthan	Soybean	Chittorgarh	60
		Jhalawar	60
Tamil Nadu	Paddy	Villupuram	60
		Tiruvarur	60
Uttar Pradesh	Paddy	Barabanki	60
		Shahjahanpur	60
	Wheat	Hardoi	60
		Budaun	60
West Bengal	Paddy	Bankura	60
		Burdwan	60
	Wheat	Murshidabad	60
		Uttar Dinajpur	60

The primary survey of farmer households was conducted in 10 states and it covered two cereals (paddy and wheat) and two pulses (tur and soybean). The distribution of sample across select states and reference crops is given in **Table 1.1**. Out of four crops two belonged to cereals (paddy and wheat) and two pulses (tur and soybean). To collect the primary data, a sample survey was conducted in two districts for each reference crop in the selected state for the agricultural year 2011-12 (July to June). In the present study, season for the wheat crop was rabi while the remaining three crops namely rice, tur and soyabean belonged to kharif season. The districts were selected such a way that they represented the major producing areas of the selected crops and different agro-climatic regions 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 household schedule. A random sample of 30 farmers were selected from each village and overall the study covered a total sample of 120 farmers for each crop in every state. Adequate representation was given to different farm size groups such as marginal, small, medium and large farmers in the sample. The individual state reports prepared by various Agro-Economic Research Centres (AERCs) provide detailed description of the sampling and other relevant information.

1.6. Organisation of the Report

The report is organised in five chapters. Chapter I provides background, rationale of the study, objectives and database. Chapter II discusses the sample household characteristics by the select states. The details of the pre harvest losses by four reference crops are discussed in the Chapter III and post harvest losses are presented in Chapter IV. The final chapter provides the summary of findings and policy suggestions.

CHAPTER II
SAMPLE HOUSEHOLDS CHARACTERISTICS AND CROPPING PATTERN

The present chapter discusses some important socio-economic characteristics of the sample households, their land holding pattern, cropping pattern, spread of high yielding varieties and crop productivity. For the purpose of analysis, sample farmers of the reference crops grown in the selected states have been pooled together, and the relevant estimates are worked out for better understating the characteristics of the entire sample households studied in the respective state. The analysis of household characteristics and crop production structure helps in assessing the farmers' capacity to identify the pest and diseases that cause crop losses-pre and post harvest stages and to undertake control measures either through physical, chemical or biological methods. Details of various characteristics of the sample households by states are provided in the following sections.

2.1. ASSAM

2.1.1. Socio-economic Characteristics of Selected Farmers

Demographic profile of the sample farmers of paddy and wheat are provided in **Table 2.1**. The small farm size groups accounted for the highest proportion of households (52.9 per cent) followed by medium (25.0 per cent), marginal (20.4 per cent) and large size group (1.7 per cent). Average household size of all the farm size groups was 6.1. On an average, 4.6 per cent of the respondents belonged to age group of less than 25 years, 33.33 per cent were between 25 and 40 years, and 62.1 per cent were in the age group of above 40 years. Analysis of educational status revealed that 7.9 per cent of family members were illiterate, 29.2 per cent studied up to primary education, 33.8 per cent secondary, 20.3 per cent higher secondary level and 9.2 per cent were graduate and above. As there is a distinct variation of social characteristics among the different social groups, an effort was made to capture the cast structure of the sample households. The sample population was dominated by the general caste (54.2 per cent) followed by SC (21.7 per cent), ST (12.5 per cent) and OBC (11.7 per cent). Average family income from all the sources ranged between Rs.75,796 per annum in marginal farm size groups and Rs. 1,84,000 per annum in large farm size groups indicating that annual income increased with increase in farm size in Assam.

Table 2.1. Demographic profile of the selected farmers in Assam

(% of households)

Characteristics		Marginal	Small	Medium	Large	Total
No of households		20.42	52.92	25.00	1.67	100.00
Household size (numbers)		5.51	6.19	6.30	6.75	6.09
Average age of the respondent	Less than 25	8.16	3.94	3.33	0.00	4.58
	Between 25 to 40	16.33	29.92	56.67	0.00	33.33
	Above 40	75.51	66.14	40.00	100.00	62.08
Highest Education status of a family member	Illiterate	14.29	5.51	8.33	0.00	7.92
	Up to primary	24.49	22.83	48.33	0.00	29.17
	Up to secondary	28.57	40.16	20.00	100.00	33.75
	Higher secondary	28.57	16.54	21.67	0.00	20.33
	Graduate & above	4.08	14.96	1.67	0.00	9.17
Caste	SC	34.69	22.05	11.67	0.00	21.67
	ST	4.08	9.45	23.33	50.00	12.50
	OBC	14.29	11.02	11.67	0.00	11.67
	General	46.94	57.48	53.33	50.00	54.17
Distance from the main market (km)		6.45	7.41	7.64	6.75	7.26
Annual family income (Rs)		75,796	84,795	90,797	1,84,000	86,112

2.1.2. Structure of Operational Holdings

The average size of net operated area (NOA) was 4.0 acres with an irrigated area of 0.4 acre (**Table 2.2**). Except large farmers, other farm size groups engaged in both leasing-in and leasing-out land for cultivation. The scattered distribution of land was the main reason for such practices. Exchange of land among the farmers were also another practice pursued in the locally for efficient use of land for crop cultivation. Cropping intensity has inverse relationship with the farm size. It might be because of the fact that the area sown more than once was higher among the smaller size groups than that of other farm size groups. The increase in gross cropped area can be attributed to increase in area under vegetables and summer paddy.

Table 2.2. Size of operational holdings in Assam

(acres/ household)

Farm size	Owned land	Un cultivated land	Leased- in	Leased - out	NOA	Irrigated area	GCA	Cropping Intensity (%)
Marginal	2.00	0.33	0.20	0.05	1.80	0.33	3.13	173
Small	3.55	0.38	0.50	0.13	3.58	0.38	5.98	167
Medium	7.40	0.63	0.20	0.78	6.20	0.63	8.95	144
Large	15.15	0.68	0.00	1.50	12.98	0.68	16.83	130
Total	4.40	0.43	0.38	0.30	4.03	0.43	6.33	157

2.1.3. Sources of Irrigation

In the sample area, diesel tube well was the only source of irrigation in all the farm size groups (**Table 2.3**). The irrigated area was the highest for small size group (45.1 per cent)

followed by medium farm size category (36.4 per cent), marginal farm size category (15.9 per cent) and large size group (2.6 per cent). Surprisingly, only groundwater was used for irrigation in the study area and water was lifted by using diesel tube wells.

Table 2.3. Source wise irrigation of net irrigated area in Assam

(Per cent)

Farm size	Only canal	Canal + tube-well	Only electric tube-well	Only diesel tube-well	Tanks	Open well	Others
Marginal	0.00	0.00	0.00	15.88	0.00	0.00	0.00
Small	0.00	0.00	0.00	45.08	0.00	0.00	0.00
Medium	0.00	0.00	0.00	36.44	0.00	0.00	0.00
Large	0.00	0.00	0.00	2.60	0.00	0.00	0.00
Total	0.00	0.00	0.00	100.00	0.00	0.00	0.00

2.1.4. Cropping Pattern

The crop season of the state is basically divided into two main seasons-*Kharif* from April to September and *Rabi* from October to March. Rice is the principal crop of the state. *Kharif* paddy occupied maximum area out of the gross cropped area across farm size groups (**Table 2.4**). The maximum area under HYV of paddy was recorded in medium size group (57.1 per cent) followed by large (54.2 per cent), small (49.6 per cent) and marginal farmers (45.1 per cent) with overall area of 51.9 per cent of the total gross cropped area. However, local paddy also found a considerable area with the highest area registered for large size group.

Table 2.4. Cropping pattern of selected farmers in Assam

(% of GCA)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif					
Paddy HYV	45.13	49.76	57.01	54.21	51.98
Paddy Local	7.49	10.11	12.66	22.88	11.27
Vegetables	2.28	1.37	0.84	2.65	1.34
Rabi					
Wheat	10.34	10.00	5.74	3.98	8.28
Pulses	0.00	1.24	0.98	1.49	1.02
Vegetables	9.73	8.96	8.52	3.86	8.67
Summer					
Paddy HYV	18.72	13.73	10.73	9.45	13.04
Annual/perennial					
Sugarcane	0.00	1.08	1.09	0.00	0.91
Horticulture crops	6.30	3.75	2.43	1.49	3.47
Total	100.00	100.00	100.00	100.00	100.00

Note : Kharif vegetables includes ridge gourd, bitter gourd, bottle gourd, okra, spike gourd, white gourd, pumpkin, water pumpkin, red pumpkin and chilli. Rabi vegetables includes cabbage, knol khol, cauliflower, tomato, brinjal and leafy vegetables

Wheat was the dominant crop grown among the sample farmers during the rabi season. The area under rabi vegetables was relatively high for marginal and small farmers with the overall

area of 8.7 per cent of GCA. The distribution of summer paddy area was found at 18.7 per cent, 13.7 per cent, 10.7 per cent and 9.5 per cent, respectively for marginal, small, medium and large farm size group. The area under horticultural crops declined with increase in operational holdings.

2.1.5. Area under HYV seeds

Area under high yielding variety (HYV) of different crops grown in the sample area is provided in **Table 2.5**. Most of the area under different crops was covered by HYV seeds. The proportion of area under HYV seeds in kharif paddy stood at 82.14 per cent. Wheat covered 100 per cent area under HYV. As compared to kharif paddy, summer paddy occupied 100 per cent area under HYV.

Table 2.5. Percentage of area under HYV seeds in Assam

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif					
Paddy HYV	85.78	83.11	81.82	70.31	82.14
Vegetables	100.00	100.00	100.00	100.00	100.00
Rabi					
Wheat	100.00	100.00	100.00	100.00	100.00
Pulses	0.00	100.00	100.00	100.00	100.00
Vegetables	100.00	100.00	100.00	100.00	100.00
Summer					
Paddy HYV	100.00	100.00	100.00	100.00	100.00

2.1.6. Crop Productivity

Table 2.6 provides the productivity of crops grown in different seasons across farm size groups in Assam. *Kharif* paddy (local and HYV) shown a decreasing pattern in yield with increase in farm size. The overall productivity of HYV paddy was 13.1 quintals per acre and 11.1 quintal per acre for local paddy. The overall productivity of wheat and pulses stood at 7.3 quintal and 4.0 quintals per acre, respectively. The productivity of summer paddy is usually more than that of the *kharif* paddy. The overall productivity of summer paddy was 17.4 quintals per acre. There are variation in yield level across farm size categories. It can be observed that marginal and small farmers, by and large, attained a higher yield level than other categories of farmers.

Table 2.6. Average yield of major crops grown by the selected households in Assam

(Quintal/ acre)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif					
Paddy HYV	14.34	13.40	12.64	11.89	13.13
Paddy Local	10.92	11.58	10.71	10.76	11.12
Rabi					
Wheat	7.39	7.34	7.30	5.98	7.31
Pulses	-	3.82	3.96	4.32	4.03
Summer					
Paddy HYV	18.06	17.82	16.62	14.83	17.42

2.2. GUJARAT

2.2.1. Socio-Economic Characteristics of the Selected Farmers

The socio-economic characteristics of the selected tur farmers in Gujarat is given in **Table 2.7**. The selected households comprised 17 per cent marginal, 20 per cent small, 21 per cent medium and 43 per cent large farmers. The household size of tur farmers varied from 5 to 7 members. There were a few households having illiterate family members (3.3 per cent) and also family members having the highest education up to primary level was less (8.33 per cent). About 38 per cent of the households had family members with education up to secondary level. Around 28 per cent of households family member had studied up to graduate level or above and 8 per cent had acquired technical education.

Table 2.7. Demographic profile of the selected farmers in Gujarat

(% of households)

Characteristics		Marginal	Small	Medium	Large	Total
No. of households		16.7	20.0	20.8	42.5	100.0
Household size (number)		5.60	6.75	6.52	6.96	6.60
Average age of the respondent	Less than 25	5.00	0.00	8.00	11.76	7.50
	Between 25 to 40	15.00	37.50	32.00	33.33	30.83
	Above 40	80.00	62.50	60.00	54.90	61.67
Highest Education status of a family member	Illiterate	0.00	0.00	12.00	1.96	3.33
	Up to primary	10.00	12.50	8.00	5.88	8.33
	Up to secondary	30.00	37.50	44.00	37.25	37.50
	Higher secondary	15.00	20.83	12.00	11.76	14.17
	Graduate & above	35.00	16.67	16.00	37.25	28.33
	Technical	10.00	12.50	8.00	5.88	8.33
Caste	SC	10.00	12.50	12.00	5.88	9.17
	ST	0.00	4.17	4.00	3.92	3.33
	OBC	35.00	33.33	44.00	31.37	35.00
	General	55.00	50.00	40.00	58.82	52.50
Distance from the main market (km.)		16.45	14.63	12.04	15.08	14.58
Annual Family income (Rs./ year)		146250	169167	203000	345686	247417

There were around 14 per cent of the households where the highest education of family members was observed at secondary level. The family member educated up to graduate and above were higher for marginal and large farmers and was quite low for the other two categories of farmers. Regarding the social composition of farm households, 52.5 per cent belonged to general caste, 35 per cent to OBC, and 12 per cent to SC/ST households. The distance of main market from the sample farms was on an average 14.6 kilometres, with the highest distance of 16.5 kilometres from the farms of marginal and the lowest of 12.0 kilometres for medium farmers. The annual average family income of farmers worked out to be Rs. 2.47 lakh. It was Rs. 1.46 lakh for marginal, Rs. 1.69 lakh for small, Rs. 2.03 lakh for medium and Rs. 3.46 lakh for large farm size categories.

2.2.2. Characteristics of Operational Holding

For the entire sample farmers, the average net operational area was worked out at 12.9 acre (**Table 2.8**). The leased-in area was 1.5 acres and uncultivable land and leased-out area were 0.7 acre and 0.2 acre, respectively. The net operated area increased with increase in farm size. The net operated area for marginal farmers was 2.1 acre, 4.2 acre for small, 8.0 acre for medium and 23.7 acre for large farmers. The irrigated area was around 67 per cent of the net operated area. About 79 per cent of the net operated area of marginal farmers was under irrigation and it was the lowest for the medium farmers. Cropping intensity varied between 115 and 117 among different categories of farmers.

Table 2.8. Characteristics of operational holdings in Gujarat

(acre/ household)

Farm size	Own land	Uncultivable land	Lease-in	Lease-out	NOA	Irrigated area	GCA	Cropping intensity
Marginal	2.20	0.12	0.00	0.00	2.07	1.64	2.39	1.15
Small	4.60	0.31	0.21	0.33	4.16	2.98	4.82	1.16
Medium	7.34	0.27	1.00	0.04	8.03	5.23	9.91	1.23
Large	22.49	1.27	2.87	0.36	23.74	15.73	27.67	1.17
Total	12.37	0.68	1.47	0.23	12.94	8.65	15.19	1.17

2.2.3. Sources of Irrigation

Analysis of data reveals that major source of irrigation for the selected farmers was canal (**Table 2.9**). Out of the total irrigated area, 45.2 per cent was irrigated by canal water only. This was followed by electric tube-well with the irrigated area of 28.8 per cent. Area irrigated by canal and tube well together was 13.97 per cent. Area irrigated by diesel tube well and open well was 2.82 and 3.66 per cent, respectively. Similar pattern of irrigation was reported

by large and medium farmers with 47 to 50 per cent of the net irrigated are was irrigated by canal, respectively. About 28 to 29 per cent of the area was irrigated through electric tube wells and 14 per cent by canal and tube wells together. Area irrigated by diesel tube wells was about 8 per cent for medium and 1 per cent for large farmers. Use of tanks for irrigation found to be, by and large, negligible for the sample farmers.

Table 2.9. Source of irrigation of net irrigated area in Gujarat

(Percentage)

Farm size	Only canal	Canal + tube well	Only electric tube-well	Only diesel tube-well	Tanks	Open well	Others
Marginal	29.05	3.61	42.87	7.65	0.00	16.82	0.00
Small	22.36	20.96	17.27	9.78	10.17	14.67	4.79
Medium	49.70	14.20	27.69	7.65	0.00	0.76	0.00
Large	47.14	13.73	29.38	1.22	0.00	2.62	5.92
Total	45.18	13.97	28.76	2.82	0.70	3.66	4.91

For the marginal farmers, the major sources of irrigation were electric tube wells and canal water only. Area irrigated by open wells was 16.8 per cent. Further, about 7.7 and 3.6 per cent area was irrigated through diesel tube wells, and canal and tube wells combined, respectively. For small farmers, the major sources of irrigation was canal (22. 4 per cent), and canal and tube well constituted about 21 per cent of the net irrigated area. The net irrigated area by electric tube wells was 17.3 per cent and by open well it was 14.7 per cent. Net area irrigated by diesel tube-wells and tanks were 10 per cent each.

2.2.4. Cropping Pattern

The cropping pattern of the selected farmers is presented in **Table 2.10.** It shows that tur, cotton, sugarcane and wheat are the main crops grown by these farmers. Overall, tur accounted for 41.1 per cent of GCA. Area under cotton cultivation was 29.7 per cent and for wheat it was 7.8 per cent. The cropping pattern varied across farm size categories. The area under cotton was the highest for medium farmers with 33.9 per cent followed by large farmers (29.9 per cent), small farmers (24.8 per cent) and marginal farmers (11.8 per cent). However, it is important to note that area under tur decreased with increasing land holding size. The area under tur cultivation was 73.4 per cent of GCA for marginal farmers, 55.1 per cent for small, 40.4 per cent for medium and 38.9 per cent for large farmers. The sample farmers grew fodder crops during all the three seasons implying that dairy production is an important activity in the study area.

Wheat was the major crop grown during rabi. The cultivation of wheat varied between 5.19 per cent of GCA for small farmers and 11.53 per cent for marginal farmers. Besides, jowar, bajra, castor, urad and green gram were grown in about 1 to 3 per cent of GCA of the total selected farmers. Sugarcane was grown during both the kharif and rabi seasons by large farmers only. It covered 5.36 per cent of GCA in kharif and 0.78 per cent in rabi season. The sample farmers also cultivated cow pea, mustard, castor and vegetables in minor scale.

Table 2.10. Cropping pattern of sample farmers in Gujarat

(% of GCA)

Name of crop	Marginal	Small	Medium	Large	Total
Kharif					
Tur	73.40	55.08	40.35	38.98	41.09
Bajra	-	0.86	1.01	0.14	0.30
Jowar	1.57	3.46	1.21	3.33	3.00
Green Gram	-	1.73	0.81	0.92	0.93
Cotton	11.82	24.76	33.93	29.91	29.66
Fodder	1.68	1.12	2.20	1.34	1.45
Others	-	1.73	4.54	9.78	8.30
Rabi					
Wheat	11.53	5.19	7.73	7.90	7.80
Fodder	-	1.73	2.72	0.89	1.17
Others	-	-	-	3.43	2.65
Summer					
Bajra	-	0.86	1.21	0.64	0.71
Fodder	-	3.46	4.09	2.72	2.89
Perennial					
Mango	-	-	0.20	-	0.03
Gross cropped area	100.00	100.00	100.00	100.00	100.00

Note: Fodder includes Sorghum fodder. Kharif others include paddy, cow pea, castor, sugarcane and vegetables; rabi others include gram, urad, mustard, castor and vegetables

2.2.5. Area under HYV

The per cent area under HYVs of different crops is given in **Table 2.11**. It can be observed that area under HYV of tur was 84.4 per cent as reported by the sample farmers. Among different farm size groups, the proportion of area under HYVs for tur varied between 77.4 per cent for marginal farms and 85.5 per cent for large farms. With respect to cotton, 97.1 per cent of total area under cotton occupied HYVs. Entire area of kharif bajra, paddy and sugarcane was under HYV seeds. However, area under HYVs for wheat was 59.6 per cent with considerable variations across farm size groups.

Table 2.11. Percentage of area under HYV seeds in Gujarat

(Per cent)

Name of crop	Marginal	Small	Medium	Large	Total
Kharif					
Tur	77.35	83.51	81.49	85.46	84.38
Bajra	0.00	100.00	100.00	100.00	100.00
Jowar	100.00	50.00	100.00	23.40	30.59
Cotton	100.00	100.00	89.89	98.34	97.13
Rabi					
Wheat	54.55	83.33	73.88	56.08	59.56
Summer					
Bajra	0.00	100.00	100.00	44.44	61.54

2.2.6. Crop Productivity

The productivity of various crops grown by the sample farmers is given in **Table 3.2**. Average yield of tur varied from 3.6 to 4.7 quintals per acre with the highest yield recorded for medium farmers and the lowest for small farmers. In cotton crop, overall yield was 4.9 quintals per acre and it was relatively high at 5.0 quintals for small farmers. In case of wheat, maximum yield of 11.8 quintals per acre was reported by large farmers while minimum of 9.8 quintals was recorded for marginal farmers with 11.6 quintals per acre. The overall yield of summer bajra was higher than that of kharif bajra.

Table 2.12. Average yield of major crops grown by the selected households in Gujarat

(Quintal/ acre)

Name of crop	Marginal	Small	Medium	Large	Total
Kharif					
Tur	3.72	3.64	4.74	4.34	4.31
Bajra	0.00	3.70	3.88	3.50	3.71
Jowar	3.47	3.68	3.60	3.70	3.69
Cotton	3.72	4.99	4.60	4.98	4.91
Rabi					
Wheat	9.82	10.58	11.39	11.83	11.64
Summer					
Bajra	0.00	3.60	3.67	4.00	3.89

2.3. KARNATAKA

2.3.1 Socio-Economic Characteristics of the Selected Farmers

Table 2.13 provides demographic profile and other important characteristics of the sample households in Karnataka. Of the total sample households, marginal famers accounted for the highest proportion (38.4 per cent) followed by small farmers (26.6 per cent), medium farmers (18.8 per cent) and large farmers (16.3 per cent). The average household size (number of family members) of entire sample was about 7.0 with the highest of about 8.0 members

recorded among large farmer households. The educational status of the family members has varied with farm size groups. A relatively high percentage of household members with graduate and above were found among the large farmer and medium farmer categories. However, it can be observed that about 60 per cent of the households across the farm size groups reported having their family members completed education of secondary and higher secondary level.

Table 2.13. Demographic profile of the selected farmers in Karnataka

(% of households)

Characteristics		Marginal	Small	Medium	Large	Total
No of HH		123	85	60	52	320
Household size (numbers)		5.48	6.89	6.60	8.40	6.54
Average age of the respondent	Less than 25	10.6	8.2	11.7	11.5	10.3
	Between 25 & 40	24.4	35.3	30.0	42.3	31.3
	Above 40	65.0	56.5	58.3	46.2	58.4
	Total	100.0	100.0	100.0	100.0	100.0
Highest Education status of a family member	Illiterate	10.57	8.24	6.67	5.77	8.44
	Up to primary	13.82	10.59	13.33	9.62	12.19
	Up to secondary	43.09	51.76	45.00	46.15	46.25
	Higher secondary	20.33	16.47	16.67	15.38	17.81
	Graduate & above	12.20	12.94	18.33	23.08	15.31
	Total	100.00	100.00	100.00	100.00	100.00
Caste	SC	21.14	15.29	6.67	13.46	15.63
	ST	28.46	22.35	18.33	3.85	20.94
	OBC	12.20	10.59	21.67	17.31	14.38
	General	38.21	51.76	53.33	65.38	49.06
	Total	100.00	100.00	100.00	100.00	100.00
Distance from the main market (km)		12.28	19.28	13.73	25.08	16.48
Annual family income (Rs)		24528	39811	68532	81806	46146

Generally, age of respondent is used as a proxy for the years of experience in farming. It can be argued that longer the experience, better the management of crop production activities including the pre and post harvest losses caused by the pest and diseases. For the entire sample, about 58 per cent of the households reported the average age of the respondent above 40 years. In fact, a high percentage of households across farm size categories too, have reported the average age of respondent above 40 years with the highest being registered among marginal farmers. The caste composition of sample households has also varied across farm size groups. Over 50 per cent of the sample households of small, medium and large farmers belonged to general category, whereas a high proportion of the marginal farmers came under the SC and ST categories. As far as the family income from all sources

concerned it was the highest for large farmers followed by medium farmers and small farmers.

2.3.2. Characteristics of Operational Holdings

The structure of the operational holdings of the sample households is presented in **Table 2.14**. It can be observed that the tenancy cultivation of land is common across the farm size groups even though it is not legally allowed in the state of Karnataka. Large farmer households leased in relatively a high amount of land as compared to other farmer categories, whereas medium farmers leased out a high amount of 0.16 acre per household. As far as the land ownership is concerned, it is skewed towards medium and large farmers with 7.06 acre and 16.51 acre per household, respectively. Actually, two of the study districts viz., Gulbarga and Bidar are predominantly rainfed and have large size of average land holdings. As a result, average net operated area was the highest for large farmers (21.01 acre) followed by medium farmers (7.36 acre). Further, gross cropped area was also higher for these farmer categories.

Table 2.14. Characteristics of operational holdings in Karnataka

(acre/ household)

Farm size	Owned land	Un cultivated land	Leased-in	Leased - out	Net operated area	Net Irrigated area	GCA	Cropping intensity
Marginal	1.68	0.07	0.08	0.02	1.66	1.01	2.47	1.48
Small	3.74	0.10	0.34	0.06	3.92	2.04	5.09	1.30
Medium	7.06	0.11	0.57	0.16	7.36	3.73	9.01	1.22
Large	16.51	0.17	4.67	0.00	21.01	4.47	22.22	1.06
Total	5.65	0.10	0.98	0.05	6.47	2.36	7.60	1.17

The per cent net irrigated area was relatively high for marginal and small farmers as compared to medium and large farmers. As a result, the cropping intensity also worked out to be higher for marginal and small farmers indicating that these farmers practice intensive cultivation of short duration crops for raising their income from farming. Overall cropping intensity for the entire sample was 1.17. The cropping intensity was higher at 1.48 for marginal farmers and 1.30 for small farmers.

2.3.3. Sources of Irrigation

Different sources of irrigation by per cent net irrigated area are provided in **Table 2.15**. In the study area, three important sources of irrigation viz., canal, tube well and open well have been used by the farmers. Canal irrigation accounted for the highest proportion of 81.2 per

cent of the net irrigated area followed by the tube well (electric and diesel) and open well irrigation. Interestingly, area irrigated through canal water was relatively high for marginal farmers (95.2 per cent), whereas for large farmers it was only 64.7 per cent indicating that resource poor marginal farmers have access to government controlled canal water. However, large farmers have access to capital intensive tube well technology irrigating about 28 per cent of the net cropped area. On the whole, canal water was the major source of irrigation across farm size groups as the study area largely covered the irrigated area, which was dictated by the choice of sample crops like paddy.

Table 2.15. Sources of irrigation in Karnataka

(% of net irrigated area)

Farm size	Canal	Tube well (diesel)	Tube well (Electric)	Open well	Other	Total
Marginal	95.18	-	3.21	1.61	-	100.00
Small	86.73	0.58	6.92	-	5.77	100.00
Medium	86.37	3.13	4.47	2.91	3.13	100.00
Large	64.69	18.08	9.47	7.75	-	100.00
Total	81.23	6.63	6.37	3.52	2.26	100.00

2.3.4. Cropping Pattern

Paddy and red gram are the sample crops selected for the present study to assess the pre and post-harvest loss caused by the pests and diseases. These two crops accounted for about three-fourth of the gross cropped area (GCA); paddy with 34.6 per cent and red gram with 40.23 per cent (**Table 2.16**). Among farm size groups, marginal and small farmers allocated relatively a high proportion of area for the cultivation of paddy mainly to meet the household food security requirements. In fact, paddy occupied about 72.8 per cent of the area under marginal farmer holdings and 53.7 per cent under small farmer holdings. In case of red gram, large farmers allocated about 52.3 per cent and small farmers about 35.5 per cent of the gross cropped area.

In the study area, famers have also cultivated other cereals like jowar, bajra, maize and wheat, which altogether constituted about 9.81 per cent. Similarly, apart from red gram, sample farmers have grown other pulses like black gram, green gram and horse gram accounting for 5.72 per cent of the total cropped area. The allocation of area under other cereals and other pulses was higher for large farmers than that of the other farmer groups. A similar pattern can also be observed for oilseeds. It can be, therefore, argued that large farm

household have diversified the crop cultivation with a higher allocation of area under non-food crops. For marginal and small farmers, food security remains an important concern in the backdrop of imperfect food markets and high volatility of food prices. As a result, they tend to allocate more area under food grains than commercial crops.

Table 2.16. Cropping pattern of selected farmers in Karnataka

(% of GCA)

Crop	Marginal	Small	Medium	Large	Total
Paddy	72.78	53.66	46.75	11.77	34.61
Other cereals	2.55	3.56	8.08	14.86	9.81
Red gram	21.51	35.50	28.64	52.34	40.23
Other Pulses	0.91	1.39	4.44	9.20	5.72
Oilseeds	0.68	1.39	1.43	3.89	2.50
Coconut	0.33	1.33	2.79	0.35	1.06
Areca nut	0.91	1.33	2.31	0.17	0.95
Sugarcane	0.33	-	1.94	0.69	0.80
Others	-	1.85	3.61	6.73	4.33
GCA	100.00	100.00	100.00	100.00	100.00

Note: Other cereals-maize, bajra, jowar and wheat; other pulses- black gram, green gram and horse gram; oilseeds- sunflower, soybean and sesamum; others- onion, beans, brinjal, mango and eucalyptus

2.3.5. Area under HYV of Important Crops

The proportion of area under the high yielding variety of different crops indicates extent of the spread of technology, which responds better to use of improved inputs like fertiliser and irrigation. The per cent area under high yielding varieties (HYV) of important crops grown by the sample farmers is given in **Table 2.17**. Among various crops, spread of HYV for coarse cereals and pulses remains low. The area under HYV for jowar was only 73.6 per cent of the total cropped area. There is scope to increase the production of jowar by increasing the area under HYV with required supply of inputs. For red gram, area under HYV was much lower at 24.8 per cent of total cropped area. Despite introduction of large number of improved varieties of red gram by various agricultural research institutions/universities, the spread of yield improving technology is still low in the state of Karnataka. However, for commercial crops like sugarcane and cotton, spread of HYV technology was 100 per cent across farm size groups in the study area.

Table 2.17. Area under HYV of Important Crops in Karnataka

(% of cropped area)

Crop	Marginal	Small	Medium	Large	Total
Paddy	99.09	100.00	100.00	100.00	99.76
Jowar	62.96	62.62	53.08	81.59	73.56
Red gram	34.20	29.97	24.13	22.65	24.80
Bengal gram	33.33	100.00	43.18	72.41	65.70
Cotton	-	100.00	100.00	100.00	100.00
Sugarcane	100.00	-	100.00	100.00	100.00

2.3.6. Crop Productivity

The average yield of major crops cultivated by the sample farmers is provided in **Table 2.18**. It can be observed that average yield of crops grown in kharif was generally high for small farmers as compared to other farmer groups. Medium farmers category has registered more or less the second highest yield level for all kharif crops after the small farmers. In fact, overall average yield of kharif paddy was 19.4 quintals per acre with the highest being recorded among the small farmers (20.1 quintals). Similarly, small farmers have registered the average yield of red gram with 3.2 quintals against overall average yield of 2.8 quintals; jowar with 5.2 quintals against overall average of 3.8 quintals; and cotton with 11.7 quintals against overall average of 9.7 quintals. However, average yield of rabi paddy was relatively high among large famers as compared to other farm categories. In case of bengal gram, average yield was higher for small farmers. Overall, these results broadly indicate that small farmers are more productive (in terms of crop yield) than the other farmer categories due to adoption of better agronomic practices and supervision.

Table 2.18. Average yield of major crops grown by the selected households in Karnataka

(Quintal/ acre)

Crop	Marginal	Small	Medium	Large	Total
Kharif					
Paddy	19.25	20.09	19.26	18.36	19.42
Jowar	3.23	5.24	4.23	3.14	3.79
Red gram	2.83	3.22	2.81	2.29	2.78
Black gram	-	3.00	-	1.60	1.83
Cotton	-	11.67	7.87	10.16	9.72
Sugarcane	10.00	-	27.29	17.17	21.92
Rabi					
Paddy	18.45	19.60	20.11	22.95	19.23
Bengal gram	2.67	2.97	2.28	1.22	1.97

2.4. MADHYA PRADESH

2.4.1. Demographic Profile of Selected Households

It can be observed from the **Table 2.19** that the average size of sample households was seven members. The sample respondents belonged to age group above 40 years, 25 to 40 years and less than 25 years constituted 59.1 per cent, 35.6 per cent and 5.3 per cent, respectively. The majority of households had education up to secondary level (31.9 per cent) followed by primary (25 per cent), illiterate (29.1 per cent), graduate & above (16.3 per cent), and higher secondary (7.8 per cent). With respect to caste composition, over fifty per cent of the sample households belonged to Other Backward Class followed by General, Schedule Caste and Scheduled tribes. The average family income of the households ranged from Rs.31,000 to Rs. 2,59,000 per annum. The annual income was reportedly high for medium farm size categories and low for marginal farm size groups. The average distance from sample farms to main market where agricultural produce sold was about 14 Km.

