Study No. 109

ASSESSMENT OF PRE AND POST HARVEST LOSSES OF WHEAT AND SOYBEAN IN MADHYA PRADESH

AGRO- ECONOMIC RESEARCH CENTRE FOR MADHYA PRADESH AND CHHATTISGARH
Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.)

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PREFACE

The present study entitled ***"Assessment of pre and post harvest losses of wheat and soybean in Madhya Pradesh"*** *has been assigned by the Directorate of Economics and Statistics Ministry of Agriculture Government of India to this centre under the close coordination of Agricultural Development and Rural Transformation, Bangalore.*

The study comprises of 160 wheat growers and 160 soybean growers of different agro climatic regions of M.P. The study revealed that that the majority of respondents had lack of technical knowhow of post harvest technology specially storage techniques. They never found to be followed sun drying, admixing with ash, smoking and other pest control measures in their storage structure. Even they were not found to be followed rat guard and removed infested grain from their storage grain. Hence, efforts should be made to popularize post harvest technology amongst the farmers so that they could able to take advantage of time place form and possession utility of the product and earn more by reducing the pre and post harvest losses occurred in their products.

The present study was conducted by Dr. H.O. Sharma, Dr. Deepak Rathi and Mr. S.C. Meena of this Centre. They have done field investigation, tabulation and analysis, and interpretation and drafting of the report. I wish to express my deep sense of gratitude to them and their team members namely; Mr. Shrikant Upadhye, Mr. C.K. Mishra, Mr. Arvind Dangi, Mr. Dushyant Kumar and Mr. Ravi Singh Chouhan for their untiring efforts in bringing this innovative study to its perfect shape.

I extend my heartfelt thanks to the Coordinator of this study Prof. Pramod Kumar, Head Agricultural Development and Rural Transformation, Institute for Social and Economic Change, Bangalore for provided necessary guidelines and time to time suggestions through e-mails for conducting the study.

On behalf of the Centre, I express my deep sense of gratitude to Dr. V.S. Tomar, Hon'ble Vice-Chancellor, Dr. S.S. Tomar, Director Research Services, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur for providing all facilities and help during various stages in successful completion of this study of high importance.

I express my sincere thanks to the Director, Department of Farmers Welfare and Agricultural Development, Bhopal Madhya Pradesh, Deputy Directors of the Districts viz. Hosangabad, Vidisha, Ujjain and Raisen, and their field staff for providing not only secondary data but also extending help in collection of field data from the selected respondents.

I hope the findings and suggestions made in the study would be useful to policy makers of the states and Govt. of India

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CHAPTER I

INTRODUCTION

Indian agriculture has undergone considerable transformations over time. The 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 fertilizers 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 this period. During 2000s, the nature of demand for agricultural commodities has changed for both the domestic and foreign requirements. The food consumption pattern have been shifted from cereals to high value commodities like fruits, vegetables and livestock products. Trade liberalization 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 specialized 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 crop productivity. The increased use of pesticides has also resulted in developing insects and disease resistance, which further led to reduction in crop yield.

The estimation of crop loss due to pests and diseases is a complex subject. It is in fact, difficult to assess the loss caused by the individual pest as a particular crop may be infested by the pest complex in the farmers' field conditions. Further, extent of crop loss either physical or financial depends on the type of variety, stage of crop growth, pest population and weather conditions. Nevertheless, the crop loss estimates have been made and updated regularly at global level. The worldwide yield loss due to various types of pest was estimated 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 him, the crop loss was estimated as 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 insect-pests in various crops has also been compiled and reported by Reddy and Zehr (2004). Further, a number of studies have established the strong relationship between pest infestation and yield loss in various crops in India (Nair, 1975; Dhaliwal and Arora, 1994; Muralidharan, 2003; Rajeswari *et al*, 2004; Muralidharan and Pasalu, 2006; Rajeswari and Muralidharan, 2006, Nag et.al. 2000, Solanki et al, 2011,).

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 this reason the estimated crop losses under these conditions may not represent the actual field conditions of farmers. Alternatively, the estimates collected directly from the farmers through sample survey may be reliable and could be used for extrapolation in similar geographical settings. However, the farmers' estimates are likely to be subjective and these should be validated with expert estimates of the state department of agriculture.