Table 2.19. Demographic profile of the selected farmers in Madhya Pradesh

(% of households)

Characteristics		Marginal	Small	Medium	Large	Total
No of HH		80.00	80.00	80.00	80.00	320.00
Household size (numbers)		6	8	7	8	7
Average age of the respondent	Less than 25	7.50	1.25	5.00	7.50	5.31
	Between 25 & 40	28.75	37.50	28.75	47.50	35.63
	Above 40	63.75	61.25	66.25	45.00	59.06
Highest Education status of a family member	Illiterate	22.50	26.25	11.25	16.25	19.06
	Up to primary	30.00	27.50	25.00	17.50	25.00
	Up to secondary	30.00	31.25	32.50	33.75	31.88
	Higher secondary	5.00	5.00	10.00	11.25	7.81
	Graduate and above	12.50	10.00	21.25	21.25	16.25
Caste	SC	23.75	11.25	5.00	5.00	11.25
	ST	2.50	2.50	1.25	1.25	1.88
	OBC	52.50	50.00	67.50	53.75	55.94
	General	21.25	36.25	26.25	40.00	30.94
Distance from the main market (km)		10.34	16.04	16.24	13.18	13.95
Annual family income (Rs)		31,000	48,000	99,000	2,59,000	1,09,000

2.4.2. Details of Operational Holdings

The average size of owned land for the sample households was 11.3 acre, while the operated area was estimated at 12.8 acre (**Table 2.20**). It was observed that the sample households cultivated their whole owned land and none of farmers leased out land to others for cultivation whereas leased in land was found to be in practice in the study area. The cultivators who were working in the nearby city leased out land to other cultivators. The

overall area irrigated was 83.4 per cent of net operated area in the study region. The per cent irrigated area was more in large farms (89.0 per cent) followed by marginal (79.8 per cent), small (78.6 per cent) and medium (73.0 per cent) size farms. The analysis of cropping intensity revealed that marginal farmers used their land resource more intensively than those of small farmers, medium farmers and large farmers. The overall cropping intensity was 189.4 per cent implying that 89.4 per cent of total net sown are was actually double cropped by the sample households.

Table 2.20. Characteristics of operational holdings in Madhya Pradesh

(acres/ household)

Farm size	Owned land	Un cultivated land	Leased-in	Leased -out	NOA	Irrigated area	GCA	Cropping intensity
Marginal	1.80	0.00	0.26	0.00	2.06	1.64	36.04	1.96
Small	4.28	0.00	1.12	0.00	5.39	4.24	91.68	1.89
Medium	10.10	0.00	3.03	0.00	13.05	9.53	235.24	1.87
Large	29.12	0.00	1.67	0.00	30.64	27.26	627.95	1.85
Total	11.32	0.00	1.52	0.00	12.79	10.67	247.73	1.89

2.4.3. Sources of Irrigation

It can be observed from the **Table 2.21** that about 67.2 per cent of net operated area was irrigated through tube well (electric + diesel) followed by canal (16.4 per cent), canal + tube well (15.5 per cent) and tanks (1.0 per cent). On an average 62.81 per cent tube well were found to be operated by electricity, while 4.38 per cent operated with diesel. It was also observed that the majority of marginal and small farmers were found to depend on canal, while majority of medium and large farmers on tube wells.

Table 2.21. Source of irrigation of net irrigated area in Madhya Pradesh

(Per cent)

Farm size	Only canal	Canal + tube-well	Only electric tube-well	Only diesel tube-well	Tanks	Total
Marginal	22.76	6.38	61.91	5.00	3.95	100.0
Small	20.13	12.89	63.22	3.75	0.00	100.0
Medium	10.07	20.07	67.37	2.50	0.00	100.0
Large	12.50	22.50	58.75	6.25	0.00	100.0
Total	16.37	15.46	62.81	4.38	0.99	100.0

2.4.4. Cropping Pattern

Soybean was the main crop of the kharif season in Madhya Pradesh, which occupied about 46.8 per cent of gross cropped area (**Table 2.22**). Wheat was the second most important crop with 40.8 per cent of the total area grown by cultivators in the rabi season. Rice (5.1 per cent), gram (8.2 per cent), lentil (1.3 per cent), tur (1.5 per cent) and jowar (0.8 per cent) were

the other crops grown by the cultivators in the study area. It was observed that potato was cultivated by medium and large farmers in the study area.

Table 2.22. Cropping pattern of selected farmers in Madhya Pradesh

(% of GCA)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif					
Soybean	49.58	45.57	46.28	45.82	46.81
Rice	0.00	6.53	7.73	6.02	5.07
Tur	1.89	1.37	0.48	2.35	1.52
Rabi					
Wheat	40.71	40.46	42.82	39.13	40.78
Gram	8.46	9.31	5.83	9.18	8.19
Lentil	0.60	1.67	1.07	1.92	1.31
Potato	0.00	0.00	2.72	1.96	1.17
Gross cropped area	100	100	100	100	100

2.4.5. Area under HYVs

It can be observed from **Table 2.23** that entire area of soybean is under the HYVs. The technological spread is uniform across farm size groups. A similar pattern in the cultivation of HYVs of wheat can also be observed in the study area. However, for rice the technological spread was worked out at 93.3 per cent. The proportion of HYVs of gram was also low at 82.2 per cent for the entire sample farmers. The per cent area under HYVs of gram was relatively low for marginal farmers with 68.0 per cent.

Table 2.23. Percentage of area under HYV seeds in Madhya Pradesh

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif					
Soybean	100.00	100.00	100.00	100.00	100.00
Rice	0.00	100.00	97.90	95.27	93.29
Rabi					
Wheat	100.00	100.00	100.00	100.00	100.00
Gram	68.02	86.34	87.34	87.14	82.21

2.4.6. Average Yield of major Crops

The average yield of selected crops grown across different farm size groups is presented in **Table 2.24**. It can be observed that wheat recorded the highest level of yield (13.9 quintals/acre) followed by rice (8.6 quintals/acre), potato (5.8quintals/acre), soybean (4.5 quintals/acre), gram (4.3 quintals/acre) and tur (2.8 quintals/acre). The overall yield from lentil was 2.0 quintals/acre. The yield level of these crops was more or less similar with minor variation across farm size groups.

Table 2.24. Average yield of major crops grown by the selected households in Madhya Pradesh

(Quintal/acre)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif					
Soybean	3.92	4.45	5.08	4.68	4.53
Rice	0.00	10.29	12.02	11.96	8.57
Tur	2.30	2.20	2.09	4.79	2.84
Rabi					
Wheat	14.86	13.80	14.98	12.01	13.91
Gram	4.34	4.39	4.45	4.16	4.33
Lentil	1.67	2.01	2.26	1.92	1.97
Potato	0.00	0.00	10.64	12.73	5.84

2.5. MAHARASHTRA

2.5.1. Socio-economic Characteristics of the Selected Farmers

The socio-economic characteristics of different categories of tur and soyabean cultivators in Maharashtra are presented in **Table 2.25.** The study covered 240 sample farmers growing tur and soybean. The sample households comprised 21.3 per cent marginal farmers, 45.0 per cent small, 24.6 per cent medium and 9.2 per cent large farmers. The average family size ranged between 5.4 among medium farmers and 6.8 among large farmers. The distribution of respondents across various age groups revealed that 58.8 per cent of respondents were above 40 years of age, 35.0 per cent between 25 and 40 years and the remaining 6.2 per cent belonged to less than 25 years of age. In general, majority of the respondents were more than 25 years of age.

Table 2.25. Demographic Profile of the Selected Farmers in Maharashtra

(% of households)

Characteristics		Marginal	Small	Medium	Large	Total
No of HH		21.3	45.0	24.6	9.2	100.0
Household size (numbers)		5.64	5.27	5.40	6.77	5.52
Average age of the respondent	Less than 25	3.92	6.48	6.78	9.09	6.25
	Between 25 to 40	47.06	37.04	27.12	18.18	35.00
	Above 40	49.02	56.48	66.10	72.73	58.75
Highest Education status of a family member	Illiterate	1.96	6.48	-	-	3.33
	Up to primary	17.65	20.37	10.17	4.55	15.83
	Up to secondary	47.06	39.81	28.81	31.82	37.92
	Higher secondary	15.69	16.67	30.51	27.27	20.83
	Graduate & above	17.65	16.67	30.51	36.36	22.08
Caste	SC	23.53	15.74	23.73	9.09	18.75
	ST	-	2.78	3.39	-	2.08
	OBC	33.33	60.19	45.76	59.09	50.83
	General	43.14	21.30	27.12	31.82	28.33
Distance from the main market (km)		23.23	18.91	19.96	22	20.37
Annual family income (Rs)		1,02,917	1,14,613	1,71,563	2,75,204	1,40,849

The education status of sampled cultivators revealed that about 3 per cent of members of sampled respondents were illiterate, 15.8 per cent attained education up to primary level, 37.9 per cent up to secondary level, 20.8 per cent up to higher secondary level, and 22.1 per cent of members of respondents were graduates and above. It can be noticed that the family members of medium and large category of sampled respondents invariably showed higher education status as compared to marginal and small category. The caste profile showed that 51 per cent of sample farmers belonged to OBC category, 28 per cent to general category and about 21percent to SC/ST category. The overall annual family income was estimated at Rs.1,40,849 with a relatively high level of income registered among large farmers.

2.5.2. Characteristics of Operational Holdings

The estimates relating to the magnitude of owned land, uncultivated land, leased in and out land, net operated area, irrigated area, gross cropped area (GCA) and cropping intensity for various categories of sampled tur and soyabean cultivators are shown in **Table 2.26**. The average size of owned land was estimated at 2.1 acre for marginal farmers category, 4.2 acre for small, 7.5 acre for medium and 18.9 acre for the large category. The overall average size of owned land of the sample farmers was 5.9 acre. It can be observed that area under leasing in and leasing out was not very high except for medium and large farmers. The net operated area was estimated at 2.0 acre for marginal category, 4.1 acre for small, 7.3 acre for medium and 15.6 acre for large farmers category. In general, about 44 per cent of the net operated area was found to be irrigated. As expected, cropping intensity was higher for marginal farmers.

Table 2.26. Characteristics of operational holdings of sample farmers

(acres/ household)

Farm size	Owned land	Un cultivated land	Leased-in	Leased - out	NOA	Irrigated area	GCA	Cropping intensity
Marginal	2.09	0.03	-	0.02	2.04	0.72	2.62	1.28
Small	4.16	0.10	0.09	0.06	4.09	1.61	5.02	1.23
Medium	7.47	0.42	0.26	-	7.31	3.36	9.44	1.29
Large	18.91	1.98	0.27	1.59	15.61	7.64	18.84	1.21
Total	5.89	0.33	0.13	0.18	5.51	2.40	6.86	1.25

2.5.3. Sources of Irrigation

Table 2.27 provides details of irrigation sources and area irrigated by sources. It can be observed that about 68 per cent of total irrigated area of sample farmers was under open well irrigation, 8 per cent under electric tube-well irrigation, 3 per cent under diesel tube-well irrigation and 8 per cent under canal plus tube well irrigation. The dependence on canal water

for irrigation was about 10 per cent for the entire the sample farmers with a higher level of access to it by the large farmers.

Table 2.27. Sources of irrigation in Maharashtra

(% of net irrigated area)

Farm size	Only canal	Canal + tube-well	Only electric tube-well	Only diesel tube-well	Tanks	Open well	Open well + river	Others (River)
Marginal	7.53	4.11	20.55	5.48	-	62.33	-	-
Small	10.65	5.76	14.10	4.89	-	64.60	-	-
Medium	8.31	3.78	5.29	3.53	-	72.04	5.04	2.01
Large	11.90	16.67	2.38	-	-	69.05	-	-
Total	10.01	8.15	8.07	3.04	-	68.31	1.73	0.69

Except for large size farmers, the proportion of open well irrigated area increased with the increase in land holding size. The proportion of open well irrigated area varied from 62 per cent for marginal category to 69 per cent for large category. However, the proportion of electric tube-well irrigated area decreased with the increase in land holding size. The proportion of electric tube-well irrigated area varied from 2.4 per cent for large category to 20.6 per cent for marginal category. These results broadly indicate that the sample farmers were mainly dependent on open well as a major source of irrigation.

2.5.4. Cropping Pattern

Table 2.28. Cropping pattern of selected of farmers in Maharashtra

(% of GCA)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif					
Tur	17.04	12.92	11.62	11.58	12.48
Soybean	40.54	32.80	35.44	41.86	36.60
Cotton	8.15	22.98	18.17	18.58	19.04
Jowar	3.75	4.84	5.56	4.58	4.93
Mung	1.12	1.04	1.35	1.09	1.16
Udid	4.87	2.54	1.26	1.81	2.11
Sunflower	0.94	0.55	0.45	0.60	0.56
Rice	0.75	0.74	0.18	0.84	0.58
Vegetable (chilli, coriander and turmeric)	-	0.42	0.81	0.24	0.47
Total	77.16	79.65	75.37	81.42	78.45
Rabi					
Wheat	6.37	10.20	10.45	7.36	9.26
Gram	9.36	6.37	10.14	9.05	8.56
Jowar	6.37	1.66	1.44	1.21	1.85
Total	22.10	18.22	22.21	17.61	19.73
Annual					
Sugarcane	0.75	2.03	1.70	0.97	1.55
Gross cropped area	100.00	100.00	100.00	100.00	100.00

The information on proportion of gross cropped area allocated under different crops grown under different seasons by the sample farmers is provided in **Table 2.28**. Among crops, soybean emerged to be a dominant crop occupying about 36.6 per cent of the gross cropped area. The other major crops grown are tur and cotton. During kharif season, the average area for tur was 12.5 per cent, 19.0 per cent for cotton, 4.9 per cent for jowar and 2.1 per cent for urad. The other important crops grown during kharif are mung, sunflower, rice and vegetables. In rabi season, wheat emerged to be a dominant crop cultivated by the sample farmers. It can be observed that 9.3 per cent of their gross cropped area was under wheat, 8.6 per cent under gram and 1.9 per cent under jowar. Sugarcane accounted for about 1.6 per cent share in gross cropped area for the average category of farmers. There is considerable variations in the allocation of land for cultivation of crops by different farm size groups.

2.5.5. Area under HYV

The introduction of high yielding varieties (HYV) seeds in the aftermath of green revolution has led to significant expansion of production of various crops in India. The proportion of area under HYVs of various crops cultivated by sample farmers is provided in **Table 2.29.** Area under HYVs of tur for the entire sample was worked out at 86.4 per cent, 99.3 per cent for soyabean, 100 per cent for cotton, 98.2 per cent for kharif jowar, 71.3 per cent for mung, 91.4 per cent for udid, 100 per cent for kharif sunflower and 84.2 per cent for rice.

Table 2.29. Percentage of area under HYVs in Maharashtra

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif					
Tur	68.13	84.65	96.14	84.38	86.38
Soybean	98.14	98.31	100.00	100.00	99.34
Cotton	99.95	100.00	100.00	100.00	100.00
Jowar	100.00	94.29	100.00	100.00	98.15
Mung	50.00	68.92	80.00	66.67	71.25
Udid	100.00	96.36	100.00	66.67	91.37
Sunflower	100.00	100.00	100.00	100.00	100.00
Rice	50.00	100.00	0.00	100.00	84.21
Rabi					
Wheat	100.00	98.19	96.57	100.00	98.03
Gram	90.00	79.71	91.15	86.67	87.06
Jowar	35.29	77.78	0.00	0.00	32.79
Annual					
Sugarcane	100.00	100.00	100.00	100.00	100.00

Among the focus crops namely tur and soybean, proportion of area under HYVs of tur was lower than that of soybean. Although the average category of tur crop cultivators showed 86 per cent of tur area under HYV seeds, this proportion varied from 66 per cent for marginal category to 94 per cent for medium category. Similarly, for soybean, medium and large farmers cultivated 100 per cent area under improved varieties. The proportion of area under HYVs for wheat was 98.0 per cent, gram 87.1 per cent and for rabi jowar it was 32.8 per cent.

2.5.6. Crop Productivity

The information related to average productivity of various crops grown by the sample farmers are given in **Table 2.30**. The average yield of tur varied from 4.4 quintals per acre for marginal category to 4.7 quintals per acre for medium category. The average yield of tur for overall sample farmers was 4.7 quintals per acre. The average yield of soyabean was 5.5 quintal per acre with the highest level of yield was recorded for medium farmers. Much wider variation in yield level of cotton was observed across various categories of farmers. The average yield of cotton varied from 5.5 quintals per acre for marginal farmers category to 6.2 quintals per acre for large farmers category.

Table 2.30. Average Yield of Major Crops Grown by the Sample Farmers in Maharashtra

(Quintal/Acre)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif					
Tur	4.44	4.54	4.73	4.86	4.66
Soybean	5.31	5.30	5.62	5.57	5.48
Cotton	5.47	5.65	5.76	6.18	5.81
Jowar	4.40	5.10	5.06	5.53	5.14
Mung	2.43	2.66	2.19	2.44	2.41
Udid	2.23	2.35	2.25	2.57	2.35
Sunflower	3.20	3.25	3.20	3.40	3.27
Rice	3.00	3.38	2.25	3.43	3.24
Rabi					
Wheat	5.12	5.54	5.56	5.80	5.58
Gram	3.90	4.17	4.27	4.88	4.38
Jowar	4.82	4.72	5.16	5.20	4.94
Annual					
Sugarcane	300.00	287.27	284.21	300.00	288.63

A similar pattern can also be observed for kharif jowar with a relatively low level of yield recorded among marginal farmers and high yield for large farmers. Average yield of wheat was worked out at 5.6 quintals per acre with the lowest level registered for marginal farmers (5.1 quintals) and the highest for large farmers (5.8 quintals). Average yield of rabi jowar was

relatively low as compared to kharif jowar. For gram, average yield was estimated at 4.4 quintals and large farmers have registered a higher yield of 4.9 quintals per acre.

2.6. PUNJAB

2.6.1. Socio-economic Characteristics of the Selected Farmers

The socio-economic characteristics of the sample farmers are presented in **Table 2.31**. It can be seen that marginal farmers constituted 18 per cent, small and medium farmers 20 per cent each and larger farmers 42 per cent of the total sample households. The household size varied from 5 to 8 members with lowest on marginal and highest on large farm category. The respondents with average age of above 40 years constituted the highest proportion with 73 per cent of the total sample farmers. Across farm size groups, 71 to 79 per cent of the respondents fallen under the age group of above 40 years. Only about 12 to 26 per cent respondents came under the age group between 25 and 40 years. There were very few (2-17 per cent) respondents having age less than 25 years on all the farm size categories.

Table 2.31. Demographic profile of the selected wheat and paddy growing farmers in Punjab

(% of households)

Characteristics		Marginal	Small	Medium	Large	Overall
No of HH		18.3	20.0	20.0	41.7	100.0
Household size (numbers)		5	6	6	8	7
Average age of the respondent	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	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	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

The education of the family members gives impetus to the adoption of new farm initiatives. Majority 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. Majority of the respondents belonged to general castes with just three per cent to other backward classes. The annual family income worked out to be Rs. 1.65 lakh on marginal, Rs. 2.7 lakh on small, Rs. 5.2 lakh on medium and Rs. 12.6 lakh on large farm categories with an overall average income of Rs. 7.1 lakh per annum.

2.6.2. Characteristics of Operational Holdings

The characteristics of operational holding are shown in **Table 2.32**. The marginal farms have high share of owned land (2.3 acres) as compared to size of land obtained through leased-in and leased-out land thereby making net operated area (NOA) of 2.2 acres. Small farmers owned land was 4.61 acres with more leased-out (1.15 acres) than leased-in (0.48 acres) land, thereby making net operated area 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 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 thereby making net operated area of 20.68 acres. For the overall sample, the net operated area was estimated at 11.4 acre. The entire area on all the farm size categories was irrigated and the cropping intensity was worked out at 200 per cent.

Table 2.32. Characteristics of operational holdings in Punjab

(acre/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

2.6.3. Sources of irrigation

The sources of irrigation for the sample farmers are depicted in **Table 2.33**. Analysis of data reveals that the entire net operated area was either canal or tube-well irrigated for marginal farmers. But, 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 tube-well. On small farms also, a similar pattern can be observed. 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. For large category farmers also, a similar situation was seen where the net operated area was also either irrigated through canal water or through electric tube-well irrigation. For the entire sample, the net operated area was irrigated either through canal water or by the tube-wells. In fact, a high proportion of 67.75 per cent of the area was irrigated exclusively by the electric tube-well. Thus, the major source of irrigation was under ground water using tube-wells as well as surface irrigation utilizing canal water.

Table 2.33. Source of irrigation of net irrigated area in Punjab (%)

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	-	-	-

2.6.4. Cropping pattern

The cropping pattern followed on the sample farms have been depicted in **Table 2.34.** For marginal farmers, paddy and wheat were the major crops comprising 35.3 per cent and 44.1 per cent of the gross cropped area followed by fodder crops, basmati paddy, cotton and maize. For small farmers also, paddy and wheat comprised 32.9 per cent and 44.4 per cent of the gross cropped area, respectively. But, for medium and large farmers, area allocation for paddy and wheat appear to be higher than those of marginal and small farmers.

Table 2.34. Cropping pattern of selected farmers in Punjab

(% of GCA)

Name of the crop	Marginal	Small	Medium	Large	Overall
Kharif					
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					
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
Vegetables	-	-	0.33	0.03	0.07
Gross cropped area	100.0	100.0	100.0	100.0	100.0

Paddy and wheat occupied about 39.4 per cent and 46.4 per cent of the gross cropped area, respectively for medium farmers. Like other farmer categories, medium farmers also grew crops such as fodder, basmati paddy, maize, cotton and vegetables. Similarly, on large farms, paddy and wheat shared 40.2 per cent and 47.4 per cent of the gross cropped area. Overall, paddy and wheat were major crops grown on all the farm size categories constituting about 86 per cent of the gross cropped area on the sample farms.

2.6.5. Area under HYVs

The introduction of high yielding varieties (HYVs) along with the requisite technological factors resulted in ushering green revolution in the country. Punjab being pioneer in the adoption of new farm technology helped to achieve self sufficiency in foodgrains production. The information regarding percentage of area under high yielding seeds are given in **Table 2.35**. It can be observed that the entire area under all crops covered high yielding varieties of various crops.

Table 2.35. Percentage of area under HYV seeds in Punjab

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif					
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
Rabi					
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

2.6.6. Crop Productivity

The productivity of various crops grown by the sample farmers is given **Table 2.36**. For paddy, average yield varied from 26.3 quintals to 27.9 quintals per acre with highest level of yield registered among large farmers. In case of basmati rice, the average productivity per acre was high on the marginal farms (17.2 quintals) and low on small farms (15.7 quintals). Productivity of kharif maize was the highest on medium farms (25.0 quintals) and lowest on marginal farms (17.5 quintals). In Bt cotton, maximum yield of 9.0 quintals per acre was observed on medium farms while minimum (4.0 quintals) yield was reported on small farm category. In case of wheat, the yield varied between 18.4 quintals and 19.2 quintals per acre

with the highest on large farms while in an overall situation 19.1 quintals per acre was reported.

Table 2.36. Average yield of major crops grown by the selected households in Punjab

(quintal/acre)

Name of the crop	Marginal	Small	Medium	Large	Overall
Kharif					
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					
Wheat	18.40	18.70	18.81	19.20	19.10
Winter maize	28.00	-	-	25.00	27.30

2.7. Rajasthan

2.7.1. Socio-Economic Characteristics of the Selected Farmers

The socio-economic characteristic of the selected soybean farmers is given in **Table 2.37**. The sample households comprised 23 per cent marginal, 25 per cent small, 31per cent medium and 21 per cent large farmers. The average household size was 8 persons with the highest of 11 members recorded among large farmers and the lowest of 7 member among marginal farm category.

Table 2.37. Demographic profile of the selected farmers in Rajasthan

(% of households)

Characteristics		Marginal	Small	Medium	Large	Total
No. of HH		23.3	25.0	30.8	20.8	100.0
Household size (numbers)		6.71	7.10	7.54	11.44	8.05
Average age of the respondent	Less than 25	7.14	6.67	5.41	0.00	5.00
	Between 25 & 40	42.86	43.33	43.24	32.00	40.83
	Above 40	50.00	50.00	51.35	68.00	54.17
Highest Education status of a family member	Illiterate	14.29	16.67	10.81	12.00	13.33
	Up to primary	7.14	3.33	8.11	0.00	5.00
	Up to secondary	35.71	40.00	37.84	28.00	35.83
	Higher secondary	25.00	26.67	29.73	28.00	27.50
	Graduate and above	14.29	13.33	13.51	24.00	15.83
	Technical	3.57	0.00	0.00	8.00	2.50
Caste	SC	0.00	0.00	2.70	0.00	0.83
	ST	14.29	10.00	5.41	4.00	8.33
	OBC	60.71	66.67	62.16	68.00	64.17
	General	25.00	23.33	29.73	28.00	26.67
Distance from the main market (km.)		10.36	10.40	12.22	14.00	11.70
Annual Family income (Rs.)		142857	227833	286081	538200	290625

The analysis on education status of the family members shown that in 36 per cent of the households, the highest education level of the family member was up to secondary. It varied between 40 per cent on small and 28 per cent on large farm categories. The family member having highest education of higher secondary was 28 per cent of the total households with variations of 25 to 30 per cent among different categories of farmers. The highest education of graduate and above of family member was reported by 16 per cent of the households with highest 24 per cent and lowest 13.3 per cent households of large and small farm size, respectively. About three per cent of households had family member having technical as highest education. The illiterate households were 13 per cent of the total households.

The social composition of sample households indicated that overall 64.2 per cent of the households were OBCs and 26.7 per cent came under general group. The households belonging to ST were 8.3 per cent and to SC were 0.83 per cent of the total households. The distance of the main market from the sample farm among the farm size categories varied from 10.4 kilometres to 14.0 kilometres. Overall, average annual family income of the selected farmers worked out to be Rs. 2.91 lakh. It was the highest for large farmers followed by medium farmers, small farmers and marginal farmers.

2.7.2. Characteristics of Operational Holding

The characteristics of operational land holding are shown in **Table 2.38**. The net operated area for the whole sample is worked out at about 8.0 acre. Average net operated area for marginal farmers was 1.9 acre, 3.9 acre for small farmers, 7.4 acre for medium farmers and 20.3 acres for large farmers. Leased out and uncultivable lands were very low for marginal and small farmers as compared to medium and large farmers. With respect to area coverage under irrigation, 92 to 97 per cent of the net operated area of all the categories of households was irrigated except small farmers (88 per cent). Overall cropping intensity of the selected farmers was 183 per cent and it varied between 175 per cent for large and 198 per cent for marginal farmers.

Table 2.38. Characteristics of operational holdings in Rajasthan

(acre/household)

Farm size	Own land	Un cultivable land	Lease-in	Lease-out	NOA	Irrigated area	GCA	Cropping intensity
Marginal	1.78	0.04	0.11	0.00	1.85	1.81	3.66	1.98
Small	3.58	0.13	0.43	0.00	3.88	3.42	7.44	1.92
Medium	6.17	0.31	1.49	0.00	7.35	6.94	14.00	1.91
Large	19.64	0.89	2.15	0.16	20.73	18.97	36.28	1.75
Total	7.30	0.32	1.04	0.03	7.99	7.37	14.59	1.83

2.7.3. Sources of Irrigation

The analysis of sources of irrigation revealed that major sources of irrigation for the sample farmers were open well and electric tube well (**Table 2.39**). Irrigation through open wells accounted for 36.1 per cent, while electric tube wells accounted for 35.6 per cent of the net irrigated area. For marginal and medium farmers, similar pattern was observed in terms of area irrigated by different sources. Marginal farmers irrigated 45.1 per cent of their net irrigated area by electric tube wells and the same was 41.5 per cent for medium farmers. Area irrigated by open wells was 30.2 and 27.1 per cent for marginal and medium farmers, respectively.

Table 2.39. Source of irrigation of net irrigated area in Rajasthan

(Per cent)

Farm size	Only canal	Canal + tube well	Only electric tube-well	Only diesel tube-well	Tanks	Open well	Others
Marginal	0.00	6.13	45.05	9.88	0.00	30.24	8.70
Small	0.00	3.12	35.26	14.45	4.29	35.45	7.42
Medium	0.00	4.52	41.52	17.87	0.00	27.06	9.03
Large	3.29	2.37	31.52	6.75	0.00	41.82	14.25
Total	1.76	3.30	35.63	11.05	0.50	36.13	11.63

In case of small farmers, the contribution of electric tube well and open well was almost the same with the share of around 35 per cent. About 14 per cent of net irrigated area was irrigated by diesel tube wells. Only small farmers were using tanks as source of irrigation. For large farmers, water from open well was the main source of irrigation with 41.8 per cent followed by electric tube wells (31.5 per cent) and other sources (14.3 per cent). Only large farmers had access to canal water for irrigation.

2.7.4. Cropping Pattern

Table 2.40. Cropping pattern of farmers in Rajasthan

(Per cent of GCA)

Name of crop	Marginal	Small	Medium	Large	Total
Kharif					
Soybean	42.69	37.81	37.22	38.44	38.25
Maize	6.81	10.00	9.91	9.47	9.51
Green gram	0.00	0.00	0.18	2.66	1.43
Urad	0.08	0.00	0.74	0.39	0.42
Groundnut	0.20	2.33	1.64	2.22	1.95
Fodder	1.00	1.43	0.82	0.30	0.64
Rabi					
Wheat	26.77	20.32	17.41	15.76	17.47
Barley	0.00	0.06	1.08	0.58	0.63
Gram	0.59	0.33	0.77	1.50	1.08
Methi	2.22	3.21	4.35	2.32	3.03
Coriander	7.51	9.41	10.57	8.75	9.30
Rapeseeds & Mustard	5.07	3.01	5.37	3.58	4.12
Black Cumin	0.00	1.43	1.24	1.17	1.16
Garlic	5.90	7.98	5.95	6.33	6.40
Other crops	1.16	2.68	2.75	6.53	4.61
Gross cropped area	100.00	100.00	100.00	100.00	100.00

Note: * Other crops includes onion, isubgul, opium and fodder crops

The cropping pattern of the sample farmers is given in **Table 2.40**. The cropping pattern of the selected farmers revealed that major crops grown by them were soybean, maize, wheat, coriander and garlic. Overall 38.3 per cent of the gross cropped area (GCA) was under soybean cultivation, with the highest of 42.7 per cent for marginal farmers and the lowest of 37.2 per cent for medium farmers. Groundnut was cultivated in about 2 per cent of the total area during the kharif season. Wheat was the most important rabi crop occupying about 26.8 per cent for marginal, 20.3 per cent for small, 17.4 per cent for medium and 15.8 per cent for large farmers. As far as garlic was concerned, it was grown on about 6 to 8 per cent of GCA. Similarly, coriander occupied about 8 to 11 per cent of total area among various categories of farmers.

2.7.5. Area under HYVs

The information about proportion of area under high yielding variety of major crops are provided in **Table 2.41**. It can be observed that 91.9 per cent of area under soybean was grown with HYV seeds. Among farm size groups, marginal farmers had entire area of soybean under HYV seeds while it was 96.3 per cent for small, 94.7 per cent for medium and 88.2 per cent for large farmers. With respect to wheat, about 93 per cent of its area was under

HYV seeds. Maize had 86.2 per cent of its area under HYV seeds. Only 18 per cent and 29 per cent of cultivated area of coriander and garlic were covered under HYVs, respectively. Overall, area under HYV seeds was 69.7 per cent of the total cropped area for the sample farmers.

Table 2.41. Percentage of area under HYV seeds in Rajasthan

Name of crop	Marginal	Small	Medium	Large	Total
Kharif					
Soybean	100.00	96.29	94.71	88.18	91.86
Maize	70.92	88.09	84.22	88.12	86.19
Urad	0.00	0.00	79.11	74.50	76.08
Groundnut	0.00	84.23	62.44	71.24	70.61
Rabi					
Wheat	79.42	94.71	85.59	98.88	92.60
Gram	0.00	17.81	0.00	29.41	21.82
Methi	0.00	26.96	25.14	0.00	14.32
Coriander	0.00	0.00	5.84	33.75	18.42
Rape Seeds & Mustard	57.69	94.06	43.85	47.00	50.94
Garlic	19.83	19.09	22.04	37.09	29.17
Onion	0.00	100.00	55.56	0.00	37.93
Isubgul	0.00	44.44	39.64	0.00	38.78
Total	75.05	74.04	68.43	68.70	69.67

2.7.6. Crop Productivity

The productivity of various crops grown by the sample farmers is given in **Table 2.42**. The overall yield of soybean as reported by the selected farmers was 8.6 quintals per acre. It was maximum at 8.8 quintals and minimum at 7.7 quintals per acre for large and marginal farmers, respectively. Average yield of maize varied from 8.1 quintals for medium farmers to 8.7 quintals per acre for marginal farmers. The average yield of maize for overall sample was 8.4 quintals. In case of wheat, the yield reported by medium farmers was 12.9 quintals while marginal farmers obtained yield of 12.3 quintal per acre.