Production in agriculture is seasonal and exposed to natural environment, but post-production operations play an important role in providing stability in the food supply chain. According to a World Bank (1999) study post harvest losses of food grains 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 tones at present, the total losses worked out around 15-25 million tones. With the given per capita cereal consumption requirement in India, the above grains lost would be sufficient to feed more than 10 crore people. Losses in food crops occur during harvesting, threshing, drying, storage, transportation, processing and marketing. In the field and during storage, the products are threatened by insects, rodents, birds and other pests. Moreover, the product may be spoiled by infection from fungi, yeasts or bacteria. Food grain stocks

suffer qualitative and quantitative losses during the 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 Food and Agriculture Organization (FAO) study, about 70 percent of the farm produce is stored by farmers for their own consumption, seed, feed and other purposes. In India farmers store grain in bulk using different types of storage structures made from locally available materials. It is necessary to clean and dry the grain to increase its life and better storage. In addition, storage structure, design and its construction also play a vital role in reducing or increasing the losses during storage. With the scientifically constructed storage, it is also essential that the grain being stored should be of good quality. At the village, generally harvesting is done at high moisture content and therefore before storing the same, it is necessary to obtain the desired moisture to obtain safe post storage grain. There are small storage structures at the farmer level and bulk storage of food grains. 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 food grains in such storage structures, about half is due to rodents and rest half is due to insects and fungi. The storage at the farmer level includes: coal tar drum bin, domestic Hapur bin, Chittore stone bin, double walled polyethylene lined bamboo bin, Pusa bin and so on. The bulk storage of food grains is done mainly by traders, cooperatives and government agencies like Food Cooperation of India (FCI), Central Warehousing Cooperation (CWC), State Warehousing Cooperation (SWC) and grain marketing cooperatives. There are many kinds of storage systems followed depending on the length of storage and the product to be stored. Some examples are cover and plinth storage, community storage structures, rural go-downs and scientific warehouses.

1.2 Need of the Study

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

Keeping in view about this important subject, the present study has been undertaken with the following objectives:

1.3: Objectives of the Study

1. To estimate the physical and financial losses caused by pests and diseases in wheat 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 wheat and soybean under different agro climatic conditions of Madhya Pradesh.
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.

1.4 Status of Agricultural economy in Madhya Pradesh

Madhya Pradesh, in its present form, came into existence on November 1, 2000 following its bifurcation to create a new state of Chhattisgarh. The undivided Madhya Pradesh was founded on November 1, 1956. Madhya Pradesh, because of its central location in India has remained a crucible of historical currents from North, South, East and West.

Madhya Pradesh is situated in the heart of India between latitudes 21^0 -53' to 22^0 53' North and longitude 77^0 47' to 78 ^{0} 44' East. It is the second largest state after Rajasthan of Indian Union with a total geographical area of 307.56 thousand square Kilometers. In terms of population (72,597,565) it occupies 7^{th} position in India (2011). It has 10 -commissionaire divisions (Chambal, Gwalior, Bhopal, Ujjain, Indore, Sagar, Rewa, Jabalpur, Hosangabad and Shahdol) divided into 50 districts, 342 Tehsil, 313 blocks & 376 towns and 54,903 villages. (Table 1.1)

It is abundantly rich in minerals and bio resources with 27 per cent of land area under forests; it supports a wide variety of animal and plant life. The state has a rich history, culture and crafts.

Table 1.1: Location of Madhya Pradesh

S. No.	Particulars	
1	Number of Division	10
2	Number of Tehsil	342
3	Number of Blocks	313
4	Number of Villages	54,903
5	Latitude	21° 53 to22° 59N
6	Longitude	76°47 to 78°44 E
7	Height from see means level (m)	50-1200
8	No of districts	50
9	No. of Gram Panchayat	23,012
10	No. of electrified Villages	35910
11	Percentage of electrified villages to total Villages	65.41

The Physiography of the state exhibits a great deal of diversity with areas ranging from less than 50 meter above mean sea level to more than 1200 meter. The state falls under the catchments of Yamuna, Ganga, Narmada, Mahanadi and Godavari rivers. On the basis of broad land features and different soil and rain fall pattern, the state could be classified in 5 physiographic regions and 11 agro-climatic zones (Table 1.2)

1. Northern low lying plains comprising Gwalior, Bhind and Morena districts and extend to Bundelkhand up to the West of Panna range and excludes certain parts of Rewa district between Panna and Kaymore hills of Baghelkhand.