Productivity of rapeseed and mustard varied between 7.4 quintals and 8.3 quintals for the sample farmers. Other important crops grown by these farmers were coriander and garlic and their productivity varied from 6.6 quintal to 7.3 quintals and 32.6 quintals to 38.6 quintals per acre, respectively among different categories of farmers.

Table 2.42. Average yield of major crops grown by the selected households in Rajasthan

(Quintal/ acre)

Name of crop	Marginal	Small	Medium	Large	Total
Kharif					
Soybean	7.70	8.22	8.61	8.77	8.59
Maize	8.67	8.63	8.05	8.50	8.39
Green Gram	0.00	0.00	2.13	2.28	2.28
Urad	6.25	0.00	2.82	2.78	2.84
Groundnut	4.50	4.56	4.75	4.55	4.60
Rabi					
Wheat	12.33	12.90	12.94	12.36	12.61
Barley	0.00	13.85	14.68	15.57	15.10
Gram	4.83	4.52	4.69	4.74	4.73
Methi	5.26	6.18	7.68	6.44	6.88
Coriander	7.17	7.26	6.74	6.56	6.74
Rapeseed & Mustard	8.21	7.37	8.31	7.98	8.07
Black Cumin	0.00	4.22	5.58	5.01	5.07
Garlic	32.56	33.58	37.78	38.56	37.23
Onion	0.00	47.50	81.94	94.00	84.91
Isubgul	0.00	6.11	5.58	6.50	5.74
Opium	0.00	1.03	0.21	0.00	0.66

2.8. TAMIL NADU

2.8.1. Socio-economic Conditions of Sample Farmers

The distribution of selected paddy farmers and their socio-economic conditions are presented in **Table 2.43**. The sample farmers comprised 33.1 per cent marginal farmers, 27.5 per cent small farmers, 17.5 per cent medium farmers and 22.0 per cent large farmers. It can be observed that more than 55 to 80 per cent of the sample farmers are in the age group of above 40. About 20 to 48 percent of the farmers are in the age group of 25 to 40 years. Only about 5 to 8 percent of the farmers who are below 25 years across farm size groups. In general, it is seen that most of the farmers belonged to the middle level age group. This implies that the younger generation is not interested to take up farming as a profession.

With respect to literacy status, about 14 percent of the total sample farmers were illiterate, 12 percent of had primary education, 47 percent had secondary and higher secondary education. And 26 percent of the farmers were either graduates or post graduates. But, 43 percent of marginal farmers were either illiterate or had only primary education. Nearly half of the graduates and post-graduates belonged to medium and large categories of farmers. The level of literacy influences the adoption of new technology in agriculture. As regards the social background, about 36 per cent of marginal farmers and 20 per cent of small farmers belonged to the scheduled caste. On the other hand, among other backward class, 80 percent of them

belonged to small, medium and large farm categories. The annual average income increased with increase in farm size.

Table 2.43. Demographic Profile of the Sample Farmers in Tamil Nadu

(% of households)

Characteristics		Marginal	Small	Medium	Large	Overall
Number of Households		33.1	27.5	17.5	22.0	100
Household Size (Numbers)		5	5	6	7	6
Average Age of the Respondent	Less than 25	5.66	8.89	0.00	0.00	3.64
	Between 25 & 40	39.62	28.89	48.15	20.00	34.16
	Above 40	54.72	62.22	51.85	80.00	62.20
Educational Status of a Family Member	Illiterate	20.75	13.33	14.81	8.57	14.37
	Up to Primary	22.64	11.11	11.11	2.86	11.93
	Up to Secondary	11.32	6.67	11.11	8.57	9.42
	Higher Secondary	33.96	37.78	37.04	42.86	37.91
	Graduate & above	11.32	24.44	22.22	25.71	20.93
	Post Graduate	0	6.67	3.70	11.43	5.45
Caste Status	SC	35.85	20.00	7.41	5.71	17.24
	ST	0	0	0	0	0
	OBC	56.60	80.00	88.89	82.86	77.09
	General	7.55	0	3.70	11.43	5.67
Distance from Market (km)		8.92	10.04	8.26	7.06	8.57
Annual Income (Rs.)		105123	200113	373928	971557	412680

2.8.2. Pattern of Operational Holdings

The distribution of average size of operational holdings estimated for the study area is presented in **Table 2.44**. The average size of operational holdings for the entire sample farmers was 9.0 acre. At disaggregated level, the average size of operational holdings was estimated the highest for large farmers (20.3 acre) and lowest for marginal farmers (1.7 acre). For overall sample, average size of own land was 6.9 acre, leased in land 1.7 acre and leased out land at 0.1 acre. The uncultivable area was worked out the highest for large farmers (1.1 acre) and for marginal farmers it was the lowest at 0.04 acre.

Table 2.44. Characteristics of Operational Holdings in Tamil Nadu

(Acre/ Household)

Farm Size	Owned Land	Uncultivated Land	Leased-In	Leased -out	NOA	Irrigated Area
Marginal	1.33	0.04	0.31	0.00	1.68	1.68
Small	3.42	0.60	0.58	0.00	4.60	4.60
Medium	6.98	0.56	1.94	0.07	9.41	9.41
Large	15.67	1.11	3.80	0.26	20.32	20.32
Overall	6.85	0.58	1.66	0.08	9.00	9.00

2.8.3. Sources of Irrigation

Electric tube well has emerged to be a predominant source of irrigation for small farmers irrigating about 55.6 per cent of the net irrigated area (**Table 2.45**). The entire operational area has been irrigated by canal, tube well and tank irrigation. In Tiruvarur, one of the sample districts, farmers mainly used cauvery river water for irrigation. However, in Villupuram, another sample district, use of water from canals and tanks was low. Most of the sample farmers in Villupuram mainly relied on ground water resources. This indicates that the two districts have different sources of irrigation facilities. Further, majority of the farmers made use of canal and tube well irrigation with 73.8 per cent of marginal farmers, 71.5 per cent of small farmers and 83.3 per cent of large farmers.

Table 2.45. Sources of Irrigation of Net Irrigated Area in Tamil Nadu

(Per cent)

Farm Size	Only Canal	Canal +Tube Well	Electric Tube Well	Diesel Tube Well	Tanks	Open well	Others	Total
Marginal	4.76	73.81	5.36	0	13.69	2.38	0	100
Small	2.17	71.52	14.57	0	9.13	2.61	0	100
Medium	9.56	77.68	3.61	0	6.16	2.98	0	100
Large	4.82	83.27	4.38	0	4.72	2.81	0	100
Overall	5.33	76.57	6.98	0	8.43	2.69	0	100

2.8.4. Cropping Pattern

The analysis of cropping pattern of the sample households revealed that paddy occupied the largest cropped area during all the seasons (**Table 2.46**). Area allocation for paddy was more or less the same proportion across marginal, small, medium and large farmers during kharif season. Groundnuts are grown only during the rabi season and cotton is grown only during kharif season. Vegetables are grown only during rabi and kharif seasons. However, paddy and pulses are grown in all the three seasons.

The percentage of GCA for the kharif season for all selected crops was 37.4 per cent, out of which paddy accounted for 29.4 per cent of GCA during the kharif season. Similarly, during the rabi season, out of 34.8 per cent of GCA, paddy alone accounted for 26.2 per cent. The other crops such as groundnut, pulses and vegetables constituted 8.6 per cent. During summer season, paddy accounted for 21.5 per cent of GCA and pulses and other crops occupied only 6.12 per cent. The analysis clearly showed that paddy is a predominant in the sample area and therefore has implications for use of water for irrigation.

Table 2.46. Cropping Pattern of Selected Farmers in Tamil Nadu

(Per cent of GCA)

Name of the Crop	Marginal	Small	Medium	Large	Overall
Kharif					
Paddy	29.42	30.21	28.14	29.98	29.44
Cotton	2.83	3.21	3.02	3.27	3.08
Pulses	3.41	2.19	3.63	3.14	3.09
Vegetables	1.12	1.15	2.82	2.21	1.83
Kharif Total	36.78	36.76	37.61	38.60	37.44
Rabi					
Paddy	26.84	27.61	24.98	25.33	26.19
Groundnut	3.89	2.24	3.83	4.81	3.69
Pulses	2.53	3.83	3.94	3.24	3.39
Vegetables	1.42	1.36	1.79	1.62	1.55
Rabi Total	34.68	35.04	34.54	35.00	34.82
Summer					
Paddy	22.58	20.83	21.34	21.34	21.52
Pulses	5.13	6.39	5.43	4.33	5.32
Others	0.83	0.98	1.08	0.73	0.91
Summer Total	28.54	28.20	27.85	26.40	27.75
Total	100.00	100.00	100.00	100.00	100.00

2.8.5. Area under High Yielding Varieties

Area under HYVs of major crops grown in the study area is shown in **Table 2.47**. It can be observed that there was a cent percent use of HYV seeds in the study area. By using the HYV seeds, the farmers achieved higher returns. This also shows that there is greater awareness among sample farmers about the new technology and advantages of using HYV seeds in crop cultivation. Further, state government also has made efforts to transfer technologies to the farmers.

Table 2.47. Percentage of Area under HYV Seeds in Tamil Nadu

Name of the Crop	Marginal	Small	Medium	Large	Overall
Kharif					
Paddy	100	100	100	100	100
Cotton	100	100	100	100	100
Rabi					
Paddy	100	100	100	100	100
Ground nut	100	100	100	100	100
Summer					
Paddy	100	100	100	100	100

2.8.6. Crop Productivity

Table 2.48 provides details of the average yield of major crops grown by selected households in the study area. The average yield of paddy was 22.9 quintals per acre during kharif season, 21.4 quintals per acre during rabi season and it was low at 20.40 quintal per acre during summer season. It is interesting to note that during the kharif season, the average yield of paddy crop was relatively high among medium size of farmers with 27.5 quintals per acre, whereas the large farmers achieved yield of 23.6 quintals per acre during rabi season and the small farmers produced the highest yield of 22.6 quintals per acre. But, yield attained by the marginal farmers was relatively low in all the seasons because of their inability to use HYV seeds in a big way.

Table 2.48. Average Yield of Major Crops grown by the Selected Households in Tamil Nadu

(Quintal/acre)

Name of the Crop	Marginal	Small	Medium	Large	Overall
Kharif					
Paddy	20.57	22.88	27.45	20.66	22.89
Cotton	6.57	6.98	7.12	6.73	6.85
Rabi					
Paddy	19.89	21.15	20.96	23.56	21.39
Ground nut	4.67	5.21	4.98	5.42	4.95
Summer					
Paddy	18.43	22.55	19.71	20.89	20.40

Cotton was the second major crop grown during kharif in the study area. For overall sample, yield of cotton was 6.9 quintals per acre and medium farmers achieved the highest yield of cotton (7.1 quintals per acre) and small farmers produced 6.98 quintals per acre. The yield of cotton for the large farmers (6.7 quintals per acre) is marginally lower than the yield for small farmers. The marginal farmers registered the yield level of 6.57 quintals per acre.

2.9. UTTAR PRADESH

2.9.1. Socio-Economic Characteristics of the Selected Farmers

The socio-economic characteristics of sample farmers in Uttar Pradesh are presented in **Table 2.49**. The sample households comprised 62.5 per cent marginal farmers, 24.6 per cent small farmers, 8.3 per cent medium farmers and 4.6 per cent large farmers. The marginal and small farmers accounted for about 87.1 per cent of total sample farmers. The average size of family varied from 7 to 11 members among farm size groups. It can be seen that about 60 per cent of

the respondents had average age of more than 40 years. Only about 3 to 6 per cent of the respondents across different size groups came under the age group with less than 25 years.

As far as education status of sample farmers was concerned, majority of family members were educated up to secondary level. There were 15 to 30 per cent of respondent's family members obtained graduation and above level of education. The proportion of illiterate family members varied from 8 per cent to 10 per cent across sample farms. The education status of family members of the sample farmers was more or less observed similar across sample farms. With respect to social composition, farmers belong to OBCs categories were dominant followed by SC and general castes. The annual income worked out at Rs. 2,32,273 for large farms followed by Rs. 1,22,035 for medium farmers, Rs. 92,063 for small farmers and Rs. 70,904 for marginal farmers.

Table 2.49. Demographic profile of the selected farmers in Uttar Pradesh

(% of households)

Characteristics		Marginal	Small	Medium	Large	Total
No of HH		150	59	20	11	240
Household size (numbers)		7	8	8	11	7
Average age of the respondent	Less than 25	6	3	5	-	5
	Between 25 & 40	43	26	15	18	35
	Above 40	51	71	80	82	60
Highest Education status of a family member	Illiterate	9	8	10	9	9
	Up to primary	24	10	25	9	20
	Up to secondary	32	34	20	18	31
	Higher secondary	19	24	15	37	20
	Graduate & above	15	24	30	27	20
Caste	SC	36	9	5	-	25
	ST	-	-	-	-	-
	OBC	48	76	75	82	59
	General	16	15	20	18	16
Distance from the main market (km)		8.67	9.12	7.10	7.72	8.61
Annual family income (Rs)		70904	92063	122035	232273	87763

2.9.2. Distribution of Operational Holdings

Distribution of operational holdings of sample farmers are presented in **Table 2.50**. At the aggregate level, average owned land was about 3.1 acre, the entire area of which was irrigated. It can observed that small and medium sample farmers had taken more area on leased-in than the other categories of sample farmers. None of sample farmers of large categories neither leased in nor leased out land for cultivation. Further, there was a marginal difference between in acreage of owned area and net area sown across the size of farms. The average gross cropped area was worked out at 5.9 acre at the aggregate level and it varied

from 2.9 acre to 37.6 acres across farm size groups. However, cropping intensity was relatively high for marginal farmers followed medium, small and large farmers.

Table 2.50. Characteristics of operational holdings in Uttar Pradesh

(acre/household)

Farm size	Owned land	Un cultivated land	Leased-in	Leased –out	NOA	Irrigated area	GCA	Cropping intensity
Marginal	1.34	0.03	0.06	0.01	1.37	1.37	2.86	209.07
Small	3.75	0.06	0.22	0.08	3.83	3.83	7.11	185.95
Medium	7.43	0.15	0.25	0.25	7.28	7.28	13.56	186.32
Large	15.14	0.18	-	-	14.96	14.96	37.64	184.80
Total	3.07	0.05	0.12	0.05	3.09	3.09	5.93	192.18

2.9.3. Sources of Irrigation

The assured irrigation facilities play an important role in improving crop productivity. Various sources of irrigation for the sample farmers are shown in **Table 2.51**. It is evident that almost all the net area sown on the sample farms was irrigated by diesel tube-wells followed by canal. At the aggregate level, out of total irrigated area, the diesel tube-wells accounted for 89.6 per cent followed by 9.9 per cent canal and 0.5 per cent electric tube-well. It can also be observed that the per cent area irrigated by diesel tube-wells increased with increase in operational holdings. For marginal farmers, exclusive diesel tube-wells irrigated area accounted for 80.3 per cent, while it was 86.3 per cent for small farmers, 95.9 per cent for medium farmers and 100 per cent for large farmers. However, canal and tube well irrigation found to be a major sources of irrigation among sample farmers.

Table 2.51. Source of irrigation of net irrigated area in Uttar Pradesh

(Per cent)

Farm size	Only canal	Canal + tube-well	Only electric tube-well	Only diesel tube-well	Tanks	Open well	Others
Marginal	17.75	100.00	1.92	80.33	-	-	-
Small	13.74	100.00	-	86.26	-	-	-
Medium	4.12	100.00	-	95.88	-	-	-
Large	-	100.00	-	100.00	-	-	-
Total	9.91	100.00	0.53	89.56	-	-	-

2.9.4. Cropping Pattern

The cropping pattern on the sample farms during reference year is presented in **Table 2.52**. It can be seen that paddy and wheat were the dominant crops in the study area. Out of total cropped area, wheat accounted for 38.8 per cent followed by paddy with 25.0 per cent. Wheat and paddy together constituted about 63.7 per cent. Bajra, mentha and mustard were the other

crops accounted for about 13.9 per cent, 11.1 per cent and 3.7 per cent of GCA, respectively. Sugarcane accounted for 4.9 per cent. Among farm size categories, paddy accounted for the highest share of 34.3 per cent for marginal farms and the lowest of 16.8 per cent for large farms. It shows that the percentage allocation of area under paddy decreased with increase in farm size. However, for bajra, an opposite pattern was observed with large farmers having a relatively high area under cultivation.

With respect to cultivation of wheat, it occupied maximum area of 41.0 per cent for large farmers followed by 40.1 per cent for small farmers, 37.9 per cent for marginal farmers and 35.8 per cent for medium farmers. Mentha is highly profitable crop cultivated among the sample farmers with a considerable area under its cultivation. Area under mentha accounted for about 13.9 per cent of GCA for medium farmers followed by 11.3 per cent for marginal farmers, 11.2 per cent for large farmers and 9.1 per cent for small farmers. Overall, kharif season crops accounted for 40.5 per cent while rabi season crops accounted for 43.2 per cent of total cropped area.

Table 2.52. **Cropping pattern of selected farmers in Uttar Pradesh**

(% of GCA)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif					
Paddy	34.32	23.63	21.39	16.78	24.96
Bajra	6.74	14.20	18.63	19.57	13.94
Til	0.47	2.44	1.48	1.64	1.49
Rabi					
Wheat	37.85	40.10	35.78	40.96	38.78
Mustard	5.18	2.07	4.52	2.96	3.65
Potato	0.50	-	-	3.29	0.85
Fodder	0.12	0.24	0.09	0.33	0.19
Summer					
Mentha	11.32	9.05	13.87	11.18	11.12
Annual					
Sugarcane	3.15	8.27	4.24	3.29	4.90
Gross cropped area	100.0	100.0	100.0	100.0	100.0

2.9.5. Area under HYV

It can be observed from the **Table 2.53** that entire area under major crops are covered with high yielding varieties of respective crops. The traditional varieties of seeds have been totally replaced by HYVs. None of sample farmers across farm size categories had used traditional varieties. This shows technological spread among different farm size groups without any bias in the diffusion of the technology.

Table 2.53. Percentage of area under HYV seeds in Uttar Pradesh

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif					
Paddy	100.0	100.0	100.0	100.0	100.0
Bajra	100.0	100.0	100.0	100.0	100.0
Til	100.0	100.0	100.0	100.0	100.0
Urad	100.0	-	-	-	100.0
Rabi					
Wheat	100.0	100.0	100.0	100.0	100.0
Mustard	100.0	100.0	100.0	100.0	100.0
Potato	100.0	100.0	100.0	100.0	100.0
Summer					
Mentha	100.0	100.0	100.0	100.0	100.0
Annual					
Sugarcane	100.0	100.0	100.0	100.0	100.0

2.9.6. Crop Productivity

The productivity of various crops grown on the sample farms are shown in **Table 2.54**. It can be seen that the average yield of paddy at the aggregate level was 20.3 quintal per acre. The paddy yield varied between 19.7 quintal among marginal farmers and 23.2 quintals for large farmers. In fact, paddy yield increased with increase in farm size. The average productivity of wheat was the highest at 17.0 quintals on marginal farms and lowest at 15.6 quintal on large farms. Unlike yield of paddy, the yield of wheat was more or less same across farm size categories. In case of bajra, the average yield was 10.7 quintal per acre at the aggregate level and it has ranged between 10.0 quintals for large farmers and 12.0 quintals for marginal farmers. For mentha, the overall yield was 42.7 litres per acre. Similarly, average yield of mustard was highest at 7.4 quintal for medium farmers followed by 6.9 quintals for small farmers, 5.4 quintals for large farmers and 5.2 quintals for marginal farmers.

Table 2.54. Average Yield of Major Crops Grown by the Selected Households in Uttar Pradesh

(quintal/ acre)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif					
Paddy	19.66	19.98	19.59	23.24	20.25
Bajra	12.00	11.28	10.18	9.95	10.71
Til	0.50	1.07	1.00	2.00	1.22
Rabi					
Wheat	16.97	16.25	16.05	15.61	16.28
Mustard	5.17	6.90	7.39	5.44	6.02
Potato	71.43	-	-	70.00	70.25
Summer					
Mentha (Litre)	45.59	43.34	38.35	42.76	42.72

2.10. WEST BENGAL

2.10.1. Socio-economic characteristics of the selected farmers

Demographic profile of the sample farmers is presented in **Table 2.55**. It can be observed that 59.2 per cent of the households belonged to marginal farmers followed by 27.9 per cent small farmers,10.4 per cent medium farmers and 2.5 per cent large farmers. The household size increased with the increase in farm size except in case of medium farms. Average household size was relatively high for medium farmers. Majority of the respondents are in the age group of above 40 years except those under large farmers category. The majority of households in large farms are in the age group of 25 to 40 years. The education of the respondents is more or less concentrated to secondary education and the distant from the main market varies from 5.84 km to 8.92 km. The annual family income increased with increase in farm size.

Table 2.55. Demographic profile of the selected farmers in West Bengal

(% of households)

Characteristics		Marginal	Small	Medium	Large	Total
No of HH		59.17	27.92	10.42	2.50	100.00
Household size (numbers)		5.01	5.76	8.32	7.33	5.62
Average age of the respondent	Less than 25	2.11	0.00	0.00	0.00	1.25
	Between 25 & 40	42.25	34.33	42.00	66.67	41.25
	Above 40	55.65	65.67	52.00	33.33	57.50
Highest Education status of a family member	Illiterate	7.04	7.46	4.00	0.00	6.67
	Up to primary	36.62	16.42	8.00	0.00	27.08
	Up to secondary	47.89	52.24	56.00	50.00	50.00
	Higher secondary	3.52	11.94	32.00	50.00	10.00
	Graduate & above	4.93	11.94	0.00	0.00	6.25
Caste	SC	16.90	17.91	24.00	16.67	17.91
	ST	0.70	0.00	0.00	0.00	0.42
	OBC	4.23	5.97	8.00	0.00	5.00
	General	78.17	76.12	68.00	83.33	76.67
Distance from the main market (km)		8.92	7.27	5.84	6.33	8.11
Annual family income (Rs)		56056	89567	133000	212500	77338

2.10.2. Characteristics of Operational Holdings

An operational holding is a techno-economic unit, which consists of one or more parcels of land and form part of the same technical unit. Holdings used exclusively for livestock and poultry raising and for production of livestock and poultry and/or pisciculture are considered as operational holdings. The characteristics of operational holdings of the respondents are presented in **Table 2.56**. It can be observed that the net operated area (NOA) varied from 1.6 acres in marginal farms to 13.7 acres in large farms. It is very interesting to note that the

gross cropped area (GCA) decreased with the increase in farm size and thereby the cropping intensity was the highest for marginal farmers followed by medium, large and small farmers.

Table 2.56. Characteristics of operational holdings in West Bengal

(Acre/household)

Farm size	Owned land	Un- cultivated land	Leased-in	Leased - out	NOA	Irrigated area	GCA	Cropping intensity (%)
Marginal	1.19	0.00	0.40	0.02	1.56	1.40	2.74	175.64
Small	3.04	0.02	0.55	0.03	3.54	2.95	5.15	145.48
Medium	6.12	0.00	0.85	0.00	6.92	5.96	10.84	156.65
Large	13.22	0.00	0.47	0.00	13.69	11.83	20.21	147.63
Total	2.52	0.01	0.49	0.02	2.98	2.57	4.69	157.38

2.10.3. Sources of irrigation

The sources of irrigation are presented in **Table 2.57**. It can be seen that canal and tube-wells dominated the irrigation profile of the selected farms. More than 50 per cent of the land was irrigated by these sources. Canal irrigation is very scanty and it is applicable to marginal farms only. Diesel tube-well is more prominent than that of electric tube-well. It is very surprising to note that tank is not important in the irrigation profile of the respondents though tanks play a very important role in irrigation in West Bengal. It has been observed that the respondents in the selected districts have no dependence on tank water, may be due to the availability of underground water sources and government canal are in abundance. Further, it is evident that over time the dependence over tank has declined throughout West Bengal and in almost all the districts except Purulia district.

Table 2.57. Source of irrigation of net irrigated area in West Bengal

(per cent)

Farm size	Only canal	Canal + tube-well	Only electric tube-well	Only diesel tube-well	Tanks	Open well	Others	Net Irrigated Area (Acres/household)
Marginal	2.06	51.22	0.00	6.74	0.00	0.00	39.98	1.40
Small	0.00	73.75	2.53	3.21	0.00	0.00	20.51	2.95
Medium	0.00	56.82	3.13	0.00	0.00	0.00	40.05	5.96
Large	0.00	14.08	0.00	0.00	0.00	0.00	85.92	11.83
Total	0.33	55.50	1.56	3.20	0.00	0.00	39.74	2.57

2.10.4. Cropping pattern

The cropping pattern of the selected farms is presented in **Table 2.58**. It can be observed that the cropping pattern of the sample farmers spread over to all the seasons viz., kharif, rabi and summer. In kharif, aman paddy dominates the cropping pattern in all farms with area of 53.2 per cent. The share of aman paddy increased with the increase in size of holdings. Aman paddy constituted about 66.1 per cent of GCA for large farmers, while it was 48.5 per cent for

marginal farmers. Similarly in rabi, wheat occupied a larger proportion than that of other crops viz., potato, mustard and pulses. Wheat accounted for about 8.8 per cent of the total cropped area. The overall share of summer paddy (boro) in the gross cropped area was 9.1 and a relatively high area allocation under boro paddy was evident among large and medium farmers as compared to small and marginal farmers.

Table 2.58. Cropping pattern of selected farmers in West Bengal

(Per cent of GCA)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif					
Aman paddy	48.54	53.62	54.55	66.09	53.19
Jute	11.43	9.03	5.29	0.00	8.15
Maize	2.96	2.57	1.47	0.00	2.21
Rabi					
Wheat	10.74	8.96	8.83	1.32	8.77
Potato	5.56	4.42	5.87	9.78	5.74
Mustard	5.78	7.07	7.87	6.38	6.74
Pulses	2.74	2.32	1.46	1.65	1.99
Summer					
Boro paddy	7.79	6.45	12.22	13.20	9.09
Vegetable*	4.46	5.56	2.97	1.59	4.13
Gross Cropped Area	100.00	100.00	100.00	100.00	100.00

Note: ***** vegetables cultivated in all seasons and they include pumpkin, brinjal, chilli and zinger

2.10.5. Area under HYV

There are three seasons for growing rice and one season for growing of wheat in West Bengal. Rice is cultivated during autumn, winter and summer. Wheat is grown during rabi. Autumn or pre-kharif rice is known as *Aus* in West Bengal. The pre-monsoon *Aus*, covers April to July in the northern region and May to September in the southern region of the state and accounts for only 5 per cent of total rice area. With the expansion of irrigation facilities, the area under this crop has gradually been declining. This is a low-yielding relatively drought-tolerant upland crop with a yield of 1.5 - 2.0 tons per hectare. During *Aus* season, at present, more than 99 per cent of the total area is covered with high yielding varieties. The winter or monsoon rice, known as *Aman*, is grown from June to December. It accounts for 69 per cent of the total rice area, and is grown under rainfed conditions in the semi-deep, deep and flooded land (mostly indigenous improved and traditional varieties) and under irrigated conditions in the flood-free medium and shallow lowlands (mostly modern high yielding varieties). During *Aman*, farmers still grow some traditional or local rice varieties having special features and it covers about 12 per cent of the total rice area cultivated during *Aman*.

The remaining 26 per cent of the rice area is covered by the summer or dry season rice popularly known as *Boro*. This is a totally irrigated rice crop with the entire cropped area

occupying with high yielding modern varieties. The sowing time of summer rice is November to February and harvesting time is March to June. The growing season for the crop sometimes overlaps with *Aus*. With the expansion of irrigation facilities, farmers have been releasing land from *Aus* and deepwater *Aman* rice for raising *Boro* crop. It can be observed from **Table 2.59** that the entire area under all type of paddy is covered with high yielding varieties. Even in case of aman paddy though this is not a totally irrigated rice crop but the entire area is cropped with modern varieties. A similar pattern can also be observed in case of wheat.

Table 2.59. Percentage of area under HYV seeds in West Bengal

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif					
Aman Paddy	100.00	100.00	100.00	100.00	100.00
Jute	100.00	100.00	100.00	100.00	100.00
Maize	77.68	100.00	100.00	100.00	90.32
Rabi					
Wheat	100.00	100.00	100.00	100.00	100.00
Potato	100.00	100.00	100.00	100.00	100.00
Mustard	98.53	90.72	100.00	100.00	96.59
Summer					
Boro Paddy	100.00	100.00	100.00	100.00	100.00

2.10.6. Crop productivity

Table 2.60. Average yield of major crops grown by the selected households in West Bengal

(quintal/ acre)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif					
Aman Paddy	18.47	18.86	18.69	19.89	18.83
Jute	11.67	12.51	13.56	0.00	12.26
Maize	23.89	28.14	24.62	0.00	25.55
Rabi					
Wheat	13.54	14.16	14.87	11.72	14.01
Potato	110.00	115.36	120.92	97.72	111.90
Mustard	7.08	6.22	4.22	5.11	5.80
Summer					
Boro Paddy	23.37	24.21	23.50	25.83	23.98

Improving productivity in agricultural sector is one of the thrust areas of the state government with a view to improving income and welfare of the agrarian classes. Average yield of major crops grown by the selected households are presented in **Table 2.60**. It can be observed that the average productivity of aman paddy was 18.8 quintal per acre, whereas the same for boro paddy is comparatively much higher at 23.98 quintal per acre. Similarly, the productivity of

wheat varied from 11.7 quintal per acre in large farms to 14.9 quintals per acre in medium farms.

2.11. TO SUM UP

In Assam, marginal and small farmers constituted about 73 per cent of the total sample farmers. Average household size across all the farm size groups was 6.1 and it increased with increase in farm size. As high as 62.1 per cent of sample farmers were in the age group of above 40 years. Literacy level found to have improved among sample farmers with only 7.9 per cent of them were illiterate. The average net operated area of entire sample farmers was 4.4 acre. Cropping intensity was high among marginal farmers with 173 per cent and for overall sample it was 157 per cent. In the sample area, the diesel tube well was the only source of irrigation in all the farm size groups. The analysis of cropping pattern revealed that paddy occupied the highest area during kharif while wheat in rabi. Yield of paddy showed decreasing pattern with increase in farm size indicating that marginal and small farms are more productive than medium and large farms.

In Gujarat, analysis of socio- economic characteristics of the sample farmers households showed that household size varied from 5 to 7 members. The education status of the family members revealed that about 38 per cent of the households had family members having the highest education up to secondary level. About 28 per cent of households had family member studied highest up to graduates level and above and 8 per cent had acquired technical education. Average net operated area of the sample farmers was 12.9 acre and gross cropped area was 15.2 acre with the cropping intensity of 117 per cent. Major source of irrigation for the selected farmers were only canal and electric tube wells. Area irrigated by using only diesel tube well, tanks and open wells was quite low. The cropping pattern of the selected farmers indicated that tur, cotton, sugarcane and wheat were the main crops grown by these farmers. Average yield of tur was 4.3 quintals per acre with highest of 4.7 quintals recorded among medium farmers and lowest of 3.64 quintals for small farmers.

Analysis of the socio-economic characteristics of the sample households in the state of Karnataka revealed that large farm holdings have relatively higher average household size. A high proportion of large and medium farmer households have family members with educational qualification of graduation and above as compared to marginal and small farmer households. The distribution of operational holdings is skewed towards medium and large farmers. The medium farmers and large farmers owned about 7.1 acres and 16.5 acres per

household, respectively. Among farm size groups, marginal and small farmers had allocated relatively a high proportion of area for the cultivation of paddy. For red gram, per cent area allocation was high among large farmers followed by small farmers. However, in terms of spread of high yielding varieties, it was low at 24.8 per cent of the cropped area. Average yield of major crops grown by the sample farmers has varied by farm size groups. Nevertheless, yield of major crops was more or less high among small farmers as compared to other groups. Further, relationship between farm size and land productivity was not very clear among the farm size categories.

In Madhya Pradesh, average household size of sample farmers was seven members. About 59.1 per cent of the respondents belonged to age of above 40 years followed by 35.6 per cent with 25 to 40 years and 5.3 per cent with less than 25 years. Education status of the sample households varied with farm size group. Average size of operated area was worked out at 11.3 acre with 1.8 acre for marginal farmers, 4.3 acre for small farmers, 10.1 acre for medium farmers and 29.1 acre for large farmers. With respect to source of irrigation, 67.2 per cent of net operated area was irrigated by tube well followed by canal (16.4 per cent), canal + tube well (15.5 per cent) and tanks (1.0 per cent). Soybean and wheat occupied about 46.8 per cent and 40.8 per cent of the gross cropped area, respectively. Average yield of soybean was 4.5 quintal per acre and it was 13.9 quintal for wheat.

The socio-economic characteristics of different categories of tur and soyabean cultivators in Maharashtra revealed that average family size ranged between 5.4 for medium farmers and 6.8 for large farmers. The distribution of respondents across various age groups showed that 58.8 per cent of respondents were above 40 years of age. Regarding education status, family members of medium and large category of sampled respondents invariably had higher education status as compared to marginal and small category. The net operated area was estimated at 2.0 acre for marginal category, 4.1 acre for small, 7.3 acre for medium and 15.6 acre for the large category. In general, about 44 per cent of the net operated area was found to be irrigated. Analysis of cropping pattern showed that soybean as the predominant crop with 36.6 per cent of the gross cropped area. The other major crops grown are tur (12.5 per cent) and cotton (19.0 per cent). Average yield of tur for overall sample farmers was 4.7 quintals per acre and 5.5 quintals for soybean.

Analysis of socio-economic characteristics of sample farmers in Punjab showed that average household size varied from 5 to 8 members with lowest on marginal and highest on large farm category. Out of total respondents, over three fourth had average age above 40 years. About 32-58 per cent 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 across farm size groups. The net operated area was 11.4 acres for the entire sample in Punjab. The entire area on all the farm size categories was irrigated and the cropping intensity was nearly 200 per cent. The major source of irrigation was electric tube well as reported by 42 per cent of the sample households. Canal irrigation along with tube well irrigation was used 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. Wheat was major rabi crop which occupied 46.9 per cent. The average yield of paddy varied form 26.3 quintals to 27.9 quintals per acre across farm size groups. For wheat, the yield varied from 18.4 quintal to 19.2 quintals per acre with an average of 19.1 quintal for the overall sample.

In Rajasthan, analysis of primary data on socio-economic characteristics of the sample soybean farmers showed that the household size varied from 7 to 11 members. The education status of the sample households revealed that 36 per cent of the households had family members with the highest education up to secondary level, 28 per cent with higher secondary, 16 per cent with graduate and above and 3 per cent with technical education. The average net operated area was 8.0 acre with the cropping intensity of 183 per cent. Major sources of irrigation were open well and electric tube well for the selected farmers. The cropping pattern of the sample farmers revealed that soybean, maize, wheat, garlic and coriander were the main crops grown by them. Among these crops, soybean accounted for the highest area of 38.2 per cent of GCA followed by wheat with 17.5 per cent. Average yield of soybean was estimated at 8.6 quintals per acre with highest of 8.8 quintals for large farmers and lowest of 7.7 quintals for marginal farmers. Average yield of soybean increased with increase in farm size.

The demographic details of sample farmers in Tamil Nadu showed that majority of the farmers were well educated and this had helped them to adopt new technology. The average size of operational holdings for the entire sample farmers was estimated at 9.0 acres. The sample farmers utilised canal and tube well irrigation to a greater extent as compared to other

sources of irrigation. Among various crops, paddy occupied a major proportion of gross cropped area during all the three seasons in the study area. In fact, paddy occupied about 29.4 per cent in kharif, 26.2 per cent in rabi and 21.5 per cent during summer season. Regarding yield of paddy, it was 22.9 quintals per acre in kharif, 21.4 quintal in rabi and 20.4 quintals in summer. The highest level of paddy yield was achieved by medium farmers followed by large farmers during kharif and small farmers produced the highest yield in rabi.

In Uttar Pradesh, average size of family was seven and most of the family members of sample households were educated. The per farm owned land was 3.1 acres which was totally under cultivation. The entire area under cultivation was fully irrigated and cropping intensity was 191.2 per cent. The net area sown of the sample farms was irrigated by diesel tube-wells followed by canal. Out of irrigated area, diesel tube-wells alone accounted for 89.6 per cent. The paddy and wheat were dominant crops grown by the sample farmers. Wheat accounted for 38.8 per cent followed by paddy (25.0 per cent), bajra (13.9 per cent) and mentha (11.1 per cent). Out of total cropped area, kharif crops accounted for 40.5 per cent while rabi crops accounted for 43.2 per cent. The average yield of paddy was 20.3 quintals, which varied between 19.7quintals for marginal farmers and 23.2 quintal for large farmers. The average productivity of wheat was relatively high for marginal farmers with about 17.0 quintals and low for large farmers at15.6 quintals per acre.

Analysis of socio-economic characteristics of sample farmers in West Bengal revealed that majority of the respondents are in the middle age group. The education of the respondents was more or less concentrated to secondary education. The net operated area varied from 1.6 acres for marginal farmers to 13.7 acres for large farmers. The gross cropped area (GCA) decreased with the increase in farm size and the cropping intensity was high among marginal farmers. With respect to irrigation, canal and tube-wells dominated the irrigation profile of the selected farms irrigating over 50 per cent of the net operated area. Analysis of cropping pattern showed that in kharif season, aman paddy dominated the cropping pattern in all farms. The share of aman paddy increased with the increase in size of holdings. In rabi season, wheat occupied a larger portion of area. The share of summer paddy was also significant. In the study area, average productivity of aman paddy was 18.8 quintals per acre, whereas for boro paddy it was relatively high at 24.0 quintal.

CHAPTER III
ASSESSMENT OF PRE HARVEST LOSSES

The present chapter provides estimates of pre harvest losses caused by the pests and diseases. Infestation of pests leads to fall in crop productivity by damaging various parts of crops at different stages of growth. The ill effects of pest infestation on crop performance can be seen in the form of stunted growth, wilting, curling of leaves, damaged stems, reduction in number of ears, low grain filling and discoloration. Pre harvest losses are encountered from planting of crop to maturity for harvest. Assessment of crop losses through a systematic method helps different stakeholders like farmers, extension officials and policy planners to take necessary steps for controlling pests and for preventing economic loss to the country. The crop loss estimates obtained directly from the farmers through a systematic survey may reflect the actual field conditions. Although farmers' estimates or perceptions about the yield loss may be subjective, yet these estimates represent actual field conditions, technology and various class of farmers. This chapter presents crop loss estimates for four reference crops viz., paddy, wheat, tur and soybean across selected states. The respective state reports prepared by the AERCs provide the details of pests attack and yield loss by crops.

3.1. PADDY

3.1.1. Assam

In the field survey, farmers were asked to mention the constraints faced in the cultivation of paddy Accordingly, five constraints were identified by the sample farmers. These constraints included poor seed quality, water deficiency, pest and disease incidence, high cost of inputs and low output/market price. After identifying the constraints, farmers were asked to rank them in the order of most important, important and least important with a view to understand the severity of constraints faced by them.

Table 3.1 provides different constraints faced in the cultivation of paddy by the sample farmers in Assam. It can be observed that about 92.5 per cent of the sample households reported that low output price was the most important constraint for them in the cultivation of paddy. This was followed by high cost of inputs (69.2 per cent) and water deficiency (52.5 per cent). In case of pests and diseases, 23.3 per cent of the sample farmers opined it as the most important and the proportion of farmers reported poor seed quality was 27.5 per cent.

Table 3.1. Constraints faced in cultivation of paddy in Assam

(% of households)

S. No	Constraints	Most important	Important	Least important	Total
1	Poor seed quality	27.50	35.00	37.50	100.00
2	Water deficiency	52.50	15.83	31.67	100.00
3	Pest and disease problems	23.33	49.17	27.50	100.00
4	High cost of inputs	69.17	30.83	0.00	100.00
5	Low output price	92.50	5.83	1.67	100.00

Since focus of the study is to estimate the crop loss due to pests and diseases, detailed information on type of pests, diseases and weeds, severity of attack and frequency of attack were collected from farmers through field survey. From these information, crop production loss due to individual pests, diseases and weeds were estimated. **Table 3.2** presents magnitude of aggregate loss of paddy due to infestation of pests in the sample farmers field conditions. The per cent loss over the actual production due to the attack of pests, diseases and weed infestations and normal production without attack in paddy (local and HYV) across the different farm size groups are given. Crop losses in HYV paddy was estimated to be high as compared to local paddy indicating a higher level of resistance of local paddy against infestation. The loss over the actual production of local paddy ranged between 5.4 per cent and 8.3 per cent while in HYV paddy, it stood between 6.2 per cent and 9.5 per cent across farm size groups. The overall losses was 7.1 per cent and 8.4 per cent for local and HYV paddy, respectively. The loss over normal production of local paddy ranged between 5.2 per cent and 7.6 per cent while in HYV paddy, it ranged between 5.8 per cent and 8.7 per cent across farm size groups. The overall losses stood at 6.7 per cent and 7.8 per cent for local and HYV paddy, respectively.

Table 3.2. Magnitude of crop loss due to pests, disease and weed infestation in Assam-Paddy

Description	Marginal		Small		Medium		Large		Total	
	Local	HYV	Local	HYV	Local	HYV	Local	HYV	Local	HYV
Actual production with attack (quintal/ha)	30.25	42.73	28.96	35.89	26.77	33.19	26.89	30.82	27.99	35.35
Normal production without attack (quintal/ha)	32.09	45.55	30.51	38.80	28.25	35.24	29.11	33.76	29.99	38.34
Loss of output (quintal/ha)	1.84	2.82	1.55	2.91	1.48	2.05	2.22	2.94	2.00	2.98
Percentage loss over actual production	6.09	6.59	5.37	8.12	5.51	6.18	8.25	9.53	7.14	8.44
Percentage loss over normal production	5.74	6.18	5.09	7.51	5.23	5.82	7.62	8.70	6.66	7.79

Assessment of yield loss due to pests and diseases helps to design appropriate pest control strategies. At the field level, farmers adopt different methods viz., chemical, mechanical and

biological methods either individually or in combination to control pests. Among these methods, chemical method has been predominantly used by the sample farmers. The particulars of chemical method used by the farmers to control weeds, insect pests and diseases are provided in **Table 3.3**. On an average, 89.2 per cent of the sample households used chemicals for controlling pests and diseases in paddy. There was no report of using weedicide in the study area. Manual uprooting of weeds was the common practice. On an average, cost for weed control was Rs. 301.3 per acre. To control the pests attack, one time chemical spray was reported to be sufficient. The overall cost of spraying of insecticides including labour charge was worked out at Rs. 262.2. In case of fungicides, the overall cost incurred by the sample farmers was Rs. 248.6 per acre.

Table 3.3. Cost of Chemical methods adopted for pests and disease control in Assam-Paddy

(Rs/acre)

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted control measures	86.21	92.98	84.38	100.00	89.17
Weedicide					
No. of sprays	0	0	0	0	0
Cost of chemicals	0.00	0.00	0.00	0.00	0.00
Labour charges	252.8	272.6	297.0	382.8	301.3
Total Cost	252.8	272.6	297.0	382.8	301.3
Insecticide					
No. of sprays	1.00	1.00	1.00	1.00	1.00
Cost of chemicals	32.3	40.3	56.5	72.6	50.4
Labour charges	180.0	217.0	195.0	255.0	211.8
Total Cost	212.3	257.3	251.5	327.6	262.2
Fungicide					
No. of sprays	1.00	1.00	1.00	1.00	1.00
Cost of chemicals	25.6	36.6	43.9	58.6	41.2
Labour charges	192.0	196.0	201.5	240.0	207.4
Total Cost	217.6	232.6	245.4	298.6	248.6

It was reported that incidence of pest and disease was very common in the study area for all the field crops. The farmers used to seek technical advice from different sources only when severity of attack went beyond a certain level. **Table 3.4** presents different sources technical advice sought by farmers to control pests and diseases of paddy in Assam. It can be noticed that overall about 74.2 per cent of the sample households sought technical advice for pest control. Among various sources, fellow farmers (39.3 per cent) were the most important source of information. Only about 19.1 per cent of the sample households considered the government extension agent as the most important and 39.3 per cent as important source of information. Majority of the sample farmers reported that the information and services received from different agencies were very useful for control of pests and diseases in the field.

Table 3.4. Extension services on pests and disease control management in paddy in Assam

(% of households)

Sources of advice	Most important	Important	Least important
Government extension agent	19.10	39.33	7.87
Private input dealer	0.00	0.00	10.11
Fellow farmers	39.33	13.48	23.60
TV/Radio service/Newspaper	3.37	5.62	39.33
Agricultural University/KVK	13.48	33.71	19.10
Any other	0.00	0.00	0.00
Percentage of HH seeking advice			74.2

3.1.2. Karnataka

Generally, farmers face more than one constraint in the cultivation of a particular crop. For paddy cultivation in Karnataka, incidence of pests and diseases emerged to be a serious problem with a reporting of 95.63 per cent of the total paddy growing farmers (160) followed by high cost of inputs (90.0 per cent) (**Table 3.5**). While a quarter of the sample farmers reported water deficiency as the constraint, less than one third of farmers reported poor seed quality affecting the performance of the paddy. In terms of severity of the problem, 54.38 per cent of the farmers reported pest and diseases problems as most important and 28.75 per cent as important. Similarly, about 30.63 per cent of the farmers reported high cost of inputs as most important constraint in growing of paddy.

Table 3.5. Constraints faced in cultivation of paddy in Karnataka

(% households)

S. No	Particulars	Most important	Important	Least important	Total
1	Poor seed quality	5.00	6.25	19.38	30.63
2	Water deficiency	6.25	5.63	13.13	25.00
3	Pest and disease problems	54.38	28.75	12.50	95.63
4	High cost of inputs	30.63	45.00	14.38	90.00
5	Low output price	4.38	13.75	31.25	49.38

For understanding of crop loss caused by all pests, yield loss reported by the farmers has been converted into aggregate physical loss. Production loss has been estimated as the difference between actual yield and normal/potential yield (no loss scenario) expressed as percentage of normal yield. **Table 3.6** provides physical loss of paddy due to pests, diseases and weeds by farm size groups. It can be noted that paddy yield loss due to all pests ranged from 13.8 per cent among medium farmers to 20.0 per cent among marginal farmers. Surprisingly, yield loss among marginal farmers is higher even though these farms are supposedly better managed than other farm categories. It has been found through field survey that marginal farmers found it difficult to control pests effectively through chemical method due to high

cost of pesticides and lack of adequate finance. The overall paddy yield loss is estimated to be 16.2 per cent. However, in terms of actual production, physical loss has been worked out at 19.3 per cent.

Table 3.6. Magnitude of crop loss due to pests, disease and weed infestation- Paddy in Karnataka

Description	Marginal	Small	Medium	Large	Total
Actual production with attack (quintal/acre)	18.3	19.5	20.1	20.3	19.5
Normal production without attack (quintal/acre)	22.9	22.8	23.3	24.6	23.3
Loss of output (quintal/acre)	4.6	3.3	3.2	4.3	3.8
Percentage loss over actual production	25.0	16.8	16.0	21.1	19.3
Percentage loss over normal production	20.0	14.4	13.8	17.4	16.2

Estimation of magnitude of yield loss helps to design appropriate pest control strategies. At the field level, farmers adopt different methods viz., chemical, mechanical and biological methods either individually or in combination to control pests. Among these methods, chemical method has been predominantly used by the sample farmers. The particulars of chemical method used by the farmers to control weeds, insect pests and diseases are provided in **Table 3.7**.

With respect to weeds, generally farmers prefer to manually remove them in the paddy field as they feel that use of chemicals/weedicide is not effective beyond certain stage of vegetative growth of paddy. The average number of spays was about one per farmer household and in terms of per acre, it was negligible. The cost of chemicals used was relatively high among medium farmers followed by marginal farmers and small farmers. Due to imputation of family labour cost, total cost of weedicide application worked out to be high among the marginal farmers. Similarly, total cost of application of insecticide to control insects also estimated to be high for marginal farmers, due to high labour cost, followed by medium and large farmers. However, cost of insecticide used was relatively high for large and medium farmers. The overall cost of application of insecticide was Rs. 484.05 per acre, which was higher than that of weedicide (Rs. 286.43) and fungicide (Rs. 211.71). Although average number of sprays of insecticide and fungicide per household was more or less equal, high cost of insecticide has resulted in high cost of its application. Further, infestation of different insects is more frequent in paddy and hence warrants regular spray of insecticide.

Table 3.7. Cost of Chemical methods adopted for pests and disease control (Rs/acre)- Paddy in Karnataka

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted control measures	100.00	100.00	100.00	100.00	100.00
Weedicide					
Av. number of Sprays	1.42	1.17	1.26	1.00	1.32
No. of sprays/acre	0.67	0.21	0.15	0.05	0.29
Cost of chemicals	211.20	172.31	236.47	101.10	190.28
Labour charges	186.73	71.66	68.24	42.65	96.14
Total Cost	397.94	243.97	304.71	143.75	286.43
Insecticide					
Av. number of Sprays	1.69	1.88	1.84	2.00	1.78
No. of sprays/acre	0.81	0.41	0.27	0.15	0.43
Cost of chemicals	346.72	262.29	370.17	380.88	336.01
Labour charges	222.61	161.53	105.02	83.82	148.03
Total Cost	569.33	423.82	475.20	464.71	484.05
Fungicide					
Av. number of Sprays	1.58	1.80	2.00	3.00	1.79
No. of sprays/acre	0.31	0.23	0.13	0.09	0.20
Cost of chemicals	134.15	154.74	163.49	124.49	147.08
Labour charges	65.64	85.34	66.85	23.53	64.63
Total Cost	199.79	240.09	230.34	148.01	211.71

The effectiveness of any method used to control pests and diseases depends on scientific way of applying it. Such scientific knowledge should be disseminated to farmers through periodical training and education by extension specialists and development agencies. Therefore, it is important to understand the current sources of knowledge that the sample farmers have access to and ability to use them for effective control of all pests. It is interesting to observe that almost all the sample farmers sought advice from some source for management of pests and diseases in paddy in Karnataka (**Table 3.8**).

Table 3.8. Extension services for pests and disease control management in paddy in Karnataka

(% households)

Sources of advice	Most important	Important	Least important	Total
Government extension agent	40.6	21.3	25.6	87.5
Private input dealer	26.3	33.1	18.8	78.1
Fellow farmers	26.9	33.8	15.6	76.3
TV/Radio service/Newspaper	3.8	5.6	23.8	33.1
Agricultural University/KVK	1.9	1.3	0.6	3.8
Percentage of HH seeking advice			99.4	

It can be noticed that a high proportion of sample farmers (87.5 per cent) relied on government extension agents for seeking advice on controlling pests and diseases. Among them, 40.63 per cent considered extension agents as most important and 21.25 per cent as important source of information. The second major source of information was the private input dealers, who in the recent years assumed important role in lending credit and in providing technical knowledge to farmers. The fellow farmers emerged as the third major source of information among the sample farmers. About a quarter of sample farmers mentioned private input dealers and fellow farmers as the most important source of advice for pest and disease management in paddy.

3.1.3. Punjab

The constraints faced in cultivation of paddy are depicted in **Table 3.9**. High cost of inputs was reported as the 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. However, most sample households reported poor seed quality as the least important constraint. Overall, important constraints in paddy cultivation as reported by the sample respondents were high cost of irrigation, erratic power supply, regular occurrence of pest and diseases, high cost of inputs such as fertilizers, weedicides, pesticides, labour and decline in profitability due to low output price.

Table 3.9 Constraints faced in cultivation of paddy in Punjab

(% of households)

S. No	Constraints	Most important	Important	Least important
1	Poor seed quality	-	-	98.00
2	Water deficiency	14.00	49.00	37.00
3	Pest and disease problems	7.00	33.00	60.00
4	High cost of inputs	73.00	14.00	13.00
5	Low output price	23.00	32.00	45.00

The magnitude of crop loss due to pests, disease and weed infestation in paddy crop is given in **Table 3.10**. The actual production with pests, disease and weed infestation fluctuated between 24.9 quintal and 26.5 quintal per acre on various farm size categories with minimum on marginal and maximum on small farms. Overall, actual production was estimated at 26.3

quintals per acre and normal production at 28.6 quintals. 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. In fact, crop loss was 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 was 8.7 per cent over actual production and about 8.0 per cent over normal production. The loss due to major pests, diseases and weeds was relatively low due to the efficient crop management by the farmers as well as varietal characteristics and timely application of plant protection chemicals.

Table 3.10. The magnitude of crop loss due to pests, disease and weed infestation- Paddy in Punjab

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

The cost of chemical methods adopted for pests and disease control in paddy crop are given in **Table 3.11**. All the households applied chemical methods to control pests, diseases and weeds. Majority of the farmers across farm size categories applied one spray to control weeds. The total cost of weedicides spray along with labour charges varied between Rs. 213.5 and Rs. 256.1 per acre. It can be observed that more than two insecticide sprays were applied on all the farm size categories in order to control various pests. The total cost of chemical used and labour charges worked out at Rs. 646.0 for marginal, Rs.579.1 for small, Rs. 636.2 for medium and Rs. 624.0 for large farmers. To control various diseases one spray of fungicide was applied by the sample farmers. The total cost of fungicide spray including labour charges varied between Rs. 180.6 and Rs. 210.8 per acre across farm size groups with the lowest amount for large farmers and highest for marginal farmers.

Table 3.11. Cost of chemical methods adopted for pests and disease control (Rs/acre)- Paddy in Punjab

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 sources of information for pest and disease control in paddy are given in **Table 3.12**. It can be observed that 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 only 4 per cent. As far as seeking 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. Fellow farmers also emerged as an important source of advice for discussing various farm related problems in paddy. Therefore, fellow farmers were ranked as important source of advice by 67 per cent households.

Table 3.12. Extension services on pests and disease control management in paddy in Punjab

(% of households)

Sources	Most important	Important	Least important
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
Any other	-	-	-
Percentage of HH seeking advice			100

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. Thus, it is clear from the discussion that private input dealers and fellow farmers were the most important source of advice for control of pest and disease, and other farm related issues.

3.1.4. Tamil Nadu

In the cultivation of paddy, the sample farmers faced a number of constrains. These constrains included poor seed quality, water deficiency, pests and disease problems, high cost of inputs and low output prices. Among constraints faced by farmers in the cultivation of paddy, low output price was reported as the most important constraint faced by 57.5 per cent of the sample farmer in Villupuram and 40 per cent in Tiruvarur (**Table 3.13**). The high cost of inputs was the next important constraint faced by the sample farmers. Water deficiency was cited as the most important constraint by 32.5 per cent in Tiruvarur and 13.8 per cent in Villupuram. In Tiruvarur, the poor quality of seeds was reported as an important constraint faced by 73.8 per cent followed by pests and disease attack as most important by 56.2 per cent of the households. In Villupuram district, a significant proportion of sample farmers expressed water problem as important constraint followed by poor quality of seeds. About 35 per cent of the sample households informed that pests and diseases problem was an important problem faced by them.

Table 3.13. Constraints faced in cultivation of paddy in Tamil Nadu

(% of household)

Constraints	Most Important	Important	Least Important	Most Important	Important	Least Important
	Tiruvarur			Villupuram		
Poor Seed Quality	13.70	73.80	12.50	15.00	52.50	32.50
Water Deficiency	32.50	36.30	31.20	13.80	60.00	26.20
Pest Disease problems	17.50	56.20	26.30	26.20	35.00	38.80
High Cost of Inputs	35.00	37.50	27.50	56.30	31.20	12.50
Low Output Price	40.00	48.80	11.20	57.50	20.00	22.50

The scale of crop loss due to pests and diseases and weed infection in paddy crop for Tiruvarur district of Tamil Nadu is given in **Table 3.14**. It can be observed that large farmers suffered heavier loss with 3.42 quintal per acre. Crop loss expressed in terms of actual production varied at 14 per cent for marginal, 12 per cent for small, 14 per cent for medium and 16 per cent for large farmers.

Table 3.14. Magnitude of Crop Loss due to Pests, Diseases and Weed Infestation- Tiruvarur

Description	Marginal	Small	Medium	Large	Overall
Actual production with attack (quintal/acre)	20.06	25.09	21.78	22.07	23.43
Normal production without attack (quintal/acre)	22.88	28.12	24.92	25.49	25.35
Loss of output (quintal/acre)	2.82	3.03	3.14	3.42	1.92
Percentage of loss over actual production	14.06	12.08	14.42	15.50	8.21
Percentage of loss over normal production	12.33	10.78	12.60	13.42	7.58

Table 3.15 provides details of the magnitude of crop loss due to pests, diseases and weed infestations in Villupuram. It can be noticed that the physical loss of output among sample households in Villupuram district was 2.5 quintal per acre for all the farmers. In terms of the percentage of loss over actual production from the attack of pests, diseases and weed infestations it was estimated at 13 per cent for marginal farmers, 9 per cent for small farmers, 12 per cent for medium farmers and 14 per cent for large farmers.

Table 3.15. Magnitude of Crop Loss due to Pests, Diseases and Weed Infestation- Villupuram

Description	Marginal	Small	Medium	Large	Overall
Actual production with attack (quintal/acre)	19.21	19.28	23.63	21.34	21.68
Normal production without attack (quintal/acre)	21.70	21.05	26.36	24.27	23.35
Loss of output (quintal/acre)	2.49	1.77	2.73	2.93	2.48
Percentage of loss over actual production	12.96	9.18	11.55	13.73	11.44
Percentage of loss over normal production	11.47	8.41	10.36	12.07	10.62

Various chemical methods are adopted in order to control pests and diseases. **Table 3.16** provides details of cost of chemical methods adopted for pest and disease control in Tiruvarur district. The majority of the farmers with different farm sizes applied only one spray of chemicals per acre in order to control the pests and the diseases in paddy. The total cost of weedicide varied from Rs.303.5 to Rs.344.6 per acre for different farm size groups. The average cost of applying insecticides by the respondents was Rs.346 per acre. The fungicides were sprayed at least once per acre by all the farmers. The average cost was the highest for small farmers at Rs.338 and the lowest for medium farmers at Rs. 301. It was observed in the field that cost varied from one season to another and farm to farm because of variations in price of chemicals in different places mostly sold by the private agents with huge margin. The labour cost also varied from one area to another.

Table 3.16. Cost of chemical methods adopted for pests and disease control (Rs /acre)- Tiruvarur

Description	Marginal	Small	Medium	Large	Overall
% HH adopted control measures	100.00	100.00	100.00	100.00	100.00
Weedicide					
No. of Sprays/Acre	0.85	1.15	0.92	0.70	0.91
Cost of Chemicals	251.85	233.50	260.77	218.03	241.04
Labour Cost	72.59	89.50	83.85	85.50	82.86
Total Cost	324.44	323.00	344.62	303.53	323.90
Insecticide					
No. of Sprays/Acre	1.00	0.95	1.08	1.10	1.03
Cost of Chemicals	228.89	238.50	253.08	298.50	254.74
Labour Cost	88.15	89.50	90.00	96.50	91.04
Total Cost	317.04	328.00	343.08	395.00	345.78
Fungicide					
No. of Sprays/Acre	1.11	1.15	0.92	1.15	1.08
Cost of Chemicals	238.89	240.50	217.69	232.00	232.27
Labour Cost	95.19	97.00	83.08	94.00	92.32
Total Cost	334.08	337.50	300.77	326.00	324.59

Table 3.17 provides details of the cost of chemical methods adopted for pest and disease control by the sample farmers in Villupuram district. Analysis of data revealed that almost all the sample farmers across farm size groups used weedicides, insecticides and fungicides to control pests and diseases in paddy cultivation. The average cost of weedicides for the overall sample farmers was Rs.299. In case of insecticides, the average cost was the lowest at Rs. 422 per acre for small farmer, whereas it was the highest at Rs.484 per acre for the large farmers. In case of fungicides, the average cost was more or less the same for all farm size categories. Overall, analysis showed that large farmers spent more on weedicide and insecticides.

The sources of information for effective management of pest and diseases in paddy are given in **Table 3.18**. It was observed in the field that various agencies have given advice to control the pests and diseases in paddy. Specifically, Government agents, private agents, fellow farmers, news papers and agricultural universities have given advice to the farmers for control of pest and diseases. The Government of Tamil Nadu has been popularising the best practices of pest management in the state since 1990s through various programmes.

Table 3.17. Cost of chemical methods adopted for pests and diseases control (Rs/acre)- Villupuram

Description	Marginal	Small	Medium	Large	Overall
% HH adopted control measures	100.00	100.00	100.00	100.00	100.00
Weedicide					
No. of Sprays/Acre	0.16	0.32	0.57	1.00	0.51
Cost of Chemicals	223.07	192.00	177.86	292.00	221.23
Labour Cost	73.08	75.60	79.29	81.33	77.33
Total Cost	296.15	267.60	257.15	373.33	298.56
Insecticide					
No. of Sprays/Acre	1.70	1.64	1.65	1.68	1.67
Cost of Chemicals	366.69	342.72	374.86	394.67	369.74
Labour Cost	74.39	78.80	83.29	89.53	81.50
Total Cost	441.08	421.52	458.15	484.20	451.24
Fungicide					
No. of Sprays/Acre	1.15	1.64	1.15	1.13	1.27
Cost of Chemicals	273.46	281.60	291.43	287.00	283.37
Labour Cost	85.77	80.12	76.07	73.00	78.74
Total Cost	359.23	361.72	367.50	360.00	362.11

It can be observed from the **Table 3.18** that while 66 percent of sample farmers in Tiruvarur regarded the services provided by the Government extension agent as the most important, only 19 percent of the households in Villupuram district considered the services provided by Government extension agent as most important. The poor utilization of the services of Government agency in Villupuram is a matter of concern and needs further study in depth. However, 59 percent of sample farmers in Villupuram considered the services of private input dealers as most important, whereas the figure for Tiruvarur was only 15 percent. The high percentage of dependence on private input dealers in Villupuram may be attributed to the easy availability of agricultural inputs on credit from private dealers. About 45 percent of sample households in Tiruvarur district considered the services of fellow farmers as most important. But, only 9 percent of sample households considered the services of fellow farmers as most important. A large majority of the sample farmers in both the districts were of the opinion that the services provided by TV/Radio/News papers, Agricultural University/KVK were of least important. Agricultural University should intensify its efforts to propagate the new techniques of production and innovative agricultural practices.

Table 3.18. Extension service on pests and diseases control management in Tamil Nadu

(% of households)

Sources	Tiruvarur			Villupuram		
	Most Important	Important	Least Important	Most Important	Important	Least Important
Government Extension Agent	66.2	18.8	15	18.8	37.5	43.7
Private Input Dealer	15	2.5	82.5	58.8	30	10.2
Fellow Farmers	45	18.8	36.2	8.7	67.5	23.8
TV/Radio /News Paper	6.2	11.3	82.5	12.5	32.5	55
Agricultural University / KVK	15	13.8	71.2	2.5	15	82.5

3.1.5. Uttar Pradesh

The constraints faced in the cultivation of paddy are depicted in **Table 3.19**. Low output price of paddy was most important constraint as reported by 53 per cent of the sample households. However, 47 per cent of sample households had reported that it was least important constraint. The high cost of inputs was also most important constraint as reported by 28 per cent, while 3 per cent of sample farmers opined that it was the important constraint. About 69 per cent of sample households reported the high cost of inputs as the least important constraint. With respect to pest and diseases problems, 17 per cent sample farmers had reported it as a constraint. Among those sample farmers reported pest and disease problems, 82 per cent household had treated it as least important constraint in the cultivation of paddy. The poor seed quality and water deficiency were only least import constraints as reported by all the sample households.

Table 3.19. Constraints Faced in Cultivation of Paddy in Uttar Pradesh

(% of households)

S. No.	Constraints	Most important	Important	Least important
1	Poor seed quality	-	-	100.00
2	Water deficiency	-	-	100.00
3	Pest and disease problems	17.00	1.00	82.00
4	High cost of inputs	28.00	3.00	69.00
5	Low output price	53.00	-	47.00

The magnitude of crop loss due to pests, diseases and weed infestation in HYV paddy is presented in **Table 3.20**. At the aggregate level, actual production with attack was worked out at 19.6 quintals per acre with the lowest being 18.6 quintals for marginal farmers and highest being 22.1 quintals for large farmers. The normal production without attack of pests, disease and weed infestation varied between 19.4 quintals and 22.5 quintals per acre across farm size

groups. The percentage loss over actual production was estimated at 2.96 per cent against 2.88 per cent over normal production. The percentage loss over actual production was estimated the highest of 4.3 per cent for marginal farmers and lowest at 1.5 per cent for large farmers. Similarly, the percentage loss over normal production was estimated at 2.9 per cent for the overall sample. It can be noticed that percentage losses over actual production as well as percentage loss over normal production were highest on marginal farms and lowest on large farms. It shows that large sample farmers had adopted plant protection measures effectively and timely than marginal sample farmers.

Table 3.20. Magnitude of crop loss due to pests, disease and weed infestation- Paddy in Uttar Pradesh

Description	Marginal	Small	Medium	Large	Total
Actual production with attack (quintal/acre)	18.62	19.02	20.66	22.14	19.57
Normal production without attack (quintal/acre)	19.42	19.55	21.06	22.46	20.15
Loss of output (quintal/acre)	0.80	0.53	0.40	0.32	0.58
Percentage loss over actual production	4.30	2.79	1.94	1.45	2.96
Percentage loss over normal production	4.12	2.71	1.90	1.42	2.88

The cost of chemical control in paddy worked out in **Table 3.21**. It can be observed that almost all the sample farmers belonging to medium and large categories had adopted plant protection measures to control the pests and diseases in paddy, while only 83 per cent sample farmers falling under marginal farm size and 84 per cent under of small categories had adopted for pest and disease control. Two type of chemical control measures viz., weedicides and insecticides were adopted by the sample farmers.