2. The Malwa and Vindhyan Plateau comprises of Vidisha, Shivpuri, Datia, Guna, Ujjain and Mandsour districts and parts of Sehore, Raisen and Dewas districts. It consists of large undulating plains of black cotton soil dotted with flat-topped hills. It has also hilly Vindhyan Plateau situated in the north of Narmada Valley and to the south of the low-lying regions of Bundelkhand and Baghelkhand. It spared from east of Malwa plateau to Maikal and Dorea hills Satpura range.

3. The Narmada Valley stretching from Jabalpur in the east up to Barwani district in the West. It is nearly 560 Km long and 48 Km wide and is walled on the north by the Vindhya Range and on the south by Satpura range. It covers the districts of Jabalpur, Narsinghpur, Hosangabad, Khandwa, Khargone, Barwani, Dhar, and some parts of Raisen, Sehore, and Dewas districts.

Fig. 1.1: Agro-Climatic Zones of Madhya Pradesh

4. The Satpura range runs from West to East for about 640 Km through Khandwa, Betul, Chhindwara, Seoni, Mandla, Bilaspur and Sarguja districts. Its northern spurs go into Hosangabad and Narsinghpur districts and in the south an extensive spur of 160 Km covers entire Balaghat districts.

Table-1.2: Agro-Climatic Regions and covered Districts /Tehsils in Madhya Pradesh

(Area in Lakh ha)

Agro-Climatic Regions	Districts /Tehsils	Geographical Area	Percent to Geographical Area
1. Malwa Plateau	Indore, Dhar, (Dhar, Badnawar, Sardarpur tehsils) Shajapur, Mandsour, Neemuch, Ratlam, Ujjain, Dewas Rajgarh districts and Petlawad tehsil of Jhabua district	51.47	16.74
2.Vindhyan Plateau	Bhopal, Vidisha, Sehore (Sehore, Ashta, Ichhawar, Narsullaganj tehsils) Raisen (Raisen, Gairatganj, Begamganj, Silwani, Goharganj, Udaipura tehsils), Damoh, Guna (Chachora & Raghogarh tehsils) & Sagar districts	42.59	13.85
3.Central Narmada Valley	Hoshangabad (Seoni-Malwa, Hoshangabad, Sohagpur tehsils), Harda, Nasinghpur districts, Budhani and Barelli tehsil of Sehore and Raisen districts respectively	17.45	5.67
4.Satpura Plateau	Betul, Chhindwara districts	21.93	7.13
5.Jhabua Hills	Jhabua, Jobat, Alirajpur tehsils of Jhabua district & kukshi tehsil of Dhar district	6.88	2.24
6.Gird Region	Gwalior, Bhind, Morena, Shivpur-Kalan, Guna (Mungawali and Ashoknagar tehsils), Shivpuri (Shivpuri, Kalaras, Pohari tehsils)	31.85	10.36
7. Kymore Plateau	Jabalpur, Katni, Rewa, Panna, Satana, Sidhi, Seoni and Gopadbanas & Deosar tehsils of Sidhi district.	49.97	16.25
8.Bundel Khand Region	Tikamgarh, Chhatarpur, Datia districts, Karela, Pachore tehsil of Shivpuri and Guna tehsil of Guna district	22.82	7.42
9.Nimar Valley	Khandwa, Khargone, Barwani district, Manawar tehsil of Dhar district and Harda district	25.17	8.18
10.Northern Hills of Chhattisgarh	Shahdol, Umariya Mandla, Dindori district & Singrauli tehsil of Sidhi district	28.17	9.16
11.Chhattisgarh plain	Balaghat district	9.25	3.00
Madhya Pradesh		**307.56**	**100.00**

5. Madhya Pradesh also covers Balaghat and Shahdol districts of Chhattisgarh Plains and Northern Hills of Chhattisgarh zone respectively. The state is bordered on the West by Gujarat, on the North-West by Rajasthan, on the North-East by Uttar Pradesh, on the East by Chhattisgarh, and on the South by Maharashtra.