At least one spray of weedicides was adopted by all the sample farmers across size farm size groups with the average cost of Rs. 221.5 at the aggregate level, out of which cost of chemicals accounted for 68.2 per cent. The marginal sample farmers had incurred the highest expenditure of Rs. 252.7 on chemical, while large farmers spent the lowest amount of Rs. 35.7 per acre. With respect to insecticides, marginal farmers adopted two sprays, while other sample farmers had adopted only one spray to control the insects. The overall cost of insecticides was worked out at Rs. 528.3 per acre, of which cost of chemical accounted for 81.1 per cent. None of sample farmers across farm size had applied fungicides for paddy during reference year.

Table 3.21. Cost of Chemical Methods adopted for Pests and Disease Control (Rs/acre)- Paddy in Uttar Pradesh

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted control measures	84.34	84.00	100.00	100.00	85.83
Weedicide					
No. of sprays/acre	0.81	0.36	0.18	0.14	0.48
Cost of chemicals	252.67	111.64	59.49	35.71	151.06
Labour charges	117.92	50.21	30.38	22.14	70.40
Total Cost	370.59	161.85	89.87	57.85	221.46
Insecticide					
No. of sprays/acre	1.12	0.66	0.35	0.29	0.74
Cost of chemicals	505.94	312.81	406.33	471.43	428.47
Labour charges	116.23	82.17	94.93	94.11	99.83
Total Cost	622.17	394.98	501.26	565.54	528.30
Fungicide					
No. of sprays/acre	-	-	-	-	-
Cost of chemicals	-	-	-	-	-
Labour charges	-	-	-	-	-
Total Cost					

The sources of information for pests and disease control included government extension agents, private input dealers, fellow farmers, television and radio services, Agricultural Universities and KVKs. The government extension services were ranked least important by 73 per cent of sample households (**Table 3.22**). Only 6 per cent of the sample farmers considered it as a most important source. The government extension agents had advised the farmers to grow the new varieties. They had also advised the framers to change the cropping pattern year by year to reduce the incidence of pests and disease in wheat and paddy crops.

Table 3.22. Extension services on pests and disease control management in Paddy in Uttar Pradesh

(% of households)

Rank of sources	Most important	Important	Least important
Government extension agent	6.00	21.00	73.00
Private input dealer	60.00	30.00	10.00
Fellow farmers	20.00	72.00	8.00
TV/Radio service/Newspaper	3.00	6.00	91.00
Agricultural University/KVK	2.00	4.00	94.00
Any other	-	-	-
Percentage of HH seeking advice			100.00

The private input dealers were also important source of advice for farmers to control the pest and diseases in paddy. About 60 of the sample farmers reported that input dealers as the most important source while 30 per cent considered it as important. Hence, the sample farmers

across farm size groups had received fruitful advice from private input dealers about the use of pesticides and insecticides. The fellow farmers were also an important source (72 per cent) of advice for sample households. The sample farmers had discussion with the fellow farmers regarding incidence of insects and diseases and what type of plant protection measures had to be applied to control the pests and diseases. Surprisingly, role of State Agricultural Universities and KVKs were not so effective in the study areas. It is evident that 94 per cent of sample farmers ranked it as least important source of advice on pest and disease control management in paddy. Overall, the discussion reflects that private input dealers, fellow farmers and government agents were most important sources of advice for pests and disease management in paddy.

3.1.6. West Bengal

Farmers face many constraints in the cultivation of paddy. The main problems and constraints are poor seed quality, water deficiency, pest and disease problems, high cost of inputs and low output price (**Table 3.23**). Among these constraints, high cost of inputs and low output price ranked first in the cultivation of paddy. Similarly, farmers perceived water deficiency as one of the most important constraints (55.00 per cent). The farmers in the study areas of West Bengal depended mostly on monsoon and almost all of them cultivated paddy in kharif season. Most sample farmers have pump sets and they could not tackle this constraint due to lack of water and increase in cost of production leading to loss of farm income.

Table 3.23. Constraints faced in cultivation of paddy in West Bengal

(% of households)

S. No.	Constraints	Most important	Important	Least important
1	Poor seed quality	20.83	31.67	47.50
2	Water deficiency	55.00	40.83	4.17
3	Pest & disease problems	57.50	32.50	10.00
4	High cost of inputs	86.67	12.50	0.83
5	Low output price	87.50	12.50	0.00

The magnitude of crop loss due to pests, disease and weed infestation in paddy has been depicted in **Table 3.24**. The actual production with attack is varied from19.4 quintal to 20.9 quintal per acre. The overall loss with attack has been found to be 3.5 quintal per acre. Similarly, the overall normal production without attack is 23.5 quintal per acre. However, the percentage loss over normal production is less than that of percentage loss over actual production.

Table 3.24. Magnitude of crop loss due to pests, disease and weed infestation- Paddy in West Bengal

Description	Marginal	Small	Medium	Large	Total
Actual production with attack (quintal/acre)	19.36	19.65	20.22	20.88	19.98
Normal production without attack (quintal/acre)	22.78	23.18	23.72	24.61	23.52
Loss of output (quintal/acre)	3.42	3.54	3.51	3.73	3.54
Percentage loss over actual production	17.68	18.00	17.34	17.87	17.72
Percentage loss over normal production	15.03	15.25	14.77	15.16	15.05

Detailed cost of chemical methods adopted for control of pests and diseases in paddy are presented in **Table 3.25**. It has been found that in paddy cultivation all the categories of farmers used weedicide although the proportion of farmers used was lower for marginal farmers. But, average cost of weedicide was found higher for marginal farmers. Interestingly, the cost of application of insecticides per acre is also higher in small farms than that of medium and large farms.

Table 3.25. Cost of chemical methods adopted for pests and disease control in paddy in West Bengal

(Rs/acre)

Particulars	Marginal	Small	Medium	Large	Total
per cent HH adopted control measures					
Weedicide					
per cent HH adopted control measures	57.14	100	100	100	77.50
No. of sprays/acre(labour hrs)	3	1.70	1.02	0.58	1.58
Cost of chemicals (Rs./acre)	81.51	53.49	36.40	26.18	48.06
Labour charges (Rs./acre)	79.04	53.60	32.04	18.63	44.88
Total Cost (Rs./acre)	160.55	107.09	68.45	44.81	92.94
Insecticide					
per cent HH adopted control measures	95.24	100	100	100	97.50
No. of sprays/acre(labour hrs)	2.46	1.29	0.89	0.66	1.32
Cost of chemicals (Rs./acre)	171.68	106.60	92.44	66.97	110.36
Labour charges (Rs./acre)	97.74	58.04	45.98	36.53	60.00
Total Cost (Rs./acre)	269.42	164.64	138.42	103.49	170.36
Fungicide					
per cent HH adopted control measures	0	0	33.33	100	
No. of sprays/acre(labour hrs)	0	0	0.28	0.30	
Cost of chemicals (Rs./acre)	0	0	28.41	21.92	23.86
Labour charges (Rs./acre)	0	0	8.52	4.93	6.01
Total Cost (Rs./acre)	0	0	36.93	27.46	30.30

Further, use of fungicides is restricted to medium and large farms only and the cost of fungicides varied from Rs. 27.5 to Rs. 36.9 per acre. Crop losses due to pests has been reportedly stable in recent years despite increased use of pesticides. Chemical pesticides can control pests in the short-term but over time pest problems may increase. This is because pesticides not only kill pests but pest predators as well. As more pests survive, more and different pesticides are applied.

With respect to the sources of information for undertaking effective pest and disease management strategy, government extension service was one of the important sources of information to control pests and diseases. Usually, different infrastructural, environmental, technical knowledge of pest control methods are being transmitted to the actual users through different processes. In reality, extension services are provided either by the public agencies or private agencies. Public agencies include agricultural universities, Krishi Vigyan Kendras, government personnel, radio and TV, whereas private agencies included input dealers and fellow farmers.

Table 3.26. Extension services on pests and disease control management in paddy in West Bengal

(% of households)

Rank of sources	Most important	Important	Least important
Government extension agent	5.83	50.83	43.34
Private input dealer	41.67	58.33	0.00
Fellow farmers	57.50	42.50	0.00
TV/Radio service/Newspaper	22.50	77.50	0.00
Agricultural University/KVK	0.00	0.00	100.00
Any other	-	-	-

Details about the extension services on pest and disease control management in the study area of West Bengal are presented in **Table 3.26**. It has been found that paddy farmers mostly depended on private input dealers and fellow farmers in controlling pests and diseases in crop cultivation. Surprisingly, it was reported by all the sample farmers that agricultural universities and Krishi Vigyan Kendras were not effective in disseminating extension services especially in case of pests and disease control management in paddy.

3.2. Wheat

3.2.1. Assam

Among various constraints faced in the cultivation of wheat, low output price was the most important constraint for 65.0 per cent of the sample households (**Table 3.27**). In case of pests

and diseases, 90.8 per cent of the households opined as the most important constraint for them. High cost of inputs was the most important constraint for 87.5 per cent. Over half of the sample households mentioned water deficiency as most important constraint in the cultivation of wheat. The poor seed quality was the most important constraints for about 58.3 per cent of households.

Table 3.27. Constraints faced in cultivation of wheat in Assam

(% of households)

S. No	Constraints	Most important	Important	Least important	Total
1	Poor seed quality	58.33	25.00	16.67	100.00
2	Water deficiency	67.50	9.17	23.33	100.00
3	Pest and disease problems	90.83	6.67	2.50	100.00
4	High cost of inputs	87.50	7.50	5.00	100.00
5	Low output price	65.00	18.33	16.67	100.00

Table 3.28 shows the amount of crop loss due to pests, diseases and weed infestations in wheat crop in Assam. There was no report of cultivation of local varieties of wheat and the reported results pertained to HYVs only. It can be observed that for overall sample the per cent loss over actual production was estimated at 16.0 per cent (**Table 3.28**). The loss over actual production varied between 16.1 per cent and 21.9 per cent across farm size groups. The loss over the normal production varied from 13.9 per cent to 18.0 per cent across different farm size categories. The sample farmers opined that the ruling seed variety and climatic conditions are susceptible to pests and diseases attack. The pre-monsoon shower at the time of harvesting also responsible for disease infestation.

Table 3.28. Magnitude of crop loss due to pests, disease and weed infestation- wheat in Assam

Description	Marginal	Small	Medium	Large	Total
Actual production with attack (quintal/ha)	20.49	18.35	18.25	14.94	18.53
Normal production without attack (quintal/ha)	24.34	21.31	22.07	18.21	21.48
Loss of output (quintal/ha)	3.85	2.96	3.82	3.27	2.96
Percentage loss over actual production	18.80	16.11	20.91	21.89	15.96
Percentage loss over normal production	15.82	13.87	17.30	17.96	13.76

Generally, farmers adopt chemical method of pests control. On an average, about 76.7 per cent of the sample households found to use chemicals for control of pests and diseases in wheat. There was no report of using weedicide in the study area but uprooting of weeds was done manually. It was reported by the farmers that they had to go for weeding at least two times in the season. To control the pests attack, one time chemical spray was sufficient enough for each crop. Cost of chemical per acre also varied with the type of chemicals used

and their price (**Table 3.29**). The overall cost of spraying of insecticides including labour charge was worked out at Rs. 273.60 and for fungicides, it was estimated at Rs. 204.1 per acre.

Table 3.29. Cost of Chemical methods adopted for pests and disease control - Wheat in Assam

(Rs/acre)

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted control measures	55.00	80.00	82.14	100.00	76.67
Weedicide					
No. of sprays/ha	-	-	-	-	-
Cost of chemicals*	-	-	-	-	-
Labour charges	264.3	381.2	596.0	337.7	394.8
Total Cost	264.3	381.2	596.0	337.7	394.8
Insecticide					
No. of sprays/ha	0.4	0.4	0.4	0.4	0.4
Cost of chemicals	70.7	101.0	126.3	176.8	118.7
Labour charges	124.7	155.0	160.0	180.0	154.9
Total Cost	195.4	256.0	286.3	356.8	273.6
Fungicide					
No. of sprays/ha	0.4	0.4	0.4	0.4	0.4
Cost of chemicals	44.5	62.3	93.5	111.3	77.9
Labour charges	87.0	124.0	144.0	150.0	126.3
Total Cost	131.5	186.3	237.5	261.3	204.1

Note: *The control of weeds by hand without using chemicals

It was reported that incidence of pest and disease was very much common in the study area for all the field crops. The farmers used to seek technical advice from different sources only when severity of attack went beyond a certain level. **Table 3.30** presents the sources of technical information that the sample farmers sought for controlling pests and diseases. Nearly 60.8 per cent of the sample households sought for technical advice. Of these farmers, 45.2 per cent considered extension agent as the most important source followed by fellow farmers (39.9 per cent). The information and services received by the sample farmers from different agencies were found to be very useful for controlling pests and diseases in the field.

Table 3.30. Extension services on pests and disease management in wheat in Assam

(per cent households)

Source of advice	Most important	Important	Least important
Government extension agent	45.21	20.55	30.14
Private input dealer	0.00	0.00	0.00
Fellow farmers	30.14	72.60	16.44
TV/Radio service/Newspaper	0.00	0.00	0.00
Agricultural University/KVK	15.07	12.33	50.68
Any other	0.00	0.00	0.00
Percentage of households seeking advice	60.8		

3.2.2. Punjab

The constraints faced in the cultivation of wheat in Punjab are presented in **Table 3.31.** 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 of the sample households reported pest and disease problem as most important constraint while 2 per cent reported poor seed quality as most important problem. However, about 43 per cent of sample households reported pest and disease problem as important constraint followed by 34 per cent informing low output price and 22 per cent revealing high cost of inputs as important constraint. Important constraints in wheat cultivation as reported by the sample respondents were: low quality and poor germination of seed, occurrence of pest and diseases every season, high cost of inputs such as fertilizers, weedicides, pesticides, labour and decline in profitability due to low output price.

Table 3.31. Constraints faced in cultivation of wheat in Punjab

(% of households)

S.N.	Constraints	Most important	Important	Least important
1	Poor seed quality	2.00	-	98.00
2	Water deficiency	-	-	100.0
3	Pest and disease problems	3.00	43.00	54.00
4	High cost of inputs	76.00	22.00	2.00
5	Low output price	21.00	34.00	45.00

The magnitude of crop loss due to pests, disease and weed infestation in wheat is shown in **Table 3.32**. The actual production with attack varied between 17.7 quintal and 18.2 quintal per acre across farm size groups. The overall loss over actual production was estimated at 17.8 quintal. Normal production without attack was 19.2 quintal for the entire sample. The loss of output varied between 1.1 quintal and 1.5 quintal per acre with the lowest amount of loss on marginal farms and highest on large farm categories. This was 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 5.9 per cent on marginal and 8.3 per cent on large farm categories. In total, magnitude of crop loss due to pests, diseases and weed infestation was 7.9 per cent over actual and 7.35 per cent over normal production.

Table 3.32. The magnitude of crop loss due to pests, disease and weed infestation- wheat in Punjab

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

There are chemical and biological methods to control pest and diseases in field crops. **Table 3.33** provides the cost of chemical methods adopted for pests and disease control. In order to control weeds in wheat, majority of the farmers on various farm categories applied over two rounds of sprays. The total cost of weedicides spray including labour charges ranged between Rs. 476.6 and Rs. 630.3 per acre across farm size groups. For controlling various insect pests, at least one insecticide spray was applied on all the farm size categories with the average cost of Rs. 158.5 per acre. One spray of fungicide was applied by more than half of the sample farmers to control diseases. The total cost of fungicide spray varied between Rs.130.0 and Rs.178.7 per acre with the lowest amount for medium farmers and the highest for small farm category.

Table 3.33. Cost of chemical methods adopted for pests and disease control (Rs/acre) - wheat in Punjab

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

The sources of information for pest and disease control are given in **Table 3.34**. It can be observed that all the sample households took advice from different sources for controlling pest and diseases in wheat. The Government extension agents were ranked as least important by 92 per cent of the sample households followed by important by 4 per cent and most important by 4 per cent. 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. Fellow farmers were also an important source of advice for discussing various farm related problems with 67 per cent considering as important, 21 per cent as most important and 9 per cent as least important. 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. However, private input dealers and fellow farmers emerged as the most important source of advice for pest/ disease control management and other farm related issues as revealed by the sample households.

Table 3.34. Extension services on pests and disease control management in wheat in Punjab

(% of households)

Rank of sources	Most important	Important	Least important
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
Any other	-	-	-
Percentage of HH seeking advice			100

3.2.3. Madhya Pradesh

Farmers face many constraints in the cultivation of wheat in the study region of Madhya Pradesh. A high proportion of the sample farmers reported the deficiency of irrigation water and high cost of inputs as the most important constraints in the cultivation of wheat (**Table 3.35**). The incidence of pest and diseases, poor quality of seed and low price of output were the least important constraints. In fact, 91.3 per cent, 88.8 per cent and 80.0 per cent of the sample farmers mentioned poor seed quality, low output price and pest and diseases problems as the least important constraints in the cultivation of wheat.

Table 3.35. Constraints faced in cultivation of wheat in Madhya Pradesh

(% of households)

S. No	Constraints	Most important	Important	Least important
1	Poor seed quality	3.13	5.63	91.25
2	Water deficiency	90.63	5.63	3.75
3	Pest and disease problems	8.75	11.25	80.00
4	High cost of inputs	81.25	13.75	5.00
5	Low output price	6.875	4.375	88.75

The magnitude of crop losses due to pest, diseases and weeds infestation is presented in **Table 3.36**. It can be observed that the crop loss over normal production was 13.9 quintal per acre and over actual production it was 12.6 quintal. There is discernible variation in the loss across farm size groups. In terms of percentages, the loss over normal production was 8.9 and for actual production 9.8. The per cent loss over actual and normal production increased with increase in farm size. In fact, the per cent loss over actual production was 7.4 per cent for marginal, 8.6 per cent for small, 9.0 per cent for medium and 15.7 per cent for large farmers.

Table 3.36. Magnitude of crop loss in wheat due to pests, disease and weed infestation in Madhya Pradesh

(Quintal/acre)

Description	Marginal	Small	Medium	Large	Total
Actual production with attack	13.24	13.00	14.82	9.50	12.64
Normal production without attack	14.22	14.12	16.16	10.99	13.87
Loss of output	0.98	1.12	1.34	1.49	1.23
Percentage loss over actual production	7.40	8.62	9.04	15.68	9.75
Percentage loss over normal production	6.89	7.93	8.29	13.56	8.89

The cost of chemical methods adopted for pest and disease control in wheat across farm size categories is presented in **Table 3.37**. It can be observed that none of the sample households applied insecticides to control insects in the study area. As regards the cost incurred in control of weeds in cultivation of wheat, it was estimated at Rs 299.6 per acre for weedicide. Among farm size categories, cost of weedicide was the highest for medium size categories followed by large farmers, small farmers and marginal farmers.

Table 3.37. Cost of Chemical methods adopted in wheat for pests and disease control in Madhya Pradesh

(Rs/acre)

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted control measures	22.50	27.50	37.50	50.00	34.38
Weedicide					
No of sprays/acre	0.23	0.28	0.38	0.50	0.34
Cost of chemicals	214.15	235.54	246.5	249.9	236.52
Labour charges	68.32	66.56	60.75	56.67	63.075
Total Cost	282.47	302.10	307.25	306.57	299.60
Insecticide					
No. of sprays/acre	-	-	-	-	-
Cost of chemicals	-	-	-	-	-
Labour charges	-	-	-	-	-
Total Cost	-	-	-	-	-
Fungicide	-	-	-	-	-
No. of sprays/acre	0.23	0.28	0.38	0.50	0.34
Cost of chemicals	25.24	33.66	48.55	60.38	41.96
Labour charges	6.20	8.18	9.63	13.50	9.38
Total Cost	31.44	41.84	58.18	73.88	51.33

Farmers also followed manual weeding as wheat is a winter crop and infestation of weeds is not a major problem. *Phalaris minor* was one of the common weed of the wheat in the study area, which in fact looks like wheat. Hence, hand weeding is the only option to solve the problem. As regards the cost of fungicides, average cost for the entire sample was worked out at Rs. 51.33 per acre. Generally, seed treatment with fungicides such as Bavistin, Thairum and Carbandazim is followed in the study area.

The sources of extension services for pest and disease management in wheat are presented in **Table 3.38**. It can be noticed that only about 26 per cent of the sample households sought advice on control of pest and disease. Private input dealers were the most important source of advice on pest and disease management as reported by 64.3 per cent of the sample households followed by agricultural university/ KVKs and TV/radio service/news paper. Government extension agent were the important source of advice as reported by 76.2 per cent of households followed by private input dealers (21.4 per cent), agricultural university/ KVKs (19.1 per cent) and TV/radio service/news paper (16.7 per cent). It was also observed that fellow farmers were reported to be the least important source for seeking advice to control pests and diseases in wheat.

Table 3.38. Extension services on pests and disease control management in wheat in Madhya Pradesh

(% of households)

Sources of advice	Most important	Important	Least imp
Government extension agent	0.00	76.19	23.81
Private input dealer	64.29	21.43	14.29
Fellow farmers	0.00	0.00	100.00
TV/Radio service/Newspaper	4.76	16.67	78.57
Agricultural University/KVK	7.14	19.05	73.81
Any other	0.00	0.00	0.00
Percentage of households seeking advice	26.25		

3.24. Uttar Pradesh

The constraints faced in the cultivation of wheat by the sample farmers are presented in **Table 3.39**. The poor quality of seed and water deficiency were the least important constraints as reported by over 90 per cent of the sample households. But, high cost of inputs and low price of output were considered to be the most important constraints. Low output price was considered most important constraint by over a quarter of the sample households. Interestingly, it can observed that that none of respondents reported pest and disease problems as a constraint in the cultivation of wheat. Overall, it emerges from the analysis that low out price and high cost of inputs were the most important constraints in the cultivation of wheat in Uttar Pradesh.,

Table 3.39. Constraints Faced in Cultivation of Wheat in Uttar Pradesh

(% of households)

S. No.	Constraints	Most important	Important	Least important
1	Poor seed quality	1.00	1.00	98.00
2	Water deficiency	4.00	3.00	93.00
3	Pest and disease problems	-	-	-
4	High cost of inputs	68.00	4.00	25.00
5	Low output price	27.00	3.00	70.00

The magnitude of crop loss due to pests and disease, and weed infestation in HYVs of wheat has been depicted in **Table 3.40**. The actual yield of wheat with attack varied from 15.2 quintal to 16.7 quintal across farm size groups and for the overall sample it was 16.0 quintal per acre. Normal production without attack varied between 16.3 quintal and 17.7 quintal per acre. It can be noticed that loss of output increased with increase in farm size. The output loss over actual production with attack was estimated at 6.5 per cent at the aggregate level which varied between 5.5 per cent in marginal farms and 7.6 per cent in large farms. Similarly, the loss over normal production was minimum at 5.2 per cent on marginal farms and maximum at 7.1 per cent on large farms. Overall, the magnitude of crop loss due to pests, diseases and

weed infestation was 6.5 per cent over actual production and 6.1 per cent over normal production. Since the farmers are very conscious about yield loss, they protect the crop by using the plant protection measure against the attack of pests and diseases.

Table 3.40. Magnitude of crop loss due to pests, disease and weed infestation- wheat in Uttar Pradesh

Description	Marginal	Small	Medium	Large	Total
Actual production with attack (quintal/acre)	16.73	16.40	15.22	15.52	16.04
Normal production without attack (quintal/acre)	17.65	17.40	16.26	16.70	17.08
Loss of output (quintal/acre)	0.92	1.00	1.04	1.18	1.04
Percentage loss over actual production	5.50	6.10	6.85	7.60	6.51
Percentage loss over normal production	5.21	5.75	6.40	7.06	6.09

Generally, farmers adopt chemical method to control the pests and diseases for its quick effects. The details of chemical methods adopted for pests and disease control in wheat are given in **Table 3.41**. In order to control the weeds, one spray of weedicide was applied by the majority of sample farmers. The average cost incurred on weedicide was about Rs. 283.0 per acre, out of which cost of chemical accounted for 73.2 per cent and the rest for labour charges. The average cost of weedicide was the highest for large farmers (Rs. 322.5) followed by marginal farmers (Rs. 314.3), medium farmers (Rs 313.8) and small farmers (Rs. 205.4). None of sample farmers across farm size categories had applied insecticides and fungicides for wheat.

Table 3.41. Cost of chemical methods adopted for pests and disease control (Rs/acre)- wheat in Uttar Pradesh

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted control measures	74.63	70.59	100.00	100.00	77.50
Weedicide					
No. of sprays/acre	0.53	0.21	0.18	0.21	0.28
Cost of chemicals	188.12	150.04	218.80	281.87	207.18
Labour charges	126.15	55.35	94.98	40.55	75.80
Total Cost	314.27	205.39	313.78	322.52	282.98
Insecticide					
No. of sprays/acre	-	-	-	-	-
Cost of chemicals	-	-	-	-	-
Labour charges	-	-	-	-	-
Total Cost	-	-	-	-	-
Fungicide					
No. of sprays/acre	-	-	-	-	-
Cost of chemicals	-	-	-	-	-
Labour charges	-	-	-	-	-
Total Cost					

The sources of information for pests and disease control are government extension agents private input dealers, fellow farmers, T.V./ radio services, agricultural universities/KVKs and others (**Table 3.42**). The government extension services were ranked as least important by 73 per cent of households followed by important and most important by 21 per cent and 6 per cent of sample households, respectively. The government extension agents had advised the farmers to grow the new varieties. They had also advised the framers to change the cropping pattern every year to reduce the incidence of pests and disease in wheat.

Table 3.42. Extension Services on Pests and Disease Control Management in wheat in Uttar Pradesh

(% of households)

Rank of sources	Most important	Important	Least important
Government extension agent	6.00	21.00	73.00
Private input dealer	60.00	30.00	10.00
Fellow farmers	20.00	72.00	8.00
TV/Radio service/Newspaper	3.00	6.00	91.00
Agricultural University/KVK	2.00	4.00	94.00
Any other	-	-	-
Percentage of HH seeking advice	100.0		

Among various sources, the private input dealers emerged as most import source of advice for about 60 per cent and important for 30 per cent of the sample households. The fellow farmers were also an important source of advice for the sample households. The sample farmers had discussion with the fellow farmers regarding incidence of insects and diseases and what type of plant protection measures had to be applied to control the pests and diseases in wheat. The television and radio were also sources of advice for sample households to know pests and disease management. The role of SAUs and KVKs were not so effective in the study area in terms of providing advice to the farmers on control of pests and diseases. The analysis clearly shows that the private input dealers and fellow farmers emerged as most important source of advice to the farmers.

3.25. West Bengal

The problems and constraints faced by the farmers in the cultivation of wheat in the study areas of West Bengal are provided in **Table 3.43**. Among various constraints, high cost of inputs and low output price were considered to be the most important constraints by a significant proportion of the sample households. Similarly, farmers perceived water deficiency as one of the most important constraints (70.0 per cent) in wheat cultivation.

About half of the sample farmers mentioned that pests and diseases problems, and poor seed quality as the most important problems.

Table 3.43. Constraints faced in cultivation of wheat in West Bengal

(% of households)

S. No.	Constraints	Most important	Important	Least important
1	Poor seed quality	52.50	47.50	0.00
2	Water deficiency	70.00	30.00	0.00
3	Pest & disease problems	59.17	40.83	0.00
4	High cost of inputs	90.00	10.00	0.00
5	Low output price	82.50	17.50	0.00

The magnitude of crop loss due to pests, disease and weed infestation in wheat is provided in **Table 3.44**. The actual production with attack varied from 3.9 quintal to 6.0 quintal per acre across farm size groups. The overall loss with attack was 0.92 quintal per acre. The loss of output was estimated higher for marginal farmers. However, the crop loss over normal production was lower (15.3 per cent) than that of percentage loss over actual production (18.1 per cent). Among farm size groups, yield loss over actual production was 17.8 per cent for marginal farmers, 18.1 per cent for small farmers and 18.4 per cent for medium farmers. The corresponding figures for loss over normal production were 15.1 per cent, 15.3 per cent and 15.6 per cent.

Table 3.44. The magnitude of crop loss due to pests, disease and weed infestation- wheat in West Bengal

Description	Marginal	Small	Medium	Large	Total
Actual production with attack (quintal/acre)	5.96	3.90	5.01	-	5.12
Normal production without attack (quintal/acre)	7.02	4.80	5.93	-	6.04
Loss of output (quintal/acre)	1.06	0.71	0.92	-	0.92
Percentage loss over actual production	17.84	18.12	18.44	-	18.05
Percentage loss over normal production	15.14	15.34	15.57	-	15.29

The sample farmers were asked to provide the measures adopted to control pests and diseases in wheat. The detailed cost of chemical methods adopted for pests and diseases in wheat are presented in **Table 3.45**. It has been found that except marginal farmers, all the sample farmers of other size category adopted chemical method to control pests. However, the use of weedicide was very high among marginal farmers with Rs. 188.8 per acre and for small and

medium farmers it was Rs. 137.7 and Rs. 114.1 per acre, respectively. Interestingly, cost of application of insecticides was also higher for small and marginal farmers than medium farmers. However, there was no evidence on use of fungicides in wheat cultivation.

Table 3.45. Cost of chemical methods adopted for pests and disease control in wheat in West Bengal (Rs/acre)

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted	82.5	100	100	0.00	87.5
Weedicide					
No. of sprays/acre	2.48	2.42	6.10	0.00	1.62
Cost of chemical	124.97	98.51	73.64	0.00	1.00
Labour charges	63.84	39.15	40.45	0.00	0.48
Total Cost (Rs./acre)	188.81	137.67	114.09	0.00	157.57
Insecticide					
No. of sprays/acre	0.00	1	5.10	0.00	0.60
Cost of chemical	0.00	21.40	84.03	0.00	0.35
Labour charges	0.00	12.59	36.82	0.00	0.17
Total Cost (Rs./acre)	0.00	33.99	120.85	0.00	37.53
Fungicide					
No. of sprays/acre	0.00	0.00	0.00	0.00	
Cost of chemical	0.00	0.00	0.00	0.00	0.00
Labour charges	0.00	0.00	0.00	0.00	0.00
Total Cost (Rs./acre)	0.00	0.00	0.00	0.00	0.00

Generally, farmers seek advice from multiple sources such as government extension agents, private input dealers, fellow farmers, agricultural universities/Krishi Vigyan Kendras, radio and television. It can be observed from the **Table 3.46** that wheat farmers mostly depended on private input dealers and fellow farmers for seeking advice for controlling pests and diseases in crop cultivation. Fellow farmers emerged as the most important source of information. Surprisingly, as stated by the farmers, agricultural universities and Krishi Vigyan Kendras had no role in disseminating extension services especially in case of pests and disease management in wheat.

Table 3.46. Extension services on pests and disease control management in wheat in West Bengal

(% of households)

Rank of sources	Most important	Important	Least important
Government extension agent	29.16	46.67	24.17
Private input dealer	28.33	71.67	0.00
Fellow farmers	56.67	43.33	0.00
TV/Radio service/Newspaper	14.17	85.83	0.00
Agricultural University/KVK	0.00	0.00	100.00
Any other	-	-	-

3.3. Tur

3.3.1. Karnataka

The sample farmers mentioned the major constraints faced in the cultivation of tur. Five constraints were identified by the sample farmers. These constraints included poor seed quality, water deficiency, pest and disease incidence, high cost of inputs and low output/market price. After identifying the constraints, farmers were asked to rank them in the order of most important, important and least important with a view to understand the severity of constraints faced by them.

Table 3.47. Constraints faced in cultivation of tur in Karnataka

(% households)

S. No	Particulars	Most important	Important	Least important	Total
1	Poor seed quality	1.25	1.88	4.38	7.50
2	Water deficiency	68.13	10.63	8.75	87.50
3	Pest and disease problems	20.00	38.75	30.63	89.38
4	High cost of inputs	8.75	38.13	40.00	86.88
5	Low output price	0.63	8.13	8.13	16.88

In the cultivation of tur, incidence of pests and diseases emerged to be a serious problem in the study area (**Table 3.47**). A high proportion of sample farmers (89.4 per cent) have reported pest and diseases problems as a major constraint affecting the production of red gram. Water deficiency has been reported (87.5 per cent) as the second most serious problem followed by high cost of inputs (86.9 per cent). However, in terms of severity of the constraints, about 68.1 per cent of the sample farmers considered water deficiency as the most important constraint followed by pest and diseases.

Aggregate yield loss of tur due to all pests by variety type and farm size groups was estimated and presented in **Table 3.48**. As expected, per cent production loss was higher for local varieties than for high yielding varieties of tur. In fact, yield loss as percentage of normal production was 44.7 for local varieties and 43.9 for high yielding varieties. Similarly, yield loss over actual production was 80.8 per cent for local varieties and 78.3 per cent for HYV.

Table 3.48. Magnitude of crop loss due to pests, disease and weed infestation- tur in Karnataka

Particulars	Marginal	Small	Medium	Large	Total
Local variety					
Actual production with attack (quintal/acre)	2.7	3.1	2.2	2.0	2.2
Normal production without attack (quintal/acre)	4.7	5.2	3.7	3.7	4.0
Loss of output (quintal/acre)	2.1	2.2	1.5	1.7	1.8
Percentage loss over actual production	76.9	70.7	66.5	89.0	80.8
Percentage loss over normal production	43.5	41.4	40.0	47.1	44.7
HYV					
Actual production with attack (quintal/acre)	2.5	3.1	3.0	2.8	2.9
Normal production without attack (quintal/acre)	5.5	4.6	6.1	5.0	5.1
Loss of output (quintal/acre)	3.1	1.4	3.1	2.1	2.2
Percentage loss over actual production	125.1	45.7	103.8	76.4	78.3
Percentage loss over normal production	55.6	31.3	50.9	43.3	43.9

There are variations in production loss across farm size groups. For local varieties, per cent loss was higher among large farmers and for HYVs it was higher among the marginal farmers. In general, tur is cultivated in dry lands with little irrigation facilities. The cultivation of tur is the important source of livelihood of people in dry land areas of Gulbarga in Karnataka. Therefore, concerted efforts by the scientists, administrators and extension specialists to reduce yield loss will considerably increase the income of the dry land farmers.

Assessment of yield loss due to pests and diseases helps to design appropriate pest control strategies. At the field level, farmers adopt different methods viz., chemical, mechanical and biological methods either individually or in combination to control pests. Among these methods, chemical method has been predominantly used by the sample farmers. The particulars of chemical method used by the farmers to control weeds, insect pests and diseases are provided in **Table 3.49**. It can be observed that all the sample farmers applied chemical method for pest control in tur. The average number of sprays per household was relatively high for insecticide application as compared to weedicide and fungicide. Further, there is no systematic relationship between cost of chemicals used and farm size groups. Nevertheless, it has been found that cost of chemical and total cost of application including labour charges was high among the marginal farmers when compared to other farm size groups.

Table 3.49. Cost of Chemical methods adopted for pests and disease control (Rs/acre) - tur in Karnataka

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted control measures	100.00	100.00	100.00	100.00	100.00
Weedicide					
Av. number of Sprays	1.50	2.33	2.57	2.67	2.12
No. of sprays/acre	0.23	0.09	0.12	0.01	0.06
Cost of chemical	172.02	68.68	148.13	37.50	68.89
Labour charges	58.10	31.25	26.99	2.71	14.73
Total Cost	230.12	99.93	175.11	40.21	83.63
Insecticide					
Av. number of Sprays	2.07	3.06	2.50	2.99	2.71
No. of sprays/acre	1.93	1.32	0.84	0.46	0.76
Cost of chemical	864.37	850.29	856.80	763.60	798.69
Labour charges	562.84	389.84	360.39	162.12	256.02
Total Cost	1427.22	1240.14	1217.19	925.72	1054.71
Fungicide					
Av. number of Sprays	2.27	1.90	2.86	3.00	2.49
No. of sprays/acre	0.38	0.12	0.13	0.05	0.10
Cost of chemical	223.24	140.43	160.75	85.65	115.33
Labour charges	102.45	38.15	21.95	23.40	30.77
Total Cost	325.69	178.58	182.70	109.04	146.09

Similarly, total cost of application of insecticide by the marginal farmers was Rs. 1427.2 per acre and for the application of fungicide it was Rs. 325.7 per acre. The cost incurred by the marginal farmers to control pests was much higher than the cost incurred by other farm size groups. High cost of chemicals incurred by the marginal farmers may be attributed to input market discrimination and low bargaining power.

The effectiveness of any method used to control pests and diseases depends on scientific way of applying it; method of application of chemicals- foliar spray or dusting, appropriate placing of chemicals, time of application and dosage of chemicals. Therefore, it is important to understand the current sources of knowledge that the sample farmers have access to and ability to use them for effective control of all pests. It is interesting to observe that almost all the sample farmers sought advice from some source for management of pests and diseases (**Table 3.50**).

Table 3.50. Extension services for pests and disease control management in tur in Karnataka

(% households)

Sources of advice	Most important	Important	Least important	Total
Government extension agent	27.5	17.5	20.6	65.6
Private input dealer	29.4	30.6	20.0	80.0
Fellow farmers	34.4	37.5	11.3	83.1
TV/Radio service/Newspaper	8.8	13.1	25.6	47.5
Agricultural University/KVK	0.0	0.0	1.3	1.3
Percentage of HH seeking advice	100.0			

For tur growers, fellow farmers are the major source of information about controlling pest and disease. Among these growers, 34.4 per cent considered the fellow farmers as the most important source and 37.5 per cent as the important source. The private input dealers have emerged as the second major source of advice followed by government extension agents in the third place. Only about 65.6 per cent of sample farmers consulted government extension agents for advice on pest and disease management. Among these farmers, 27.5 per cent considered it as most important and 17.5 per cent as important source of information.

3.3.2. Gujarat

The constraints faced in cultivation of tur are presented in **Table 3.51** indicating the severity of various constraints faced by the selected households. Pests and diseases problem was reported as most important constraint in cultivation of tur by 80.8 per cent, while 63.3 per cent and 61.7 per cent of sample households mentioned water deficiency and high cost of inputs as the most important constraints, respectively. Low output price was the most important constraint for about 35.8 per cent of the households and poor seed quality for 15.8 per cent of the households. However, 50.8 per cent of the sample farmers mentioned low output price as an important constraint followed by 44.2 per cent indicating poor seed quality and 37.5 per cent revealed high cost of inputs as important constraints. Regarding least important constrains in the cultivation of tur, 34.2 per cent of sample households reported poor seed quality as least important constraint followed by 11.7 per cent and 10.8 per cent of sample households indicating water deficiency and low output price least important constraints, respectively. Thus, it is clear from the analysis that in Gujarat, the important constraints in the cultivation of tur as reported by the sample respondents were pests and disease problem, high cost of inputs, low output price and water deficiency.

Table 3.51. Constrains faced in cultivation of tur in Gujarat

(% of households)

Constraints faced	Most important	Important	Least important
Poor seed quality	15.83	44.17	34.17
Water deficiency	63.33	19.17	11.67
Pest and disease problem	80.83	18.33	0.83
High cost of inputs	61.67	37.50	0.83
Low output price	35.83	50.83	10.83
Others (wild animals and suitable environment)	5.83	13.33	0.00

The magnitude of crop loss due to pests, disease and weed infestation in tur is presented in **Table 3.52**. The actual production with pests, disease and weed infestation attack was 3.6 quintals per acre for local variety of tur and 4.4 quintals for HYV. The actual production of local variety with attack varied from 3.3 quintal and 4.7 quintal across farm size groups. In case of HYV, it varied between 3.6 quintal for small farmers to 4.8 quintal for medium size farm categories. Overall, normal production without attack was 4.4 quintal for local variety and 5.2 quintal per acre for HYV. The magnitude of crop loss due to pests, disease and weed infestation recorded an average 0.7 quintal per acre each for local variety and HYV of tur. Loss of output of tur fluctuated between 0.66 and 0.99 quintal for local variety, and 0.61 and 0.83 quintal per acre for HYV among different categories of farmers.

Table 3.52. Magnitude of crop loss due to pests, disease and weed infestation in tur in Gujarat

Description	Marginal		Small		Medium		Large		Total	
	Local	HYV	Local	HYV	Local	HYV	Local	HYV	Local	HYV
Actual production with attack (quintal/ acre)	4.00	3.64	3.76	3.62	4.70	4.75	3.29	4.52	3.60	4.44
Normal production without attack (quintal/ acre)	4.91	4.25	4.62	4.26	5.69	5.58	3.94	5.26	4.35	5.17
Loss of output (quintal/ acre)	0.91	0.61	0.86	0.64	0.99	0.83	0.66	0.73	0.74	0.73
Percentage loss over actual production	22.65	16.75	22.78	17.68	20.98	17.48	19.96	16.24	20.64	16.53
Percentage loss over normal production	18.46	14.35	18.56	15.03	17.34	14.88	16.64	13.97	17.11	14.18

The per cent loss over actual and normal production was comparatively low in case of HYV in relation to local variety among various categories of farmers. In case of local variety, it varied between 20.0 per cent and 22.8 per cent over actual production and between 16.6 per cent and 18.6 per cent over normal production. However, for HYV it ranged between 16.2 per cent and 17.7 per cent over actual production, and 14.0 per cent and 15.0 per cent over normal production. The loss of output per acre was more in local variety than in HYV.

There are chemical and biological methods adopted by the farmers to control pests and disease in field crops. The cost of chemical methods used by farmers to control pests and disease of tur is given in **Table 3.53**. Almost all selected households adopted chemical control measures for pests and disease. In order to control weeds, farmers of different farm size categories applied around one chemical spray. The average cost of weedicides for overall sample was Rs. 955 per acre. The average cost of weedicides was high at Rs. 965 for medium farmers and low at Rs. 757 for marginal farmers.

Table 3.53. Cost of chemical methods adopted for pests and disease control in tur in Gujarat

(Rs / acre)

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted control measures	100.00	100.00	100.00	100.00	100.00
Weedicides					
No. of sprays/ acre	1.21	1.24	1.49	1.31	1.32
Cost of chemicals	528	696	730	725	720
Labour charges	228	229	234	236	236
Total cost	757	925	965	961	955
Insecticide					
No. of sprays/ acre	5.24	5.29	5.42	5.74	5.63
Cost of chemicals	1412	1461	1442	1457	1453
Labour charges	290	310	311	275	284
Total cost	1702	1771	1753	1733	1737
Fungicide					
No. of sprays/ acre	1.00	1.00	1.11	1.84	1.69
Cost of chemicals	670	812	812	802	802
Labour charges	225	256	247	275	270
Total cost	895	1068	1059	1077	1072

Number of spray required to control insecticides by the selected farmers was maximum 6 sprays per acre for large size farmers and minimum 5 sprays for marginal farmers. Overall, the sample farmers applied 6 sprays to control insects in tur with average cost of Rs. 1737 per acre. The average cost of insecticides including labour charges varied between Rs. 1702 and

Rs. 1771 per acre across farm size groups. One to two sprays of fungicides was applied by the various categories of farmers to control pests and disease. The overall cost of fungicides was Rs. 1072 per acre and it was the highest at Rs. 1077 per acre in case of large farmers and lowest Rs. 895 for small farmers. Analysis showed that average cost of weedicides, insecticides and fungicides was reported more or less lower for marginal farmers.

The source of information to control pests and disease as revealed by the sample farmers is given in **Table 3.54**. It can be observed that about 22.5 per cent of sample farmers ranked government extension agent as most important source of advice while 30.8 per cent and 30.0 per cent as important and least important, respectively. As far as advice from private input dealers is concerned, 62.5 per cent indicated it as most important source of advice followed by 35 per cent reporting it as important and only 0.83 per cent as least important. Similarly, fellow farmers were ranked as most important source of advice by 61.7 per cent and important by 35.8 per cent and least important by 1.7 per cent of the sample households only.

Table 3.54. Extension services on pests and disease control management in tur in Gujarat

(% of households)

Source of advice	Most Important	Important	Least Important
Government extension agent	22.50	30.83	30.00
Private input dealer	62.50	35.00	0.83
Fellow farmers	61.67	35.83	1.67
TV/ Radio service/ Newspaper	4.17	44.17	50.00
Agricultural University/ KVK	3.33	20.00	7.50
Any other	1.67	15.83	0.00
Percentage of HH seeking advice	100		

Another important source of advice for sample farmers regarding pest and disease control were TV/ radio service/ newspaper. But, only 4 per cent of households ranked it as most important source of advice, while 44.2 per cent and 50.0 per cent considered it important and least important source of advice, respectively. Similarly, a small proportion of the sample farmers indicated Agricultural University/KVK as important source of information. Overall, private input dealers and fellow farmers appear to be the most important sources of information.

3.3.3. Maharashtra

The sample farmers faced many constraints in the cultivation of tur. These constraints included poor seed quality, water deficiency, pests and disease problems, input costs and output prices. About 10 per cent of the sample farmers reported poor seed quality as an important problem, while only 4 per cent considered it as most important and 37 per cent as least important (**Table 3.55**). Over 20 per cent of sample farmers reported water deficiency, pest and disease problems, high cost of inputs and low output price as the most important constraints faced in the cultivation of tur. With respect to pests and disease problems, the sample farmers mentioned the regular occurrence of aphids, pod borer and plume moth.

Table 3.55. Constraints faced in cultivation of tur in Maharashtra

(% of households)

S.N.	Constraints	Most important	Important	Least important
1	Poor seed quality	4.10	10.24	36.67
2	Water deficiency	22.05	18.90	23.33
3	Pest and disease problems	27.18	47.24	6.67
4	High cost of inputs	24.10	18.11	33.33
5	Low output price	22.57	5.51	-

The magnitude of crop loss due to various pests, diseases and weeds infestation for various categories of sample farmers is presented in **Table 3.56**. The magnitude of crop production loss in relation to normal production was estimated at 0.39 quintal per acre for marginal category, 0.4 quintal for small, 0.4 quintal for medium, and 0.40 quintal for large farmers. Average quantity of loss for local variety was 0.4 quintal per acre and for HYV it was 0.6 quintal per acre. However, the proportion of tur production loss with respect to actual production was 8.8 per cent for local variety and 13.4 per cent for high yielding variety.

The proportion of tur production loss in relation to normal production was 8.1per cent for the overall sample in case of local variety and 11.8 per cent for HYV variety. The per cent loss, both in terms of actual production and normal production, was relatively low for marginal farmers and high for large farmers. The analysis clearly showed that there is an increase proportion of tur crop production loss with the increase in land holding size of tur crop cultivators.

Table 3.56. The magnitude of crop loss due to pests, disease and weed infestation- Tur in Maharashtra

Description	Marginal		Small		Medium		Large		Total	
	Local	HYV	Local	HYV	Local	HYV	Local	HYV	Local	HYV
Actual production with attack (quintal/acre)	4.22	4.60	4.30	4.76	4.40	4.74	4.40	4.62	4.30	4.71
Normal production without attack (quintal/acre)	4.61	5.09	4.67	5.36	4.80	5.40	4.80	5.32	4.68	5.34
Loss of output (quintal/acre)	0.39	0.49	0.37	0.61	0.40	0.66	0.40	0.70	0.38	0.63
Percentage loss over actual production	9.24	10.65	8.60	12.82	9.09	13.92	9.09	15.15	8.84	13.38
Percentage loss over normal production	8.46	9.63	7.92	11.38	8.33	12.22	8.33	13.16	8.12	11.80

In order to control the infestation of pests, diseases and weeds, the sample farmers used various chemical methods. The estimates relating to cost of chemicals used, labour charges, number of sprays with respect to weedicide, insecticide and fungicide for various categories of cultivators are furnished in **Table 3.57**. The average cost of weedicide varied from Rs.1026 for small category to Rs.993 for the large category with overall cost of Rs. 1013 for the entire sample. The average cost of insecticide varied from Rs. 1595 for marginal category to Rs. 1856 for the medium category with overall cost of Rs.1709. In case of fungicides, average cost was relatively low and it varied from Rs.485 for small category to Rs.633 for the marginal category. All the categories of sample farmers used around two sprays each of weedicide, insecticide and fungicide in order to control infestation of various pests, diseases and weeds on their farm.

Table 3.57. Cost of chemical methods adopted for pests and disease control (Rs/acre)- Tur in Maharashtra

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted control measures	100.00	100.00	100.00	100.00	100.00
Weedicide					
No. of sprays/acre	-	1.80	-	1.67	1.75
Cost of chemicals	-	920.00	-	883.33	906.25
Labour charges	-	105.56	-	110.00	107.14
Total Cost	-	1025.56	-	993.33	1013.39
Insecticide					
No. of sprays/acre	2.04	1.76	1.69	2.20	1.84
Cost of chemicals	1483.15	1578.06	1751.03	1601.00	1600.42
Labour charges	111.70	106.49	104.52	121.53	108.21
Total Cost	1594.85	1684.55	1855.55	1722.53	1708.63
Fungicide					
No. of sprays/acre	1.50	1.50	1.33	1.50	1.44
Cost of chemicals	550.00	391.67	441.67	475.00	440.63
Labour charges	83.33	93.75	87.50	95.83	91.86
Total Cost	633.33	485.42	529.17	570.83	532.49

Farmers tend to seek advice for controlling weeds, insect pests and diseases when it crosses certain thresh hold level. It can be observed from the **Table 3.58** that the sample farmers received advise on pests and disease control measures from various sources, which included government extension agents, private input dealers, fellow farmers, TV, radio service/newspaper, and agricultural university/KVK.

Table 3.58. Extension services on pests and disease control management

(% of households)

Source of advice	Most important	Important	Least important
Government extension agent	32.68	32.11	21.42
Private input dealer	47.52	21.10	17.86
Fellow farmers	19.80	44.95	46.43
TV/Radio service/Newspaper	-	0.92	14.29
Agricultural University/KVK	-	0.92	-
Any other	-	-	-
Percentage of HH seeking advice	100		

The government extension agent was one of the sources of advise on pests and disease control measures, and 33 per cent of sample farmers found it most important and 32 per cent as important source of advice. Another source of advice was private input dealers, who were perceived to be most important source by 48 per cent and an important source by 21 per cent. About 45 per cent of sample cultivators considered fellow farmers as an important source of advice on pests and disease control measures. Unfortunately, only one per cent of sample cultivators considered agricultural university/KVK as an important source of advice on pests and disease control measures. These sources provided information related to use of insecticides, pesticides and other agronomic methods.

3.4. Soybean

3.4.1. Madhya Pradesh

Among various constraints faced in the cultivation of soybean in the study areas of Madhya Pradesh, high cost of inputs has been reported as the most important constraint by 60 per cent of the sample households (**Table 3.59**). Over one-third of the sample farmers mentioned the problem of pests and diseases attack as an important constraint in the cultivation of soybean. Water deficiency is also constrained as an important constraint by about 29 per cent of the sample farmers. A high proportion of sample farmers mentioned other constraints such as quality of seed and low output price as least important in affecting the production.

Table 3.59. Constraints faced in cultivation of soybean in Madhya Pradesh

(% of households)

S. No	Constraints	Most important	Important	Least important
1	Poor seed quality	8.13	15.00	76.88
2	Water deficiency	10.00	28.75	61.25
3	Pest and disease problems	16.88	33.13	50.00
4	High cost of inputs	60.00	18.13	21.88
5	Low output price	10.00	20.63	69.38

The magnitude of crop losses due to pest diseases and weeds infestation in soybean is presented in **Table 3.60**. It can be observed that the average quantity of crop loss over actual production was 5.6 quintal per acre and crop loss over normal production was 6.3 quintal per acre. The yield loss over actual output increased with increase in farm size with 8.7 per cent for marginal farmers, 10.7 per cent for small farmers, 15.8 per cent for medium farmers and 16.5 per cent for large farmers. The yield loss over normal production was 14.2 per cent for large farmers, 13.6 per cent for medium farmers, 9.6 per cent for small farmers and 8.0 per cent for marginal farmers.

Table 3.60. Magnitude of crop loss in soybean due to pests, disease and weed infestation in Madhya Pradesh

(Quintal/acre)

Description	Marginal	Small	Medium	Large	Total
Actual production with attack	6.53	5.53	5.00	5.33	5.60
Normal production without attack	7.10	6.12	5.79	6.21	6.31
Loss of output	0.57	0.59	0.79	0.88	0.71
Percentage loss over actual production	8.73	10.67	15.80	16.51	12.93
Percentage loss over normal production	8.03	9.64	13.64	14.17	11.37

The sample farmers mostly adopted the chemical method of pest and disease control in soybean. The infestation of weeds is the major problem in cultivation of soybean as it is largely grown under rainfed condition. Farmers spray weedicides to control weeds and has been most popularly followed in the study area as manual weeding is not possible due to low soil moisture. The average cost of application of weedicide for the overall sample was Rs. 411.6 per acre and it increased with increase in size of farms from Rs 393.6 per acre for marginal farmers to Rs 419.5 for large farmers (**Table 3.61**). The incidence of insect pests on soybean was found to be very common in study area and all the sample households used insecticide to control insects. The average cost of application of insecticide was Rs. 555.3 per acre. The seed treatment with fungicide was common in the study area. The average cost of

use of fungicide was Rs. 97.7 acre for the overall sample and it varied across farm size groups.

Table 3.61. Cost of Chemical methods adopted in soybean for pests and disease control in Madhya Pradesh

(Rs/acre)

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted control measures	87.50	90.00	100.00	100.00	94.38
Weedicide					
No. of Sprays/acre	0.92	0.94	1.00	1.00	0.97
Cost of chemical	322.21	339.33	352.20	357.89	342.91
Labour charges	71.38	76.06	65.75	61.59	68.695
Total Cost	393.59	415.39	417.95	419.48	411.60
Insecticide					
No. of sprays/acre	1.32	1.41	1.95	2.18	1.715
Cost of chemical	427.00	436.59	455.42	462.23	445.31
Labour charges	115.00	109.13	113.36	102.43	109.98
Total Cost	542.00	545.72	568.78	564.66	555.29
Fungicide					
No. of sprays/acre	0.12	0.13	0.14	0.14	0.13
Cost of chemical	61.25	63.00	70.00	70.00	66.06
Labour charges	28.00	31.50	35.00	32.00	31.63
Total Cost	89.25	94.50	105.00	102.00	97.69

The information related to extension services for pest and disease management in soybean is presented in **Table 3.62**. It can be noticed that about 77.5 per cent of the sample farmers sought advice related to control of pests and diseases. Among various sources, private input dealers emerged as the most important source of advice as reported by 71.8 per cent of sample farmers followed by fellow farmers (21.8 per cent). Agricultural Universities/KVKs also played some important role providing crop advice, but unfortunately about 80 per cent of the sample farmers opined that these are least important sources. Similarly, government extension agent, audio-visual and print medium are also considered to be the least important source of advice. It is clear from the analysis that private input dealers were the most important whereas government extension agent and fellow farmers were mostly considered to be the least important source of advice for controlling pests and diseases in soybean.

Table 3.62. Extension services on pests and disease management in soybean in Madhya Pradesh

(% of households)

Sources of advice	Most important	Important	Least important
Government extension agent	4.03	4.03	91.94
Private input dealer	71.77	15.32	12.90
Fellow farmers	21.77	45.97	32.26
TV/Radio service/Newspaper	0.00	15.32	84.68
Agricultural University/KVK	11.29	8.87	79.84
Any other	0.00	0.00	0.00
Percentage of HH seeking advice	77.5		

3.4.2. Maharashtra

The soybean growers face various constraints in the study areas of Maharashtra. Poor seed quality was considered as an important problem by 10 per cent of sample farmers (**Table 3.63**). Due to poor seed quality the germination was reported to be low. Since soybean was largely grown in dry land areas, water deficiency was one of the major problems faced by the farmers. Another major problem confronted by soybean cultivators was the attack of pests and diseases. About 45 per cent of the sample farmers considered pest and disease problem as important as well as most important constraint. Low output price was treated as the most important in the cultivation of soybean by 29.1 per cent of the sample farmers.

Table 3.63. Constraints Faced in Cultivation of Soybean in Maharashtra

(% of households)

S.N.	Constraints	Most important	Important	Least important
1	Poor seed quality	1.82	9.82	18.18
2	Water deficiency	5.45	16.07	4.55
3	Pest and disease problems	41.21	41.07	22.72
4	High cost of inputs	22.42	22.32	50.00
5	Low output price	29.10	10.72	4.55

All the sample farmers cultivated only high yielding varieties. The magnitude of crop production loss in relation to normal production was estimated at 0.6 quintals per acre for marginal category, 0.6 quintals for small, 0.7 quintals for medium and 0.8 quintals for large farmers (**Table 3.64**). The average crop loss over normal production was estimated at 0.68 quintals per acre. However, proportion of crop loss in relation to actual production was worked out at 10.3 per cent for marginal category, 10.9 per cent for small, 11.7 per cent for medium and 13.2 per cent for large farmers. The proportion of soybean crop production loss with respect to normal production translated into 9.4 per cent for marginal category, 9.8 per cent for small, 10.4 per cent for medium and 11.7 per cent for large category with an average of 10.48 per cent for the average category of soybean crop cultivators. Similarly, the

proportion of crop loss in relation to actual production varied from 10.3 per cent for marginal farmers to 13.2 per cent for large farmers category. Further, it can be observed that amount of crop loss showed a positive relationship with farm size.

Table 3.64. Magnitude of crop loss due to pests, disease and weed infestation- soybean in Maharashtra

Description	Marginal	Small	Medium	Large	Total
Actual production with attack (quintal/acre)	5.43	5.60	5.92	6.06	5.81
Normal production without attack (quintal/acre)	5.99	6.21	6.61	6.86	6.49
Loss of output (quintal/acre)	0.56	0.61	0.69	0.80	0.68
Percentage loss over actual production	10.31	10.89	11.66	13.20	11.70
Percentage loss over normal production	9.35	9.82	10.44	11.66	10.48

The sample growers of soybean used chemical methods to control infestation of pests, diseases and weeds on their farms. The average per acre cost of weedicide varied from Rs. 1,357 for marginal category to Rs.1,581 for the large category with an overall average cost of Rs.1,443 (**Table 3.65**). The per acre cost of insecticide varied from Rs.848 for marginal category to Rs.1,135 for the large category with an average of Rs.968 for the entire sample farmers. The cost of applying weedicide and insecticide increased with the increase in land holding size of soybean cultivators.

The sample farmers also used fungicide to control the effect of various diseases on production of soybean. The number of sprays of fungicide varied from 1 to about 1.5 per acre. The cost of applying fungicide varied from Rs.548 for medium category, Rs. 594.2 for small farmers, Rs. 620.0 for marginal farmers and Rs.648 for the large category with an average of Rs.583 for the average category of farmers. The average cost of fungicide for overall sample farmers was Rs. 583 per acre. Overall, analysis revealed that there is, more or less, a positive relationship between farm size and cost of applying weedicide and insecticides. But, such a pattern is not distinctly observable in use of fungicide.

Table 3.65. Cost of Chemical methods adopted for pests and disease control (Rs/acre) in soybean in Maharashtra

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted control measures	100.00	100.00	100.00	100.00	100.00
Weedicide					
No. of sprays/acre	1.33	1.25	1.25	1.40	1.28
Cost of chemicals	1244.17	1370.00	1308.50	1460.00	1322.46
Labour charges	112.50	108.00	110.00	121.43	110.87
Total Cost	1356.67	1478.00	1418.50	1581.43	1443.33
Insecticide					
No. of sprays/acre	1.92	2.09	2.13	1.83	2.04
Cost of chemicals	757.50	853.61	937.33	1046.25	874.58
Labour charges	90.28	95.12	95.92	88.75	93.27
Total Cost	847.78	948.73	1033.25	1135.00	967.85
Fungicide					
No. of sprays/acre	1.00	1.29	1.00	1.50	1.18
Cost of chemicals	545.00	528.57	485.71	560.00	515.59
Labour charges	75.00	65.63	62.50	87.50	67.11
Total Cost	620.00	594.20	548.21	647.50	582.80

All the sample soybean cultivators received advice on pests and disease control measures from various sources, which included government extension agents, private input dealers, fellow farmers, radio service/television/newspaper and agricultural university/KVK. The perceptions of the sample farmers regarding source of advice are provided in **Table 3.66**. Among these sources, sample farmers mentioned only three sources viz., government extension agent, private input dealers and fellow farmers for seeking advice.

Table 3.66. Extension services on pests and disease control management in soybean in Maharashtra

(% of households)

Sources of advice	Most important	Important	Least important
Government extension agent	35.16	32.73	16.67
Private input dealer	62.64	40.00	33.33
Fellow farmers	2.20	27.27	50.00
TV/Radio service/Newspaper	-	-	-
Agricultural University/KVK	-	-	-
Any other	-	-	-

About 35 per cent of sample farmers considered government extension agent as the most important source of advice for taking pests and diseases control measures, whereas 33 per cent considered it as an important source of advice. Similarly, about 63 per cent of sample cultivators found private input dealers as the most important source of advice, whereas 40 per cent considered it as an important source of advice. Another source of advice on pests and

disease control measure was the fellow farmers, which was considered as an important source by 27 per cent of the sample farmers. Overall, private input dealers emerged as the most important source of advice to the farmers for controlling pests and diseases in soybean.

3.4.3. Rajasthan

The constraints faced in cultivation of soybean in the study areas of Rajasthan are presented in **Table 3.67**. Pests and disease problem was reported as most important constraint in by 69.2 per cent of the sample households. About 27 per cent of the households reported poor seed quality and high cost of inputs as major constraints, while 23.3 per cent and 19.2 per cent mentioned low output price and water deficiency as the most important constraints in the cultivation of soybean, respectively.

Table 3.67. Constraints faced in cultivation of soybean in Rajasthan

(% of households)

Constraints faced	Most important	Important	Least important
Poor seed quality	26.67	18.33	24.17
Water deficiency	19.17	28.33	29.17
Pest and disease problem	69.17	17.50	11.67
High cost of inputs	26.67	55.00	10.83
Low output price	23.33	41.67	15.83
Others like, problem of wild animals and not suitable environment	0.83	21.67	7.50

However, 55 per cent of the sample households reported high cost of inputs as important constraint followed by low output price (41.7 per cent) and water deficiency (28.3 per cent). The analysis showed that pests and disease problem, poor seed quality and high cost of inputs were reported as the most important constraints affecting soybean production. Water deficiency and low output price were also considered to be important constraints by the sample farmers.

Table 3.68 shows the magnitude of crop loss due to pests, disease and weeds infestation in soybean crop. The actual production with pests, disease and weeds infestation was 7.7 quintals per acre for local variety and 8.7 quintals per acre for HYV of soybean. Production with attack fluctuated between 2.9 quintal and 8.0 quintal per acre for local variety and 7.7 quintal and 8.9 quintal for HYV among different size of farms. Normal production of

soybean without attack was 10.1 quintal and 10.9 quintal per acre for local and HYV, respectively.

Table 3.68. Magnitude of crop loss due to pests, disease and weeds infestation in soybean in Rajasthan

Description	Marginal		Small		Medium		Large		Total	
	Local	HYV	Local	HYV	Local	HYV	Local	HYV	Local	HYV
Actual production with attack (quintal/ acre)	0.00	7.70	2.88	8.43	7.84	8.65	8.01	8.88	7.68	8.67
Normal production without attack (quintal/ acre)	0.00	9.76	3.80	10.87	10.04	10.91	10.55	11.13	10.07	10.93
Loss of output (quintal/ acre)	0.00	2.06	0.92	2.44	2.20	2.26	2.54	2.26	2.38	2.27
Percentage loss over actual production	0.00	26.70	31.94	28.92	28.00	26.14	31.70	25.42	31.00	26.16
Percentage loss over normal production	0.00	21.07	24.21	22.43	21.88	20.72	24.07	20.27	23.66	20.74

The overall loss of output was 31 per cent over actual production and 23.7 per cent over normal production for local variety. Similarly, overall loss of output was 26.2 per cent over actual production and 20.7 per cent over normal production for HYV. It can be observed that variation in per acre production of HYV soybean among different size groups of farmers was quite less and there was a huge variation in per hectare production of local variety of soybean.

The cost of chemical methods used by farmers to control weeds, insect pests and diseases for soybean is given in **Table 3.69**. The sample farmers in all categories of farm size applied around one spray with an average cost of Rs. 1703 per acre for weedicides. The average cost varied between Rs. 1358 and Rs. 1799 per acre across farm size groups. Around two sprays of insecticides were applied by all the categories of farmers to control various pests with overall average cost of Rs. 1760 per acre with the highest being at Rs. 1855 per acre for large farmers and lowest at Rs. 1519 per acre to small farmers. The sample farmers also applied fungicide with overall average cost of Rs. 1939 per acre.

Table 3.69. Cost of chemical methods adopted for pests and disease control

(Rs / acre)

Particulars	Marginal	Small	Medium	Large	Total
% HH adopted control measures	89.29	86.67	86.49	100.00	90.00
Weedicides					
No. of sprays/ acre	1.15	1.06	1.21	1.23	1.21
Cost of chemicals	1077	1134	1470	1413	1387
Labour charges	281	282	329	319	316
Total cost	1358	1416	1799	1732	1703
Insecticide					
No. of sprays/ acre	2.15	1.79	2.09	2.41	2.22
Cost of chemicals	1376	1174	1323	1444	1369
Labour charges	368	345	381	411	391
Total cost	1743	1519	1704	1855	1760
Fungicide					
No. of sprays/ acre	1.67	2.00	1.16	1.61	1.49
Cost of chemicals	1722	1951	1313	1720	1597
Labour charges	356	401	290	366	342
Total cost	2078	2352	1602	2086	1939

The sources of information to control pests and disease as revealed by the sample farmers are provided in **Table 3.70**. Extension services provided by the government extension agents was considered very important by 75 per cent of the sample households, important by 16.7 per cent and 7.5 per cent as least important. Another source of advice for farmers was private inputs dealers. As compared to other states under study, only 15.8 per cent of the sample farmers in Rajasthan ranked it as most important source of advice for controlling pests and disease while 41.67 per cent reported it as important source and 29.17 per cent of considered it as least important.