The main soil types found in Madhya Pradesh are alluvial, deep black, medium black, shallow black, mixed red and black, mixed red and yellow and skeletal soils (Table 1.3).

Table 1.3: Soil types and districts covered in Madhya Pradesh.

Types of Soil	Districts covered
Alluvial Soil	Bhind, Morena and Gwalior
Deep Black Soil	Hosangabad and Narsinghpur
Medium Black Soil	Jabalpur, Sagar, Vidisha, Sehore, Damoh, Guna, Bhopal, Raisen, Rajgarh, Indore, Dewas, Ujjain, Mandsour, Shajapur, Ratlam, Dhar, Khargone and Khandwa
Shallow Black Soil	Betul, Chhindwara and Seoni
Red & Black Soil	Shivpuri, Rewa, Satna, Panna, Sidhi, Chattarpur, Tikamgarh, Datia and some parts of Guna district.
Red & Yellow Soil	Balaghat.
Gravelly Soil	Mandla.

The climate of Madhya Pradesh by virtue of its location is predominately moist sub humid to dry sub humid, semi arid to dry sub-humid and semi arid in East, West and Central plateau and hills respectively, according to agro-climatic regions of India. The seasons in Madhya Pradesh are as given below (Table 1.4).

Table 1.4: Seasons and their periods in Madhya Pradesh

Seasons	Period	
	From	To
Rainy	June	September
Post Monsoon	October	November
Winter	December	February
Summer	March	May

The annual rainfall received in the state varies from 800 mm. in the Northern and Western regions to 1600 mm in the Eastern districts. In some years rainfall goes much below to the normal. The most of rainfall is received in the *Monsoon* season from June to September and about 10 per cent of the rainfall is received in the remaining months of the year.

The maximum temperature during extreme summer reaches as high as 47^0C and the minimum during winter dips up to 5^0C. The maximum normal

temperature varies between 25^0 to 35^0C and minimum normal between 10^0 to 20^0C.The relative humidity ranges from 40 to 70 per cent throughout the year.

According to 2011 census the population of the state was 72,598 thousands comprises of 51.81 per cent of male and 48.19 per cent female. Over 1000 males there were only 930 female. The state had a rural background as the 72.40 per cent of total population lives in villages and rest 27.60 per cent in urban areas (Table 1.5).

Table 1.5: Population parameters of Madhya Pradesh (Census 2011)

(In Thousand)

S. No.	Particulars	Population	Percentage to total
1	Total Population	72,598	100
A	Male	37,613	51.81
B	Female	34,985	48.19
2	Sex ratio over1000 males	930	
3	Rural Population	52,538	72.4
4	Urban Population	20,060	27.6
5	Population of Schedule Caste*	91551	15.17
6	Population of Schedule Tribes*	12233	20.27
7	Number of Literate persons	43,827	60.37
8	Number of Farmers	11038	18.32
9	Agriculture Labour	7401	12.23
10	Home Industry	1033	1.67
11	Other Workers	6322	10.45
12	Total Main Workers	19103	31.61
13	Marginal Workers	6691	11.07
14	Total Workers	25794	42.68
15	Non Workers	34554	57.16

* Census 2001

The percentage of literacy was found only 60.37 per cent, Madhya Pradesh comes under tribal area 20.27 per cent of total population were belongs to scheduled tribes. The percentage of workers was observed to be 42.68 per cent of total population, while 57.16 per cent of total population belongs to non worker category. 31.61 per cent population classified under main worker category, while 18.32 and 12.23 per cent were farmers and agricultural laboures respectively.

Table 1.6: Land use Classification of Madhya Pradesh

Particulars	2000-01	**%to Geographical area**	2009-10	**%to Geographical area**	Absolute Change	Relative Change
Geographical area	307.50	100.00	307.56	100.00	0.06	0.02
Forests	86.11	28.00	86.89	27.92	0.78	0.91
Not available for cultivation						
A. Land put to non-agricultural uses.	18.35	5.97	20.70	6.73	2.35	12.81
B. Barren and un Culturable land	13.65	4.44	13.62	4.36	-0.03	-0.22
Total	32.00	10.41	34.32	11.09	2.32	7.25
Other Uncultivated land excluding fallow land						
A. Permanent pastures & other grazing lands	16.57	5.39	13.38	4.34	-3.19	-19.25
B. Land under misc. tree crops & groves.	0.15	0.05	0.24	0.06	0.09	60.00
TOTAL	16.72	5.44	13.62	4.40	-3.10	-18.54
Total Culturable waste land.	28.42	9.24	11.47	3.77	-16.95	-59.64
Fallow Land						
A. Current fallows.	4.86	1.58	5.47	1.89	0.61	12.55
B. Old fallow.	5.75	1.87	6.08	2.02	0.33	5.74
Total	10.61	3.45	11.55	3.91	0.94	8.86
Cropped Area						
A. Net area sown.	150.70	49.01	149.72	48.91	-0.98	-0.65
B. Area sown more than once.	53.49	17.40	64.39	18.58	10.90	20.38
C. Gross Cropped Area.	204.19	66.40	214.11	67.50	9.92	4.86
Cropping Intensity in %	122.00		143.00		21.00	

The total geographical area of the State is 307.56 lakh ha (2009-10) out of which 48.91 per cent land was found to be under cultivation (Table 1.6) and 11.09 per cent land not available for cultivation, 3.77 and 3.91 per cent of total land was classified under cultivable waste and fallow land respectively. The cropping intensity of the state was found to be 143.00 per cent (2008-09), which was found to be increased by 21 percent as compared to 2000-01. The area sown more than once, land put to non agricultural uses, total fallow land and gross cropped area hive been found to be increased by 20.38, 12.81, 8.86 and 4.86 per cent respectively during the period 2009-10 over the year 2000-01, while total Culturable land and permanent pasture have been found to be decreased by 59.64 and 19.25 per cent respectively during this period.

Wells (39.93%), tube wells (25.51%), canals (18.31%) and tanks (2.36%) are the major sources of irrigation in M.P. The state had 5,681 thousand hectare area under irrigation. (Table 1.7)

Table 1.7: Irrigation Status of Madhya Pradesh

S. No.	Sources	Net Irrigated Area	Percentage to total	Gross Irrigated Area	Percentage to total
1	Canal	1030	18.13	1076	18.31
2	Tanks	134	2.36	138	2.35
3	Tube-well	1449	25.51	1494	25.42
4	Well	2246	39.54	2347	39.93
5	Others	822	14.46	823	14.00
6	Total	5681	100.00	5878	100.00

Table 1.8: Change in Cropping Pattern of M.P. (000'ha)