Table 3.70. Extension services on pests and disease control management in soybean in Rajasthan (% of households)

Sources of Advice	Most Important	Important	Least Important
Government extension agent	75.00	16.67	7.50
Private input dealer	15.83	41.67	29.17
Fellow farmers	36.67	37.50	20.00
TV/ Radio service/ Newspaper	15.83	46.67	28.33
Agricultural University/ KVK	21.67	28.33	22.50
Any other	0.00	1.67	0.00
Percentage of HH seeking advice	100		

Fellow farmers were considered most important and important source of advice by 37 per cent of sample households each. The media like television/radio/newspapers were also source of advice for 46.7 per cent of households, who considered it an important source and about 15.8 per cent treated as a most important source of advice to control pests and disease.

Agriculture University/ KVK were also the source of advice, which was ranked as most important and important source of advice for 21.7 per cent and 28.3 per cent of sample households, respectively.

Table 3.71. Magnitude of crop loss due to pests, diseases and weeds for sample crops and states

Crop	% loss over normal production	
Paddy	Local	HYV
Assam	6.66	7.79
Karnataka	-	16.2
Punjab	-	8.00
Tamil Nadu	-	9.07
Uttar Pradesh	-	2.88
West Bengal	-	15.05
Wheat		
Assam	-	13.76
Punjab	-	7.35
Madhya Pradesh	-	8.89
Uttar Pradesh	-	6.09
West Bengal	-	15.29
Tur		
Karnataka	44.7	43.9
Gujarat	17.11	14.18
Maharashtra	8.12	11.8
Soybean		
Madhya Pradesh	-	11.37
Maharashtra	-	10.48
Rajasthan	23.66	20.74

The overall yield loss for the sample crops by the select states is presented in **Table 3.71**. The yield loss for paddy varied from 7.8 per cent in Assam to 16.2 per cent in Karnataka. West Bengal also registered the yield loss of 15.1 per cent. Uttar Pradesh recorded the lowest level of yield loss at 2.9 per cent. In case of wheat, crop loss was relatively high at 15.3 per cent in West Bengal and low at 6.1 per cent in Uttar Pradesh. Madhya Pradesh and Punjab showed yield loss of 8.9 per cent and 7.4 per cent, respectively. For tur, yield loss varied for local and high yielding varieties. Karnataka registered yield loss of as high as 44.7 per cent for local and 43.9 per cent for HYV. Yield loss of tur was relatively low in Maharashtra. In case of soybean, yield loss was the highest in Rajasthan with 20.7 per cent for HYV and 23.6 per cent for local varieties. Yield loss of soybean in Madhya Pradesh was 11.4 per cent and in Maharashtra it was 10.5 per cent.

3.5. TO SUM UP

Among the constraints faced in the cultivation of paddy, 23 per cent of the sample households in Assam mentioned pest and disease problem as the most important constraint and 49.2 per cent as important constraint. In Karnataka, over 50 per cent of the sample farmers opined pest and disease as the most important problem in the cultivation of paddy. Of the total sample households, 95.6 per cent reported pest and disease as a problem. Interestingly, in Punjab, only 7 per cent of the sample farmers mentioned it as a most important constraint and 33 per cent as important. Similarly, in Tamil Nadu and Uttar Pradesh a low proportion of sample households reported pest and disease as a problem in the cultivation of paddy. However, in West Bengal, about 57.5 per cent and 32.5 per cent of the sample households reported pest and disease as the most important and important constraints, respectively.

In the cultivation of wheat, about 90.8 per cent of the sample households mentioned pest and disease as the most important constraint. High cost of inputs was also considered as the most important problem by a large proportion of the sample households in Assam. A similar pattern was observed among sample farmers in West Bengal. However, in Punjab and Madhya Pradesh, only 3.0 per cent and 8.8 percent of the sample households reported pest and disease as the important constraint, respectively in the cultivation of wheat.

In case of Tur, 20 per cent of the sample households in Karnataka considered infestation of pest and disease as the most important constraint. In Maharashtra also, only a small proportion of the sample households mentioned pest and disease as a serious problem affecting tur production. However, in Gujarat, about 80.8 per cent of the households reported it as a most important and 18.3 per cent as important problem. For soybean, incidence of pest and disease was not a serious constraint in Madhya Pradesh, but in Maharashtra and Rajasthan.

To control pest, diseases and weeds, sample farmers largely adopted chemical measures. The sample farmers sought advice from various sources for pest and disease management. Private input dealers, by and large, emerged to be a major source of extension service providers to the sample farmers. The crop yield loss varied across states with a relatively higher level of loss in major producing states.

CHAPTER IV
ASSESSMENT OF POST HARVEST LOSSES

In the previous Chapter, quantum of pre harvest crop losses due to incidence of different pests and diseases were presented for four reference crops viz., paddy, wheat, tur and soybean in different states. The issues related to cost of pest control and other pest management practices were also discussed. However, besides pre harvest losses farmers also encounter significant proportion of post harvest losses caused by various factors like excess moisture, improper harvesting time, unsuitable harvesting methods, poor mode of transport and unscientific storage practices. Empirically, post harvest losses are estimated from the point of harvesting to marketing of crop produce. It also encompasses the losses occurring during the intermediate processes like threshing, cleaning, packing, transportation and storage. For a holistic understanding of the magnitude of crop losses, it is better take into account both the pre harvest and post harvest losses for appropriate policy interventions.

In this chapter, quantity of crop produce lost/wasted has been estimated at different stages of its movement from harvesting in the field to final disposal by the farmers. More specifically, in the present study post harvest crop loss is estimated for harvesting, threshing, winnowing, transportation, handling and storage. The amount of crop loss estimated at all these stages has been added to arrive at the total post harvest loss for the reference crops. Post harvest loss at the aggregate level for the sample crops in the selected states are presented in this chapter. The respective state reports provide more details about different type of post harvest losses.

4.1. PADDY

4.1.1. Assam

The aggregate estimate of the post harvest losses captured at different stages of processing of paddy are given in **Table 4.1**. These estimates were worked out across farm size groups. The harvesting loss ranged between 0.48 kg for marginal farmers and 0.81 kg for large farmers. In case of threshing and winnowing, the overall loss was estimated at 1.3 kg and 0.98 kg per quintal of paddy, respectively. The loss of produce appears to be high during transportation and it was even higher during storage. The overall loss during storage for the entire sample farmers was estimated at 2.1 kg, which varied between 1.3 kg for marginal farmers and 2.8 kg for large farmers.

The total post harvest loss was worked out at 5.4 kg per quintal of paddy for marginal farmers, 6.5 kg for small farmers, 8.0 kg for medium farmers and 9.4 kg for large farmers. It can be noticed that there is a positive relationship between the land holding pattern and quantity of post harvest loss. The overall loss stood at 7.3 kg per quintal. The total post harvest loss per acre was 77.8 kg among marginal size group, 92.4 kg for small size group, 106.9 kg for medium size group and 117.7 kg for large size group with an overall loss of 101.8 kg.

Table 4.1. Total Post harvest losses per quintal of paddy by farm size in Assam

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in harvest (kg/quintal)	0.48	0.58	0.62	0.81	0.62
Quantity lost in threshing (kg/quintal)	0.91	0.98	1.41	1.78	1.27
Quantity lost in winnowing (kg/quintal)	0.79	0.88	1.02	1.22	0.98
Quantity lost in transport (kg/quintal)	1.30	1.49	1.79	2.11	1.67
Quantity lost in handling (kg/quintal)	0.57	0.77	0.76	0.73	0.71
Quantity lost in storage (kg/quintal)	1.34	1.78	2.43	2.77	2.08
Total post harvest loss (kg/quintal)	5.39	6.48	8.03	9.42	7.33
Total post harvest loss (kg/acre)*	77.8	92.4	106.9	117.7	101.8

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

4.1.2. Karnataka

The total post harvest losses per quintal of paddy in Karnataka by farm size groups is presented in **Table 4.2**. Except storage loss, all other type of post harvest losses of paddy has been found high for the marginal farmers. In fact, losses of grains by different types of operations encountered by marginal farmers are in terms of harvesting loss (2.32 Kg), threshing loss (0.48 Kg), winnowing loss (0.16 Kg), transport loss (0.84 Kg) and handling loss (0.42 Kg). The overall loss during harvesting was 1.9 kg, threshing and winnowing 0.28 kg, transport 0.6 kg and handling 0.3 kg. The crop loss during storage was estimated very high at 3.8 kg for the overall sample farmers. Among farm size groups, the loss was recorded the highest for medium farmers followed by small farmers, marginal farmers and large farmers.

Among the farm size groups, post harvest losses are worked out low for large farmers. Unlike marginal farmers, large farmers have access to improved technology for harvesting, threshing, winnowing and storage, and also to finance for different operations. As a result, different type of post harvest losses and harvest loss encountered by large farmers are

relatively low. The total post harvest loss per acre of paddy was the highest for marginal farmers (103.68 Kg) followed by medium farmers (73.19 Kg), small farmers (66.34 Kg) and large farmers (54.13 Kg). The total post harvest loss for the overall sample farmers was 76.2 kg per acre.

Table 4.2. Total Post harvest losses per quintal of paddy by farm size in Karnataka

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in harvest (kg/quintal)	2.32	1.80	1.99	1.26	1.90
Quantity lost in threshing (kg/quintal)	0.48	0.17	0.11	0.00	0.20
Quantity lost in winnowing (kg/quintal)	0.16	0.12	0.04	0.00	0.08
Quantity lost in transport (kg/quintal)	0.84	0.39	0.55	0.52	0.57
Quantity lost in handling (kg/quintal)	0.42	0.26	0.25	0.17	0.28
Quantity lost in storage (kg/quintal)	3.89	3.90	4.74	2.73	3.83
Total post harvest loss (kg/quintal)	8.11	6.64	7.69	4.68	6.87
Total post harvest loss (kg/acre)*	103.68	66.34	73.19	54.13	76.22

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

4.1.3. Punjab

The total post harvest loss per quintal of paddy by farm size category is provided in **Table 4.3**. The quantity lost during harvesting of the crop was worked out at minimum of 1.2 kg per quintal on marginal farms while on medium farms it was 1.64 kg which was the highest among the farm categories. In total, quantity lost in paddy harvest worked out to be 1.5 kg per quintal. A meagre quantity of 0.05 kg per quintal recorded to be lost during transportation on medium farms while a maximum of 0.09 kg per quintal was lost for marginal and small farms. In total, transportation losses in paddy was estimated at 0.06 kg per quintal.

The quantity of paddy lost in handling varied from 0.17 kg to 0.29 kg per quintal with lowest on small farms and highest on medium and large farm categories. Storage losses mainly due to weight loss varied from 4.3 kg to 1.7 kg per quintal with the highest registered on marginal farms and lowest on medium farm category. The overall loss during storage was 2.5 kg per quintal due to decline in weight. Total post harvest loss of paddy was calculated as 3.7 kg per quintal on medium farm category which were lowest while on marginal farm category these came out to be 6.0 kg per quintal which were the highest of all the farm categories. The total post harvest losses in paddy was worked out to be 4.4 kg per quintal and 122.4 kg per acre as revealed by the sample respondents.

Table 4.3. Total post harvest losses per quintal of paddy by farm size in Punjab

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in harvest (kg/quintal)	0.93	1.42	1.57	1.54	1.52
Quantity lost in threshing (kg/quintal)	0.05	0.09	0.02	0.04	0.04
Quantity lost in winnowing (kg/quintal)	-	-	-	-	-
Quantity lost in transport (kg/quintal)	0.10	0.08	0.05	0.06	0.06
Quantity lost in handling (kg/quintal)	0.29	0.22	0.17	0.21	0.20
Total post harvest loss (kg/quintal)	1.412	1.828	1.839	1.865	1.84
Total post harvest loss (kg/acre)*	25.99	34.18	34.57	35.81	35.14

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

4.1.4. Tamil Nadu

The total post harvest loss during different operations has been estimated for the sample districts in Tamil Nadu and it is presented in **Table 4.4**. The loss of paddy in Villupuram district which occurred during harvesting season was 3.4 kg for marginal, 3.2 kg for small, 3.1 kg for medium and 2.9 kg for large farmers. The overall loss during harvesting was worked out at 3.2 kg per quintal. In Tiruvarur district, loss of paddy occurred during harvesting for marginal, small, medium and large size of sample households was estimated at about 3.1 kg each. The next important post harvest loss was registered in case of storage. The overall quantity of paddy lost in storage was 2.3 kg per quintal for sample households in Tiruvarur district, whereas it was 0.8 kg per quintal for sample farmers of Villupuram district. Among farm size categories, storage loss was relatively high for medium size farmers.

The overall quantity of paddy lost during threshing was high for sample households in Tiruvarur district as compared to overall threshing losses in Villupuram district. The overall winnowing losses were very insignificant for the sample households in both the districts. However, sample farmers suffered a significant quantity of paddy during transport. The total post harvest loss was 7.7 kg for marginal, 8.0 kg for small, 10.2 kg for medium and 7.3 kg for large farmers in Tiruvarur district. Similarly, total post harvest loss among sample farmers of Villupuram district was estimated at 6.3 kg for marginal, 5.7 kg for small, 5.4 kg for medium and 4.5 kg for large farmers. It is clear from the analysis that there is distinct relationship between the size of land holding and quantity of post harvest loss.

Table 4.4. Total Post Harvest Losses per Quintal by Farm Size in Tamil Nadu

Particulars	Tiruvarur					Villupuram					Total
	Marginal	Small	Medium	Large	Overall	Marginal	Small	Medium	Large	Overall	
Quantity lost in harvest (kg/quintal)	3.12	3.08	3.14	3.07	3.10	3.36	3.19	3.14	2.94	3.16	3.13
Quantity Lost in threshing (kg/quintal)	1.73	2.57	2.77	1.38	2.11	1.12	1.07	0.66	0.46	0.83	1.47
Quantity lost in winnowing (kg/ quintal)	0.15	-	0.46	0.10	0.18	-	-	-	-	-	0.09
Quantity lost in transport (kg/ quintal)	0.73	0.56	0.50	0.44	0.56	0.84	0.81	0.54	0.40	0.65	0.61
Quantity lost in handling (kg/quintal)	-	-	-	-	-	-	-	-	-	-	
Quantity lost in storage (kg/quintal)	1.95	1.74	3.37	2.28	2.34	0.95	0.66	1.08	0.65	0.84	1.59
Total post harvest loss (kg/quintal)	7.68	7.95	10.24	7.27	8.29	6.27	5.73	5.42	4.45	5.47	6.88

4.1.5. Uttar Pradesh

The total post harvest losses per quintal of paddy during different operations by farm size are provided in **Table 4.5**. It can be noticed that the quantity lost during harvesting of paddy was 2.7 kg per quintal as on a whole which was minimum at 2.5 kg on large size farms and maximum at 3.2 kg on small farms. The quantity lost during threshing of paddy was worked out at minimum of 0.6 kg per quintal on medium farms while it was maximum of 1.8 kg per quintal on marginal farms. The total loss for overall sample farmers was 1.3 kg per quintal during threshing of paddy. In case of winnowing of paddy, the total quantity lost for the overall farms was estimated at 0.04 kg per quintal which varied between 0.16 kg and 0.64 kg per quintal across farm size groups. The quantity lost during transportation varied between 0.3 kg and 0.6 kg per quintal with aggregate loss of 0.5 kg. The quantity lost during handling of paddy grains was witnessed maximum at 0.4 kg for small farmers and minimum at 0.2 kg for large farmers.

Quantity lost during storage of paddy was the highest at 0.6 kg per quintal on marginal farms and lowest at 0.08 kg on large farms with overall loss of 0.4 kg on all size of farms. It can be observed that quantity lost during different operations from harvesting to storing, was relatively high for marginal and small farmers. It appears that large sample households had

better managerial capacity than marginal and small sample households. The total post harvest loss in paddy was worked out at 5.6 kg per quintal for the entire sample farmers. Further, the overall post harvest loss per acre was estimated at 127.3 kg, which varied between 103.2 kg for large farmers and 153.4 kg per acre for marginal farmers. Thus, the total post harvest loss per quintal and also per acre was higher on marginal sample farms than other categories of sample farms. The main reason for maximum total post harvest loss in paddy on marginal farms was due to lack of storage facilities and no use of machines in most of post harvest operations.

Table 4.5. Total Post Harvest Losses per Quintal by Farm Size in Uttar Pradesh

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in harvest (kg/quintal)	2.53	3.19	2.56	2.45	2.71
Quantity lost in threshing (kg/quintal)	1.78	1.23	0.58	0.98	1.28
Quantity lost in winnowing (kg/quintal)	0.64	0.41	0.10	0.16	0.40
Quantity lost in transport (kg/quintal)	0.49	0.62	0.41	0.31	0.48
Quantity lost in handling (kg/quintal)	0.30	0.35	0.31	0.19	0.30
Quantity lost in storage (kg/quintal)	0.64	0.40	0.18	0.08	0.40
Total post harvest loss (kg/quintal)	6.38	6.20	4.14	4.17	5.57
Total post harvest loss (kg per acre)*	153.55	138.87	94.48	103.21	127.34

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

4.1.6. West Bengal

The total post harvest losses per quintal of paddy by farm size categories are presented in **Table 4.6**. It can be observed that the quantity lost during harvest was 0.78 kg and during threshing it was 0.3 kg. The quantity of paddy lost during winnowing for the overall sample was 0.55 kg. The quantity lost during transport and handling was estimated at 0.6 kg and 0.3 kg per quintal, respectively. Similarly, quantity lost during storage due to loss of weight and damage by insect pests was worked out at 1.8 kg. Among various type of losses, storage loss was found to be relatively high among sample farmers. The storage loss was the highest for large farmers followed by medium, small and marginal farmers.

The total post harvest loss of paddy was worked out at 76.8 kg per acre, which varied across farm size groups. The total post harvest was higher for large farmers with 229.5 kg per acre than those for medium, small and marginal farmers. It is worthwhile to note that the total post harvest loss increased with the increase in farm size. The share of storage loss has been found

to be higher than that of other type of losses. The improvement in storage facilities required immediate attention of the policy makers for reducing post-harvest losses of crop produce.

Table 4.6. Total post harvest losses per quintal by farm size in West Bengal

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in harvest (kg/quintal)	0.96	0.85	0.74	0.58	0.78
Quantity lost in threshing (kg/quintal)	0.46	0.34	0.28	0.23	0.32
Quantity lost in winnowing (kg/quintal)	0.20	0.15	0.12	0.10	0.13
Quantity lost in transport (kg/quintal)	0.71	0.61	0.52	0.39	0.55
Quantity lost in handling (kg/quintal)	0.34	0.35	0.33	0.25	0.31
Quantity lost in storage (kg/quintal)	0.59	1.04	2.13	4.36	1.78
Total post harvest loss (kg/quintal)	1.51	2.66	5.34	9.39	3.51
Total post harvest loss (kg per acre)*	33.41	51.37	122.40	229.49	76.84

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

4.2. WHEAT

4.2.1. Assam

The post harvest losses of wheat recorded for different operations are presented by farm size groups in **Table 4.7.** The quantity lost during harvesting for entire sample was 1.98 kg per quintal, which varied across farm size groups with the highest being recorded for large farmers. Loss of grains during threshing of wheat was found to be relatively high at 3.3 kg per quintal. The threshing loss was relatively high at 4.1 kg for large farmers followed by medium farmers (3.9 kg), small farmers (3.0 kg) and marginal farmers (2.3 kg). Loss of grains during transportation and storage was also significantly high at 2.95 kg and 2.2 kg per quintal, respectively.

Table 4.7. Total post harvest losses per quintal of wheat by farm size in Assam

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in harvest (kg/quintal)	1.50	1.90	2.26	2.26	1.98
Quantity lost in threshing (kg/quintal)	2.28	2.98	3.88	4.10	3.31
Quantity lost in winnowing (kg/quintal)	0.34	0.43	0.61	0.83	0.55
Quantity lost in transport (kg/quintal)	2.21	3.06	3.22	3.32	2.95
Quantity lost in handling (kg/quintal)	0.53	0.62	0.76	0.85	0.69
Quantity lost in storage (kg/quintal)	1.62	1.75	2.72	2.82	2.23
Total post harvest loss (kg/quintal)	8.48	10.73	13.45	14.17	11.71
Total post harvest loss (kg/acre)*	62.68	78.78	98.18	84.70	85.57

**Note:* Post harvest loss per acre was calculated by multiplying the losses in kg per quintal by the productivity per ha

The total post harvest loss was computed at 8.5 kg for marginal, 10.7 kg for small, 13.5 kg for medium and 14.2 kg for large farmers. The overall loss for entire sample farmers was 11.7 kg per quintal. The average post harvest loss per acre was 85.6 kg with the highest quantity of loss being recorded for medium farmers followed by large farmers, small farmers and marginal farmers. On the whole, it can be observed that there is, by and large, a positive relationship between land holding pattern and quantity of post harvest loss of wheat.

4.2.2. Madhya Pradesh

The total post harvest losses per quintal of wheat by different size of farm size groups is presented in **Table 4.8**. Among various operations, quantity of wheat grains lost was observed higher during harvesting with 2.9 kg per quintal. Large farmers registered the highest level of harvesting loss followed by small, medium and marginal farmers. The next higher level of loss was observed during storage. The average storage loss for overall sample farmers was 4.8 kg per quintal with the highest amount of loss being estimated for large farmers followed by medium, small and marginal farmers.

The total post harvest loss was estimated at 8.6 kg per quintal, which varied across farm size groups. It was relatively high for large farmers as compared to other farmer categories. In terms of proportion of quantity of crop produce harvested, the post harvest loss appears to be positively related with land holding size. However, the total post harvest loss per acre was worked out at 118.2 kg for the overall sample. The medium farmer categories registered the highest amount of 130.8 kg followed by small farmers (119.5 kg), marginal farmers (115.0 kg) and large farmers (107.5 kg).

Table 4.8. Total post harvest losses kg per quintal of wheat by farm size in Madhya Pradesh

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in harvest (kg/quintal)	2.59	2.78	2.42	3.73	2.88
Quantity lost in threshing & winnowing (kg/quintal)	0.28	0.32	0.29	0.51	0.35
Quantity lost in transportation (kg/quintal)	0.16	0.18	0.18	0.21	0.18
Quantity lost in handling (kg/quintal)	0.36	0.38	0.40	0.44	0.40
Quantity lost in storage (kg/quintal)	4.68	4.77	4.79	4.90	4.79
Total post harvest loss (kg/quintal)	8.09	8.46	8.10	9.78	8.61
Total post harvest loss (kg per acre)*	115.04	119.47	130.84	107.48	118.21

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

4.2.3. Punjab

For the sample farmers of Punjab, the total post harvest losses per quintal by farm size are given in **Table 4.9**. It can be observed that the quantity lost during harvesting of wheat varied from 0.9 kg to 1.6 kg per quintal with minimum on marginal and maximum on medium farm size category with total loss of 1.5 kg per quintal. Quantity lost during transport varied from a meagre 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 with average loss of 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.

The total post harvest losses in wheat was worked out at 1.8 kg per quintal with a minimum of 1.4 kg per quintal on marginal farms and maximum of 1.9 kg per quintal on large farms. In terms of total post harvest loss per acre, it was estimated at 35.1 kg. Among farm size groups, it was estimated high for large farmers followed by medium farmers, small farmers and large farmers. There is a distinct positive relationship observed between land holding size and quantity of post harvest loss.

Table 4.9. Total post harvest losses per quintal of wheat by farm size in Punjab

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in harvest (kg/quintal)	0.93	1.42	1.57	1.54	1.52
Quantity lost in threshing (kg/quintal)	0.05	0.09	0.02	0.04	0.04
Quantity lost in winnowing (kg/quintal)	-	-	-	-	-
Quantity lost in transport (kg/quintal)	0.10	0.08	0.05	0.06	0.06
Quantity lost in handling (kg/quintal)	0.29	0.22	0.17	0.21	0.20
Quantity lost in storage (kg/quintal)	0.042	0.018	0.029	0.015	0.02
Total post harvest loss (kg/quintal)	1.412	1.828	1.839	1.865	1.84
Total post harvest loss (kg per acre)*	25.99	34.18	34.57	35.81	35.14

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

4.2.4. Uttar Pradesh

The total post harvest losses per quintal at different stages of processing of wheat at farm level are presented in **Table 4.10**. It is evident that the quantity lost in harvesting of wheat varied from 1.4 kg to 1.7 kg per quintal on marginal and medium size of farms, respectively with average loss of 1.6 kg. In case of threshing, the quantity lost was estimated at 0.49 kg per quintal as on a whole which was maximum at 0.7 kg on marginal farm and minimum at 0.4 kg on large farms. The quantity lost in winnowing of wheat was very nominal at 0.05 kg

and 0.02 kg per quintal on marginal and small size of farms, respectively. The quantity lost during transport varied between 0.11 kg on large farms and 0.13 kg per quintal on small size of sample farms. The storage losses of wheat varied from a minimum of 0.2 kg per quintal on large sample farms to maximum of 0.6 kg per quintal on marginal sample farms with overall loss of 0.34 kg per quintal. It reflects that the post harvest losses of wheat were much more on marginal sample farms than the other categories of sample farms.

It can be noticed that total post harvest loss of wheat at the aggregate level was 2.7 kg per quintal which varied between 3.0 kg among marginal farms and 2.4 kg on large farms. It indicates that total post harvest loss per quintal decreased with increase in size of farms. The overall post harvest loss per acre of wheat was 43.8 kg, which was the highest at 50.7 kg per acre for marginal farmers and lowest at 36.8 kg per acre for large farmers. The marginal and small farmers suffered a relatively high amount of loss as compared to other farm categories, as these resource poor farmers do not have better transport and scientific mode of storages.

Table 4.10. Total Post Harvest Losses per quintal of wheat by Farm Size in Uttar Pradesh

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in harvest (kg/quintal)	1.43	1.60	1.73	1.67	1.60
Quantity lost in threshing (kg/quintal)	0.70	0.49	0.39	0.36	0.49
Quantity lost in winnowing (kg/quintal)	0.05	0.02	-	-	0.02
Quantity lost in transport (kg/quintal)	0.12	0.13	0.11	0.11	0.12
Quantity lost in handling (kg/quintal)	0.17	0.23	0.17	0.08	0.15
Quantity lost in storage (kg/quintal)	0.56	0.32	0.31	0.15	0.34
Total post harvest loss (kg/quintal)	3.03	2.79	2.71	2.37	2.74
Total post harvest loss (kg per acre)*	50.69	45.5	41.29	36.81	43.80

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

4.2.5. West Bengal

The total post harvest losses per quintal of wheat by sample farm size categories in West Bengal are presented in **Table 4.11**. It has been observed that the quantity lost during harvest was 1.3 kg in wheat for the overall sample. Quantities lost during threshing and winnowing of wheat was 0.26 kg and 0.12 kg, respectively. The transport loss was high among medium farmers with 0.85 kg. The handling loss of wheat was estimated at 0.63 kg. The storage loss varied from 0.3 kg for marginal farmers to 0.7 kg for medium farmers. The total post harvest loss was 7.2 kg with highest being recorded for medium farmers followed by small and marginal farmers.

Table 4.11. Total post harvest losses of per quintal of wheat by farm size in West Bengal

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in harvest (kg/quintal)	1.30	1.30	1.26	-	1.26
Quantity lost in threshing (kg/quintal)	0.89	0.89	0.93	-	0.26
Quantity lost in winnowing (kg/quintal)	0.44	0.44	0.43	-	0.12
Quantity lost in transport (kg/quintal)	0.78	0.77	0.85	-	0.83
Quantity lost in handling (kg/quintal)	0.58	0.59	0.68	-	0.63
Quantity lost in storage (kg/quintal)	0.30	0.37	0.69	-	3.93
Total post harvest loss (kg/quintal)	0.66	0.76	2.03	-	7.22
Total post harvest loss (kg per acre)*	32.1	21.8	90.8	-	30.59

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

The per acre post harvest loss in wheat was estimated at 30.6 kg, which varied across farm size groups. It is worthwhile to note that the total post harvest loss increased with the increase in farm size. Therefore, it has been observed that post-harvest handling has led to considerable loss of wheat grains. The share of storage loss has been found to be higher for the sample farmers than that of other type of losses. The improvement in storage facilities required immediate attention of the policy makers for reducing post-harvest loss.

4.3. TUR

4.3.1. Karnataka

In case of tur in Karnataka, the post harvest losses were high for marginal farmers and small farmers as compared to medium farmers and large farmers (**Table 4.12**). Among different type of losses, harvesting loss and storage loss was very high at 3.7 kg and 11.2 kg, respectively for the entire sample farmers. The marginal farmers registered a relatively high level of harvesting loss (5.9 kg) followed by small farmers, large farmers and medium farmers. Threshing loss is also found to be high for marginal farmers with 2.99 kg and it showed decreasing pattern with increase in farm size. Similarly, transport loss was estimated at 1.1 kg for the overall sample. The quantum of loss incurred during storage was the highest for marginal farmers with 5.5 kg per quintal followed by small farmers (3.9 kg), medium farmers (2.6 kg) and larger farmers (1.9 kg).

The total post harvest loss was estimated at 24.2 kg per acre. The post harvest loss showed an inverse relationship with land holding pattern. These post harvest losses can generally be avoided through provisioning of adequate infrastructures in the form of better road, threshing floor, scientific ware houses and locating output markets closer to the villages. To provide

such facilities, increase in both public and private investment and quality of such investments are very important.

Table 4.12. Total post harvest losses per quintal of tur by farm size in Karnataka

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in harvest (kg/quintal)	5.85	4.14	3.09	3.46	3.72
Quantity lost in threshing (kg/quintal)	2.99	2.03	1.79	1.95	2.02
Quantity lost in winnowing (kg/quintal)	2.18	1.23	1.25	1.09	1.23
Quantity lost in transport (kg/quintal)	1.90	1.35	1.24	0.89	1.11
Quantity lost in handling (kg/quintal)	1.08	0.74	0.66	0.58	0.66
Quantity lost in storage (kg/quintal)	5.47	3.90	2.59	1.86	2.42
Total post harvest loss (kg/quintal)	19.48	13.40	10.62	9.82	11.15
Total post harvest loss (kg/acre)*	43.08	33.62	23.28	20.02	24.21

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

4.3.2. Maharashtra

The estimates relating to total post-harvest loss of tur on account of harvesting, threshing, winnowing, transportation, handling and storage for different categories of farmers are presented in **Table 4.13**. Analysis of data revealed that there is a wide variations in post harvest losses across various categories of sample farmers. The per quintal average loss of tur was estimated at 6.0 kg, which comprised harvesting loss of 1.6 kg, threshing loss of 1.2 kg, winnowing loss of 0.6 kg, transportation and handling loss of 1.3 kg, and storage loss of 1.3 kg. As it can be noticed that among different type of losses, harvesting loss was estimated to be high. Harvesting loss for marginal and small farmers was relatively high as compared to medium and large farmers.

Table 4.13. Total post harvest losses per quintal of tur by farm size in Maharashtra

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in harvest (kg/quintal)	2.02	2.04	1.26	0.78	1.56
Quantity lost in threshing (kg/quintal)	1.67	1.62	0.85	0.82	1.24
Quantity lost in winnowing (kg/quintal)	1.35	0.83	0.25	0.14	0.59
Quantity lost in transport (kg/quintal)	0.89	0.62	0.45	0.28	0.54
Quantity lost in handling (kg/quintal)	1.47	0.95	0.40	0.29	0.73
Quantity lost in storage (kg/quintal)	1.97	1.78	0.86	0.85	1.34
Total post harvest loss (kg/quintal)	9.37	7.84	4.07	3.16	6.00
Total post harvest loss (kg per acre)*	41.88	36.77	19.21	14.54	27.90

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

The per quintal post harvest loss of tur declined sharply with the increase in land holding size of farmers with 9.4 kg for marginal category and 3.2 kg for large category of farmers. The declining trend in post harvest losses with rise in land holding size was witnessed with respect to all the post harvest operations viz. harvesting, threshing, winnowing, transportation, handling and storage operations. The per acre post harvest losses of tur also declined with the increase in land holding size of farmers; from 41.9 kg for marginal farmers to 14.5 kg for the large farmers with an average of 27.9 kg for the overall sample farmers.

4.3.3. Gujarat

The post harvest losses which occurred during the different operations are given in **Table 4.14**. It can be observed that per quintal loss of tur in various stages of post harvest was the highest in marginal farmers and the lowest for large farmers. The quantity lost during harvesting of tur ranged between 2.4 kg and 0.9 kg per quintal, during threshing it varied from 1.6 kg to 0.6 kg, in winnowing from 0.4 kg to 0.2 kg, in transport between 1.0 kg and 0.2 kg, in handling it varied from 0.6 kg to 0.2 kg and in storage ranged between 1.2 kg and 0.4 kg per quintal.

Table 4.14. Total post harvest losses per quintal of tur by farm size in Gujarat

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in harvesting (kg/quintal)	2.37	1.69	1.16	0.93	1.08
Quantity lost in threshing (kg/quintal)	1.62	1.20	0.85	0.56	0.69
Quantity lost in winnowing (kg/quintal)	0.41	0.42	0.28	0.15	0.20
Quantity lost in transport (kg/quintal)	1.02	0.74	0.51	0.24	0.35
Quantity lost in handling (kg/quintal)	0.60	0.45	0.29	0.15	0.21
Quantity lost in storage (kg/quintal)	1.23	0.90	0.78	0.39	0.52
Total post harvest lost (kg/quintal)	7.24	5.41	3.88	2.43	3.05
Total post harvest lost (Kg/ acre)*	25.66	17.92	18.42	11.51	13.84

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

Overall, quantity of tur lost during harvesting was 1.1 kg, in threshing 0.7 kg, in winnowing 0.2 kg, in transport 0.4 kg, in handling 0.02 kg and in storage it was 0.5 kg per quintal. Total post harvest loss was worked out at 3.1 kg per quintal for the sample farmers and in terms of per acre it was estimated at 13.8 kg. Thus, quantity loss of tur crop was highest in harvesting stage followed by threshing and in storage. Quantity lost in post harvest operations like

winnowing, transportation and handling was comparatively low. Further, quantity of produce lost during different stages of post harvest decreased with increase in farm size.

4.4. SOYBEAN

4.4.1. Madhya Pradesh

The post harvest losses per quintal of soybean by different farm size groups in Madhya Pradesh are presented in **Table 4.15**. The quantity of soybean lost during harvesting was the highest at 7.1 kg followed by storage (2.6 kg) and threshing and winnowing (2.4 kg). Among farm size categories, large farmers registered the a higher level of loss as compared to other categories. Similarly, quantity of grains lost during threshing and winnowing was the highest for large farmers with 2.95 kg per quintal followed by small farmers, marginal farmers and medium farmers. The storage loss was also higher for large farmers as compared to other categories.

The total post harvest loss for the overall sample was 12.6 kg per quintal. For the different farm size categories, it was 11.8 kg for marginal farmers, 2.3 kg for small farmers, 2.8 kg for medium farmers and 3.4 kg for large farmers. In terms of quantity of soybean loss per acre, it was worked out at 59.9 kg for the overall sample. Among various farm size categories, it varied form 50.7 kg per acre for marginal farmers to 70.3 kg per acre for large farmers. Analysis clearly showed that there is by and large, a positive relationship between size of land holdings and quantity of soybean lost during different harvest and post harvest operations.

Table 4.15. Total post harvest losses per quintal of soybean by farm size Madhya Pradesh

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in Harvest (kg/quintal)	7.25	7.42	6.10	7.53	7.08
Quantity lost in Threshing & winnowing (kg/quintal)	2.18	2.30	1.98	2.95	2.35
Quantity lost in Transportation (kg/quintal)	0.20	0.22	0.23	0.26	0.23
Quantity lost in Handling (kg/quintal)	0.32	0.33	0.34	0.36	0.34
Quantity lost in Storage (kg/quintal)	1.82	2.26	2.78	3.40	2.57
Total post harvest loss (kg/quintal)	11.76	12.53	11.42	14.50	12.56
Total post harvest loss (kg per acre)*	50.69	55.16	63.25	70.32	59.85

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

4.4.2. Maharashtra

The estimates relating to total post harvest loss of soybean arising from harvesting, threshing, winnowing, transportation, handling and storage for various categories of farmers are given in **Table 4.16**. The total post harvest loss per quintal was estimated at 3.7 kg, which comprised 1.1kg of harvesting loss, 0.5 kg of threshing loss, 0.4 kg of winnowing loss, 0.5 kg of transportation loss, 0.6 kg of handling loss and 0.6 kg of storage loss. It is discernible that the highest quantity of loss was observed during harvesting followed by handling, storage, threshing, transportation and winnowing.

Table 4.16. Total post harvest losses per quintal of soybean by farm size in Maharashtra

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in harvest (kg/quintal)	1.87	1.49	1.05	0.54	1.13
Quantity lost in threshing (kg/quintal)	0.92	0.69	0.40	0.25	0.50
Quantity lost in winnowing (kg/quintal)	0.51	0.52	0.31	0.18	0.36
Quantity lost in transport (kg/quintal)	0.82	0.68	0.38	0.17	0.46
Quantity lost in handling (kg/quintal)	1.41	0.91	0.44	0.28	0.63
Quantity lost in storage (kg/quintal)	1.20	0.70	0.53	0.30	0.58
Total post harvest loss (kg/quintal)	6.73	4.99	3.11	1.72	3.66
Total post harvest loss (kg/acre)*	36.54	27.94	18.41	10.42	21.26

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

The per quintal post harvest loss of soyabean with respect to different type of losses declined sharply with the increase in land holding size of farmers with 6.7 kg for marginal farmers and as low as 1.7 kg for large farmers. The per acre post harvest losses of soyabean also declined with the increase in land holding size of farmers. It was 36.5 kg for marginal farmers, 27.9 kg for small farmers, 18.4 kg for medium farmers and 10.4 kg for large farmers with overall average of 21.3 kg for the entire sample farmers.

4.4.3. Rajasthan

The total post harvest losses per quintal of soybean by farm size are given in **Table 4.17**. It can be observed that quantity of soybean lost was the highest in harvesting stage followed by threshing and storage. The quantity lost during harvesting was minimum at 1.3 kg per quintal on large farms and it was maximum at 2.2 kg per quintal on small farms. The quantity of soybean lost in threshing varied between 0.9 kg and 1.3 kg per quintal with lowest on medium and highest on marginal farms. Quantity lost in winnowing, transportation and handling of soybean was meagre for all size group of farmers. The maximum quantity lost in

storage was 0.9 kg per quintal by medium farmers and the least was 0.5 kg per quintal by large farmers.

Table 4.17. Total post harvest losses per quintal of soybean by farm size in Rajasthan

Particulars	Marginal	Small	Medium	Large	Total
Quantity lost in harvesting (kg/quintal)	1.91	2.24	1.32	1.29	1.45
Quantity lost in threshing (kg/quintal)	1.33	1.15	0.86	0.72	0.85
Quantity lost in winnowing (kg/quintal)	0.42	0.03	0.10	0.00	0.11
Quantity lost in transport (kg/quintal)	0.29	0.24	0.27	0.16	0.21
Quantity lost in handling (kg/quintal)	0.23	0.20	0.15	0.11	0.14
Quantity lost in storage (kg/quintal)	0.55	0.65	0.93	0.53	0.65
Total post harvest lost (kg/quintal)	4.73	4.50	3.64	2.81	3.41
Total post harvest lost (kg/acre)*	31.80	34.32	21.45	18.29	21.67

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

Among farm size groups, the total post harvest loss in soybean was estimated low at 2.8 kg per quintal for large farmers and high at 4.7 kg per quintal for small farmers. The overall post harvest lost was worked out at 3.4 kg per quintal for the sample farmers. The total post harvest loss per acre was estimated at 21.7 kg for the overall sample. It varied across farm size groups with 31.8 kg for marginal farmers, 34.3 kg for small farmers, 21.5 kg for medium farmers and 18.3 kg for large farmers. There is no distinct relationship between farm size and quantity of post harvest loss among the sample farmers in Rajasthan.

The overall post harvest loss by select crops and states is presented in **Table 4.18**. It can be observed that total post harvest loss of paddy was highest in Assam with 7.3 per cent followed by Tamil Nadu and Karnataka with 6.9 per cent. The post harvest loss in Uttar Pradesh was 5.6 per cent and in West Bengal it was 3.5 per cent. In case of wheat, the post harvest loss was relatively high in Assam with 11.7 per cent followed by Madhya Pradesh (8.6 per cent) and West Bengal (7.2 per cent). For tur, the post harvest loss was relatively high in Karnataka (11.2 per cent). Maharashtra and Gujarat registered the post harvest loss of 6.0 per cent and 3.1 per cent, respectively. In case of soybean, the post harvest loss was the highest in Madhya Pradesh. Maharashtra and Madhya Pradesh registered the post harvest loss of 3.7 per cent and 3.4 per cent, respectively. It is clear from the analysis that the largest producing states have, by and large, recorded a higher level of post harvest loss.

Table 4.18. Overall Post Harvest Loss of the Sample Crops in the Select States

Crop	Post Harvest Loss (%)
Paddy	
Assam	7.33
Karnataka	6.87
Punjab	4.43
Tamil Nadu	6.88
Uttar Pradesh	5.57
West Bengal	3.51
Wheat	
Assam	11.71
Madhya Pradesh	8.61
Punjab	1.84
Uttar Pradesh	2.74
West Bengal	7.22
Tur	
Karnataka	11.15
Gujarat	3.05
Maharashtra	6.00
Soybean	
Madhya Pradesh	12.56
Maharashtra	3.66
Rajasthan	3.41

4.5. FACTORS INFLUENCING POST HARVEST LOSS AND CONTROL MEASURES

There are many factors that operate at the farm level and beyond influencing the post harvest losses of crop produce. Among the different stages of post harvest, loss occurred during harvesting and storage was estimated very high in different states. Time of harvesting affect the level of loss of produce at the time of harvesting. In fact, farmers adjust the time of harvesting of the crops based on availability of certain resources such as irrigation water, labour, financial capital, weather conditions and market prices. Crop varietal characteristics also determine the time of planting and harvesting. Appropriate time of planting and harvesting helps to protect against avoidable losses. In the present study, three different time periods of harvesting of the reference crops were captured in the field survey. They were early harvest (timely harvest), mid harvest (delayed harvest) and late harvest. It has been observed that harvesting loss varied by different time of harvesting which is generally carried out after the maturity of grains of the standing crops. Another important dimension of causes of harvesting loss is the method of harvesting; manual or mechanical.

It has been estimated that the quantity of grains lost per acre was more or less high during the late harvesting followed by mid harvesting and early harvesting. Study results across sample states showed that farmers suffer considerable amount of gains loss due to delayed harvesting, which can be avoided by providing adequate support facilities like harvesting machines and threshing machines on custom hiring basis.

In most states, farmers stored grains either in open space inside the home or in gunny bags. The sample farmers in agriculturally advanced states like Punjab, grains were stored in steel drum for later use or household consumption. However, use of gunny/plastic bags seem to be the predominant mode of storage in many places. Lack of proper storage facilities particularly among the marginal and small farmers led to considerable loss of grains during storage. These resource poor farmers generally constructed storage rooms in mud walls, which are often prone to collapse due to rain or wind.

The sample farmers adopted various strategies to minimise the losses that occur at different stages of post harvesting of crop produce. The strategies adopted varied in different states and also by type of farmers. The sample farmers in Assam reported that they generally remove the grains infested by insect pests and other pathogens during storage as a way of controlling the spread of infestation.

In Karnataka, the sample farmers installed rat guards to prevent the damage to the grains. The rat guards were changed frequently as they become obsolete and ineffective in operation. Infestation of pests on stored grains reported to cause considerable storage loss. In order to protect the grains from pest infestation, farmers undertake certain operations periodically. These included sun drying, removal of infested grains and destroying them, admixing with ash and plant materials, and fumigation. About of a quarter of paddy and red gram farmers in Karnataka have mentioned manual removal of infested grains and destroying them so as to prevent spreading of infestation to the whole grain lot. Some farmers have also mixed charcoal ash and plant materials with the grains as repellent to insects and pathogens. Red gram farmers have practiced fumigation of store house or room annually mainly to prevent the rodents and storage insects.

Similarly, sample households in Maharashtra practiced removal of infested grains from storage and their destruction regularly. For controlling storage pests, the sun drying of tur was

performed on monthly basis by 47 per cent of households, quarterly basis by 7 per cent of households, six monthly basis by 7 per cent of households and annual basis by 18 per cent of households. As for storage pests control measures, sun drying of soybean was performed on monthly basis by 7 per cent of households and annual basis by 16 per cent of households. Some farmers practiced admixing the grains with ash and other plant materials to ward off the insect pests.

In Gujarat, about 65 per cent of the sample tur farmers followed annual sun drying and removal of infested grains from storage and destroying them every six month. Some farmers adopted the method of admixing the grains with ash and other plant materials annually and quarterly for controlling the storage pests. Practice of smoking as a storage pests control was followed by only a few sample farmers. In Rajasthan, only a quarter of the sample households used sun drying as a method of storage pest control. Some farmers practiced the removal of infested grains from storage and destroying it annually. The sample farmers in West Bengal used gunny bags disinfected with 1per cent Malathion solution for 3-4 minutes and dry it. The sample farmers generally make sure that storage structure and bags properly dried to check infestation and maintain hygiene.

4.6. TO SUM UP

The amount of post harvest loss varied by crops and states. Among the post harvest losses, amount of grains lost during transportation and storage was considerably high. There is by and large, a positive relationship observed between land holding size and quantity of post harvest loss. Among farm size groups, it was estimated high for large farmers followed by medium farmers, small farmers and large farmers. However, there are exceptions. In case of wheat in Uttar Pradesh, the marginal and small farmers suffered a relatively high amount of loss as compared to other farm categories. These resource poor farmers do not have better transport facilities and scientific mode of storages.

The overall post harvest loss of paddy was highest in Assam followed by Tamil Nadu and Karnataka. The post harvest loss of wheat was significantly high in Assam. For tur, the post harvest loss was relatively high in Karnataka. Maharashtra and Gujarat also recorded a significant proportion of loss of grains during different stages of post-post harvest operations. In case of soybean, the post harvest loss was the highest in Madhya Pradesh followed by Maharashtra and Madhya Pradesh.

CHAPTER V
SUMMARY OF FINDINGS AND POLICY SUGGESTIONS

5.1. BACKGROUND

India's agricultural production pattern has undergone significant changes overtime. Technology has played an important role in bringing the transformation in agriculture. But, technological developments have altered a multi commodity production system to a specialised system in different parts of the country. In the process, many traditionally cultivated crops either have lost their area or gone out of cultivation. Further, these developments have entailed increased build up of pest and diseases, and consequent use of higher amount of pesticides to raise the productivity of crops. The increased use of pesticides has also resulted in developing resistance by insects and pathogens, which further led to reduction in crop yield. The indiscriminate and excess use of pesticides combined with chemical fertilisers is partly responsible for environmental degradation. Further, this has led to destruction of habitat of beneficial insects and also increase in the cost of cultivation of crops.

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, crop loss estimates have been made and updated regularly at global level (Oerke, 2007). At all India level, crop loss estimates due to insect pests have been provided by Dhaliwal *et al* (2010).

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, crop loss estimates collected directly from the farmers through sample survey may be reliable and could be used for extrapolation in similar geographical settings.

Agricultural production is seasonal and exposed to natural environment, but post-production operations play an important role in providing stability in the food supply chain. Losses in food crops occur during harvesting, threshing, drying, storage, transportation, processing and marketing. In the field and during storage, the products are damaged by insects, rodents, birds and other pests. 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.

As per the available data (Oerke, 2006; Dhaliwal et al, 2010), crop loss caused by pests and diseases are substantially higher. But, the knowledge on the subject of 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 the selected 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 may cause significant 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 was made to estimate such losses based on the farmers' estimates.

Keeping in view of importance of the subject, the present study focuses on the following objectives.

5. To estimate the physical losses caused by pests and diseases in rice, wheat, tur and soybean at farm level
6. To examine the measures of pest and disease management to reduce the crop loss due to pests and diseases at farm level
7. To arrive at post harvest losses in rice, wheat, tur and soybean under different agro climatic conditions
8. 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

The present study was based on the farm level data collected from major states growing four reference crops viz., rice, wheat, tur and soybean. 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 sample 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 quantification of yield loss was estimated by asking the farmers to identify the pests and diseases by name, frequency of attack and crop loss by individual pests. Farmers were also asked to mention the actual production with attack of all pests and normal production in the absence of pests.

The post harvest losses encountered during the process of harvesting, threshing, transportation and storage were quantified based on the estimates provided by the sample farmers. The study also attempted to identify the storage structure at the farmers' level and enumerate the losses occurring during storage for the reference crops. The control measures adopted by the farmers to minimise the post harvest losses were also captured through field survey.

5.2. SUMMARY OF FINDINGS

5.2.1 Pre Harvest Losses

In Assam, 92.5 per cent of the sample households reported that low output price was the most important constraint in the cultivation of paddy. In case of pests and diseases, 23.3 per cent of the sample farmers opined it as the most important constraint. Crop losses in HYV paddy was estimated to be high as compared to local paddy indicating a higher level of resistance of local paddy against infestation. The loss over the actual production of local paddy ranged between 5.4 per cent and 8.3 per cent while in HYV paddy, it stood between 6.2 per cent and 9.5 per cent across farm size groups. The loss over normal production of local paddy ranged between 5.2 per cent and 7.6 per cent while in HYV paddy, it ranged between 5.8 per cent and 8.7 per cent across farm size groups.

For paddy cultivation in Karnataka, incidence of pests and diseases emerged to be a serious problem with a reporting of 95.6 per cent of the total paddy growing farmers followed by high cost of inputs (90.0 per cent). Paddy yield loss due to all pests ranged from 13.8 per cent among medium farmers to 20.0 per cent among marginal farmers. In Punjab, high cost of inputs was reported as the 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. The loss of paddy output varied from 1.6 to 2.4 quintals per acre with lowest on small farms 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 7.9 per cent on marginal, 6.1 per cent on small, 8.5 per cent on medium and 8.9 per cent on large farms categories. In total, magnitude of crop loss due to pests, diseases and weed infestation in paddy was 8.7 per cent over actual production and about 8.0 per cent over normal production.

Among constraints faced by farmers in the cultivation of paddy in Tamil Nadu, low output price was reported as the most important constraint faced by 57.5 per cent of the sample farmer in Villupuram and 40 per cent in Tiruvarur. About 35 per cent of the sample households informed that pests and diseases problem was an important problem faced by them. Crop loss expressed in terms of actual production varied at 14 per cent for marginal, 12 per cent for small, 14 per cent for medium and 16 per cent for large farmers in Tiruvarur. The overall loss of paddy was estimated higher among sample farmers of Villupuram.

In Uttar Pradesh, low output price of paddy was reported as most important constraint by 53 per cent of the sample households. With respect to pest and diseases problems, 17 per cent of the sample farmers had reported it as a constraint. The percentage loss over actual production was estimated at 2.96 per cent against 2.88 per cent over normal production. The percentage loss over actual production was estimated the highest of 4.3 per cent for marginal farmers and lowest at 1.5 per cent for large farmers. Similarly, the percentage loss over normal production was estimated at 2.9 per cent for the overall sample. The analysis of data revealed that percentage losses over actual production as well as percentage loss over normal production were highest on marginal farms and lowest on large farms.

Among various constraints, high cost of inputs, low output price, and pest and diseases problem ranked most important in the cultivation of paddy in West Bengal. The overall yield loss with attack was estimated at 3.5 quintal per acre. The overall normal production without attack was 23.5 quintal per acre. However, the percentage loss over normal production was less than that of percentage loss over actual production.

In case of wheat, low output price was the most important constraint for 65.0 per cent of the sample households, and pests and diseases for 90.8 per cent of the households. The yield loss over actual production varied between 16.1 per cent and 21.9 per cent across farm size groups. The loss over the normal production varied from 13.9 per cent to 18.0 per cent. The sample farmers opined that the ruling seed variety and climatic conditions are susceptible to pests and diseases attack. In Punjab, 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 of the sample households reported pest and disease problem as most important constraint. The per cent loss over actual production increased with increase in farm size. Overall, the magnitude of crop loss due to pests, diseases and weed infestation was 7.9 per cent over actual and 7.35 per cent over normal production.

The incidence of pest and diseases, poor quality of seed and low price of output were the least important constraints mentioned by the sample farmers in Madhya Pradesh. Crop loss over normal production was 13.9 quintal per acre and over actual production it was 12.6 quintal. There is discernible variation in the loss across farm size groups. In terms of percentages, the

loss over normal production was 8.9 and for actual production it was 9.8. The per cent loss over actual and normal production increased with increase in farm size.

In Uttar Pradesh, high cost of inputs and low price of output were considered to be the most important constraints. Low output price was considered most important constraint by over a quarter of the sample households. Interestingly, none of the respondents reported pest and disease problems as a constraint in the cultivation of wheat. The actual yield of wheat with attack varied from 15.2 quintal to 16.7 quintal across farm size groups and for the overall sample it was 16.0 quintal per acre. Normal production without attack varied between 16.3 quintal and 17.7 quintal per acre.

Among various constraints in the cultivation of wheat, high cost of inputs and low output price were considered to be the most important constraints by a significant proportion of the sample households in West Bengal. About half of the sample farmers mentioned that pests and diseases problems, and poor seed quality as the most important problems. The level of crop loss over normal production was lower (15.3 per cent) than that of percentage loss over actual production (18.1 per cent). Among farm size groups, crop loss over actual production was 17.8 per cent for marginal farmers, 18.1 per cent for small farmers and 18.4 per cent for medium farmers. The corresponding figures for crop loss over normal production were 15.1 per cent, 15.3 per cent and 15.6 per cent.

A high proportion of sample farmers (89.4 per cent) have reported pest and diseases problems as a major constraint affecting the production of tur in Karnataka. The per cent production loss was higher for local varieties than for high yielding varieties. In fact, yield loss as percentage of normal production was 44.7 for local varieties and 43.9 for high yielding varieties. Similarly, yield loss over actual production was 80.8 per cent for local varieties and 78.3 per cent for HYV.

In Gujarat, pests and diseases problem was reported as the most important constraint in cultivation of tur by 80.8 per cent, while 63.3 per cent and 61.7 per cent of sample households mentioned water deficiency and high cost of inputs as the most important constraints, respectively. The per cent loss over actual and normal production was comparatively low in case of HYV in relation to local variety among various categories of farmers. In case of local variety, it varied between 20.0 per cent and 22.8 per cent over actual

production and between 16.6 per cent and 18.6 per cent over normal production across farm size groups. However, for HYV it ranged between 16.2 per cent and 17.7 per cent over actual production, and 14.0 per cent and 15.0 per cent over normal production.

Over 20 per cent of sample farmers reported water deficiency, pest and disease problems, high cost of inputs and low output price as the most important constraints faced in the cultivation of tur in Maharashtra. The proportion of tur production loss in relation to normal production was 8.1per cent for the overall sample in case of local variety and 11.8 per cent for HYV variety. The per cent loss, both in terms of actual production and normal production, was relatively low for marginal farmers and high for large farmers.

High cost of inputs has been reported as the most important constraint by 60 per cent of the soybean sample households in Madhya Pradesh. Over one-third of the sample farmers mentioned the problem of pests and diseases attack as an important constraint in the cultivation of soybean. The yield loss over actual output increased with increase in farm size with 8.7 per cent for marginal farmers, 10.7 per cent for small farmers, 15.8 per cent for medium farmers and 16.5 per cent for large farmers. The yield loss over normal production was 14.2 per cent for large farmers, 13.6 per cent for medium farmers, 9.6 per cent for small farmers and 8.0 per cent for marginal farmers.

In Maharashtra, about 45 per cent of the sample farmers considered pests and disease problem as important as well as most important constraint. Low output price was treated as the most important in the cultivation of soybean by 29.1 per cent of the sample farmers. The proportion of crop loss in relation to actual production was worked out at 10.3 per cent for marginal category, 10.9 per cent for small, 11.7 per cent for medium and 13.2 per cent for large farmers. The proportion of soybean crop production loss with respect to normal production translated into 9.4 per cent for marginal category, 9.8 per cent for small, 10.4 per cent for medium and 11.7 per cent for large category.

Pest and disease problem was reported as most important constraint by 69.2 per cent of the sample households in Rajasthan. The overall loss of output was 31 per cent over actual production and 23.7 per cent over normal production for local variety. Similarly for HYV, overall loss of output was 26.2 per cent over actual production and 20.7 per cent over normal production.

5.2.2. Post Harvest Losses

Post harvest losses were captured in the form of quantity of grains lost during different post harvest operations such as harvesting, threshing, winnowing, transport, handling and storage undertaken by the sample farmers. The total post harvest loss varied by crops and states. However, there seems to be, by and large, an inverse relationship between post harvest loss and farm size groups indicating that marginal and small farmers encounter considerable quantity of post harvest loss due to lack of access to suitable machineries and financial capital.

Among different type of post harvest losses, quantity of grains lost during harvesting and storage was estimated higher for the reference crops in the select states. In Assam, the overall loss of paddy during storage for the entire sample farmers was estimated at 2.1 kg, which varied between 1.3 kg for marginal farmers and 2.8 kg for large farmers. The overall loss of paddy in Karnataka during harvesting was 1.9 kg, threshing and winnowing 0.28 kg, transport 0.6 kg and handling 0.3 kg. However, in Punjab, harvesting loss was estimated at 1.52 kg, transportation loss at 0.06 kg and storage loss was 2.5 kg per quintal. A similar pattern can be observed in Tamil Nadu, Uttar Pradesh and West Bengal.

In case of wheat, total post harvest loss was computed at 8.5 kg for marginal, 10.7 kg for small, 13.5 kg for medium and 14.2 kg for large farmers in Assam. In Madhya Pradesh, quantity of wheat grains lost was observed higher during harvesting with 2.9 kg per quintal. The average storage loss for overall sample farmers was 4.8 kg per quintal with the highest amount of loss being estimated for large farmers followed by medium, small and marginal farmers. In Uttar Pradesh, total post harvest loss of wheat at the aggregate level was 2.7 kg per quintal which varied between 3.0 kg among marginal farms and 2.4 kg on large farms. It indicates that total post harvest loss per quintal decreased with increase in size of farms. However, in West Bengal, total post harvest loss was 7.2 kg with highest being recorded for medium farmers followed by small and marginal farmers.

For tur, among different type of losses, harvesting loss and storage loss was very high at 3.7 kg and 11.2 kg, respectively for the entire sample farmers in Karnataka. In Maharashtra, per quintal average loss of tur was estimated at 6.0 kg, which comprised harvesting loss of 1.6 kg, threshing loss of 1.2 kg, winnowing loss of 0.6 kg, transportation and handling loss of 1.3

kg, and storage loss of 1.3 kg. However, in Gujarat, per quintal loss of tur in various stages of post harvest was the highest for marginal farmers and the lowest for large farmers.

In case of soybean, the quantity of soybean lost during harvesting was the highest at 7.1 kg followed by storage (2.6 kg) and threshing and winnowing (2.4 kg) in Madhya Pradesh. In Maharashtra, the total post harvest loss per quintal was estimated at 3.7 kg, which comprised 1.1kg of harvesting loss, 0.5 kg of threshing loss, 0.4 kg of winnowing loss, 0.5 kg of transportation loss, 0.6 kg of handling loss and 0.6 kg of storage loss. Similarly, in Rajasthan it could be observed that quantity of soybean lost was the highest in harvesting stage followed by threshing and storage.

Total post harvest loss of paddy was the highest in Assam followed by Tamil Nadu and Karnataka. The post harvest loss in Uttar Pradesh was 5.6 per cent and in West Bengal it was 3.5 per cent. In case of wheat, the post harvest loss was relatively high in Assam with 11.7 per cent followed by Madhya Pradesh (8.6 per cent) and West Bengal (7.2 per cent). For tur, the post harvest loss was relatively high in Karnataka. In case of soybean, the post harvest loss was the highest in Madhya Pradesh. Maharashtra and Madhya Pradesh registered the post harvest loss of 3.7 per cent and 3.4 per cent, respectively. It is clear from the analysis that the largest producing states have, by and large, recorded a higher level of post harvest loss.

5.3. POLICY SUGGESTIONS

1. Concerted efforts should be made to supply agricultural equipments including harvesters and threshing machines on custom hiring basis so that resource poor farmers can avail these services at the village level. Local bodies should be facilitated to own and hire out the machineries to the farmers.

2. There is lack of adequate scientific storage facilities at the village level. Construction of common godown should be encouraged among local farmers with active support from various agencies. The non-governmental organisations (NGOs) and grama panchayats should play an important role in this regard.

3. Infusion of new technologies, better practices, coordination and investment in rural infrastructure are critical for reducing losses. Research investment on crops such as tur has so far focused on the identification and development of resistant cultivars and on

chemical to control pests and diseases. Biotechnological tools offer greater scope for development of geographically suitable varieties.

4. Amount of pre and post harvest losses caused by biotic and abiotic factors is found to be substantial. In order to reduce these losses, scientific knowledge on cultivation practices and post harvest operations need to be imparted to the farmers. For this, advantages of information and communication technology (ICT) should be tapped to provide practical advice for control of insect pests, diseases and weeds.

5. Pests and diseases occur in a complex way affecting the crop yield performance. Evidence shows that adoption of integrated pest and disease management practices is promising for control of pests. Therefore, an integrated approach needs to be promoted for effective control of pests.

6. Rural infrastructure will play an important role in reducing avoidable post harvest losses. There is a need to step up not only the amount of public and private investment in building rural agricultural infrastructure, but also quality of such investments.

7. There is a need for rejuvenation of the government 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. There is a need for 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.

8. Sensible agronomic practices such as wet and dry system of irrigation, and profitable crop rotation should be encouraged to the farmers. This will reduce the build up of pest, diseases and weeds.

9. Reliable database on crop loss estimates helps to make proper planning for monitoring and controlling of pests in different crops. Therefore, it is necessary that all the available published estimates should be compiled and published regularly for use by different stakeholders.

REFERENCES

Dhaliwal, G.S. and Ramesh Arora (1994). *Trends in Agricultural Insect Pest Management,* Commonwealth Publishers, New Delhi.

Dhaliwal, G.S., Vikas Jindal and A. K. Dhawan (2010). "Insect Pest Problems and Crop Losses: Changing Trends", *Indian Journal of Ecology*, 37(1): 1-7.

FAO, Food and Agricultural Organisation (FAO), Research and development issues in grain postharvest problems in Asia; www.fao.org/wairdocs/x5002e/X5002e02.htm

Groote, Hugo De (2002). "Maize Yield Losses from Stemborers in Kenya", *Insect Science and its Application,* 22(2): 89-96.

IRRI (1990). *Crop Loss Assessment in Rice,* International Rice Research Institute (IRRI), Philippines.

Kranz, J (2005). "Interactions in Pest Complexes and Their Effects on Yield", *Journal of Plant Diseases and Protection,* 112(4): 366-385.

Muralidharan, K and I. C. Pasalu (2006). "Assessments of Crop Losses in Rice Ecosystems due to Stem Borer Damage (Lepidoptera: Pyralidae)", *Crop Protection,* 25: 409-417.

Muralidharan, K., D. Krishnaveni, N.V.L. Rajeswari and A. S. R. Prasad (2003). "Tungro Epidemics and Yield Losses in Paddy Fields in India", *Current Science,* 85(8): 1143-1147.

Nair, M. R. G. K. (1975). *Insects and Mites of Crops in India,* Indian Council of Agricultural Research, New Delhi.

Oerke, E C (2006). "Crop Losses to Pests", *Journal of Agricultural Science,* 144: 31-43.

Oerke, E C (2007). "Crop Losses to Animal Pests, Plant Pathogens, and Weeds", In: David Pimental (ed.), *Encyclopaedia of Pest Management,* 116-120, CRC Press, USA.

Rajarajeswari, N. V.L. and K. Muralidharan (2006). "Estimates of Farm Yield Yields and District Production Loss from Blast Epidemics", *Journal of Mycology and Plant Pathology,* 36(2): 115-124.

Rajarajeswari, N. V.L., C. Dinaker and K. Muralidharan (2004). "Assessing Injury to Grain Filling and Yield Losses from Tungro Virus Epidemics", *Indian Journal of Plant Protection,* 32(1): 73-79.

Reddy, K.V.S and Usha B. Zehr (2001). "Novel Strategies for Overcoming Pests and Diseases in India" In: *New Directions for a Diverse Planet,* proceedings of the 4th International Crop Science Congress, 26-1October 2004, Brisbane, Australia.

Rola, Agnes C and P L Pingali (1993). *Pesticides, Rice Productivity and Farmers' Health: An Economic Assessment*, International Rice Research Institute (IRRI), Philippines and World Resources Institute, USA.

Shukla, B.D. and R.T. Patil (1999). 'Overview of grain drying and storage problems in India' in World Bank Report, "Post-harvest Management, Fight Hunger with FAO, India Grains", March 2002, 4(3).

Walker, P T (1983). "Crop Losses: The Need to Quantify the Effects of Pests, Diseases and Weeds on Agricultural Production", *Agriculture, Ecosystems and Environment*, 9: 119-158.