Crops	1999-2000	2009-10	Absolute Change	Relative Change
Paddy	1740.00	1584.00	-156.00	-8.97
Jowar	674.00	428.00	-246.00	-36.50
Maize	139.00	849.00	710.00	510.79
Bajara	801.00	202.00	-599.00	-74.78
Kodo Kutki	458.00	248.00	-210.00	-45.85
Other Cereals	72.00	23.00	-49.00	-68.06
Kharif Cereals	3884.00	3334.00	-550.00	-14.16
Wheat	4669.00	4645.00	-24.00	-0.51
Barlay	85.00	77.00	-8.00	-9.41
Other Cereals	9.00	5.00	-4.00	-44.44
Total Rabi Cereals	4763.00	4727.00	-36.00	-0.76
Total Cereals	8647.00	8061.00	-586.00	-6.78
Tur	311.00	642.00	331.00	106.43
Urid	426.00	557.00	131.00	30.75
Moong	90.00	85.00	-5.00	-5.56
Kulthi	41.00	20.00	-21.00	-51.22
Other Pulses Kharif	4.00	4.00	0.00	0.00
Total Pulses Kharif	872.00	1308.00	436.00	50.00
Gram	2575.00	2888.00	313.00	12.16
Pea	196.00	248.00	52.00	26.53
Lentil	507.00	699.00	192.00	37.87
Teora	63.00	53.00	-10.00	-15.87
Other Pulses Rabi	13.00	13.00	0.00	0.00
Total Pulses Rabi	3354.00	3901.00	547.00	16.31
TOTAL Pulses	4226.00	5209.00	983.00	23.26
Total Food grain kharif	4756.00	4642.00	-114.00	-2.40
Total food grain Rabi	8117.00	8628.00	511.00	6.30
Total food grain	12873.00	13270.00	397.00	3.08
Groundnut	224.00	204.00	-20.00	-8.93
Soybean	4440.00	5552.00	1112.00	25.05
Sesame	137.00	361.00	224.00	163.50
Niger	121.00	92.00	-29.00	-23.97
Other oilseed	4.00	0.00	-4.00	-100.00
Total Kharif oilseeds	4926.00	4926.00	0.00	0.00
Rape seed & Mustard	626.00	727.00	101.00	16.13
Linseed	231.00	95.00	-136.00	-58.87
Sun flower & others	7.00	1.00	-6.00	-85.71
Total Rabi oilseeds	864.00	823.00	-41.00	-4.75
Total oilseeds	5790.00	5749.00	-41.00	-0.71
Cotton	488.00	593.00	105.00	21.52
Sugarcane (G)	43.00	48.00	5.00	11.63
Total Kharif	10170.00	11445.00	1275.00	12.54
Total Rabi	9024.00	9499.00	475.00	5.26
Gross Cropped Area	19194.00	20944.00	1750.00	9.12

The change in cropping pattern of Madhya Pradesh is presented in table 1.8. It is observed from the data that gross cropped area of Madhya Pradesh has been found to be increased by 9.12 per cent in the year 2009 – 10 (20944 thousand ha) over the year 1999 – 2000 (19194 thousand ha). The area under total kharif crops (12.16%) was increased more as compared to Rabi crops (5.26%). The area under total pulses found to be increased by 23.26 per cent, while the area under cereal and oilseeds decreased by -6.78 per cent and -0.71 per cent during the period under study. Crop wise analysis show that the highest area was found to be increased in maize (510.79%) followed by sesame (163.50%), tur (106.43%), lentil (37.87%), pea (26.53%), soybean (25.05%), cotton (21.52%), rapeseed and mustard (16.13%), gram (12.16%) and sugarcane (11.63%). The area under paddy (-8.97%), jowar (- 36.50%), bajra (-74.87%), kodon – kutki (-45.85%), moong (-5.50%), kulthi (-51.22%), Niger (-23.97%), linseed (-58.67%) and sunflower (-85.71%) were found to be decreased during the period.

Change in Production

The total production of crops in Madhya Pradesh was found to be increased by 14.33 per cent in the year 2009 – 10 (25399 thousand t) over the year 1999 – 2000 (22215 thousand t).

The total production of Kharif crops (30.71%) showed higher relative change as compared to total Rabi crops (2.04%). The production of cereal (7.00%) and oilseeds (41.57%) found to be increased, while the production of pulses decreased by 11.61 per cent. As regards to production of major crops the production of paddy (1.37%), jowar (13.23%), maize (5.51%), bajra (178.42%), wheat (6.22%), urad (60.90%), moong (6.90%), groundnut (37.39%), soybean (42.885), sesame (474.19%), rapeseed & mustard (31.04%), cotton (140.28%) and sugarcane (3.16%) found to be increased, while the production of kodo – kutki (-35.94%), barley (-1.98%), tur (-24.07%), kulthi (-12.05%), gram (-10.615), pea (-33.00%), lentil (-26.28%), teora (-57.14%), niger (-22.22%), linseed (-64.57%), and sunflower (-100.00%) found to be decreased during the period.

Table 1.9: Change in Production of M.P.

(000't)

Crops	1750.00	**2009-10**	**Absolute Change**	**Relative Change**
Paddy	529.00	1774.00	24.00	1.37
Jowar	1270.00	599.00	70.00	13.23
Maize	139.00	1340.00	70.00	5.51
Bajara	128.00	387.00	248.00	178.42
Kodo Kutki	26.00	82.00	-46.00	-35.94
Other Cereals	3842.00	9.00	-17.00	-65.38
Kharif Cereals	8687.00	4191.00	349.00	9.08
Wheat	101.00	9227.00	540.00	6.22
Barley	7.00	99.00	-2.00	-1.98
Other Cereals	8795.00	5.00	-2.00	-28.57
Total Rabi Cereals	12637.00	9331.00	536.00	6.09
Total Cereals	270.00	13522.00	885.00	7.00
Tur	133.00	205.00	-65.00	-24.07
Urid	29.00	214.00	81.00	60.90
Moong	8.00	31.00	2.00	6.90
Kulthi	2.00	7.00	-1.00	-12.50
Other Pulses Kharif	442.00	2.00	0.00	0.00
Total Pulses Kharif	2536.00	459.00	17.00	3.85
Gram	100.00	2266.00	-270.00	-10.65
Pea	274.00	67.00	-33.00	-33.00
Lentil	70.00	202.00	-72.00	-26.28
Teora	5.00	30.00	-40.00	-57.14
Other Pulses Rabi	2985.00	5.00	0.00	0.00
Total Pulses Rabi	3427.00	2570.00	-415.00	-13.90
TOTAL Pulses	4284.00	3029.00	-398.00	-11.61
Total Food grain kharif	11780.00	4650.00	366.00	8.54
Total food grain Rabi	16064.00	11901.00	121.00	1.03
Total food grain	222.00	16551.00	487.00	3.03
Groundnut	4743.00	305.00	83.00	37.39
Soybean	31.00	6777.00	2034.00	42.88
Sesame	27.00	178.00	147.00	474.19
Niger	2.00	21.00	-6.00	-22.22
Other oilseed	5025.00	0.00	-2.00	-100.00
Total Kharif oilseeds	625.00	7281.00	2256.00	44.90
Rape seed & Mustard	93.00	819.00	194.00	31.04
Linseed	2.00	33.00	-60.00	-64.52
Sun flower & others	720.00	0.00	-2.00	-100.00
Total Rabi oilseeds	5745.00	852.00	132.00	18.33
Total oilseeds	216.00	8133.00	2388.00	41.57
Cotton	190.00	519.00	303.00	140.28
Sugarcane (G)	9525.00	196.00	6.00	3.16
Total Kharif	12690.00	12450.00	2925.00	30.71
Total Rabi	22215.00	12949.00	259.00	2.04
Gross Cropped Area				

Change in yields

The productivity of all the crops has been found to be increased except paddy (-8.50%), maize (-13.68%), kodo kutki (-2.50%), tur (-8.62%), gram (-0.51%), pea (-4.48%), lentil (-7.61%) and toria (-31.92%) in the year 2009-10 as compared to 1999-

2000. The maximum increase in productivity of crops was noticed in sesame (80.87%) followed by kulthi (62.81%), cotton (59.28%), sunflower (54.20%), bajra (37.50%), urid (21.47%), barley (12.58%), moong (3.11%), linseed (2.99%) and sugarcane (1.28%) during the period under study.

Table 1.10: Change in yield of Madhya Pradesh. (kg/ha)

Crops	1999-2000	2009-10	Absolute Change	Relative Change
Paddy	1059.00	969.00	-90.00	-8.50
Jowar	784.00	1203.00	419.00	53.44
Maize	1586.00	1369.00	-217.00	-13.68
Bajara	1008.00	1386.00	378.00	37.50
Kodo Kutki	279.00	272.00	-7.00	-2.51
Wheat	1938.00	1895.00	-43.00	-2.22
Barley	1192.00	1342.00	150.00	12.58
Tur	870.00	795.00	-75.00	-8.62
Urid	312.00	379.00	67.00	21.47
Moong	322.00	332.00	10.00	3.11
Kulthi	193.00	313.00	120.00	62.18
Gram	985.00	980.00	-5.00	-0.51
Pea	513.00	490.00	-23.00	-4.48
Lentil	539.00	498.00	-41.00	-7.61
Teora	1106.00	753.00	-353.00	-31.92
Groundnut	992.00	1162.00	170.00	17.14
Soybean	1068.00	1120.00	52.00	4.87
Sesame	230.00	416.00	186.00	80.87
Niger	225.00	229.00	4.00	1.78
Other oilseed	333.00	355.00	22.00	6.61
Rape seed & Mustard	998.00	1056.00	58.00	5.81
Linseed	402.00	414.00	12.00	2.99
Sun flower & others	286.00	441.00	155.00	54.20
Cotton	442.00	704.00	262.00	59.28
Sugarcane (G)	4378.00	4434.00	56.00	1.28

Horticulture

The area of all the horticultural crops i. e. fruits (96.76%), vegetable (12.00%) and flowers (125.15%) except spices (-1.95%) has been found to be increased in the year 2009-10 as compared to 1999-2000. The production of all the horticulture crops i. e. fruits (81.38%), vegetable (30.89%), flowers (200.00%) and spices (28.48%) has also found to be increased in the year 2009-10 as compared to 1999-2000. The productivity of all the horticultural crops i. e. vegetable (16.87%), flowers (33.25%) and spices (31.04%) except fruits (-7.82%) has been found to be increased in the year 2009-10 as compared to 1999-2000.

Table 1.11: Change in Area, Production and Yield of Horticultural crops in Madhya Pradesh

Particulars		1999-2000	2009-10	Absolute Change	Relative Change
Fruits	Area (000'ha)	57.48	113.10	55.62	96.76
	Production (000'tonns)	1579.00	2864.00	1285.00	81.38
	Yield (qnt./ha)	27.47	25.32	-2.15	-7.82
Vegetables	Area (000'ha)	223.84	250.70	26.86	12.00
	Production (000'tonns)	2378.00	3112.60	734.60	30.89
	Yield (qnt./ha)	10.62	12.42	1.79	16.87
Flowers	Area (000'ha)	3.42	7.70	4.28	125.15
	Production (000'tonns)	2.00	6.00	4.00	200.00
	Yield (qnt./ha)	0.58	0.78	0.19	33.25
Spices	Area (000'ha)	293.23	287.50	-5.73	-1.95
	Production (000'tonns)	322.00	413.70	91.70	28.48
	Yield (qnt./ha)	1.10	1.44	0.34	31.04

Land Holding

The total number and area of land holding has been found to be increased by 73.59 thousand to 88.73 thousand and from 163.69 thousand ha to 158.36 thousand ha respectively in the year 2009-10 as compared to 1999-2000. The percentage number of marginal and small holdings have been found to be increased from 38.57 percent (1999-2000) to 38.91 percent (2009-10) and 26.51(1999-2000) to 27.60 percent (2009-10),while in case of semi medium, medium and large holdings the number were decreased from 20.22 (1999-2000) to 18.65 percent (2009-10), 12.45 (1999-2000) to 8.89 percent (2009-10) and 2.26 (1999-2000) to 1.00 percent (2009-10), while the percentage area under marginal, small and semi medium holdings has been found to be increased from 8.54 (1999-2000) to 12.09 percent (2009-10), 17.28 (1999-2000) to 21.89 percent (2009-10) and 25.18 (1999-2000) to 28.48 percent (2009-10). The percentage area under medium and large size of holding has been found to be decreased from 33.28 percent (1999-2000) to 28.70 percent (2009-10) and 15.73 percent (1999-2000) to 8.84 percent (2009-10) respectively.

Table 1.12: Change in land holding in Madhya Pradesh

Particulars	1999-2000				2010-11			
Category	Number	%	Area	%	Number	%	Area	%
Marginal (Below 1 ha.)	28.38	38.57	13.98	8.54	38.91	43.85	19.15	12.09
Small (1 ha. to 2 ha.)	19.51	26.51	28.28	17.28	24.49	27.60	34.66	21.89
Semi Medium (2 ha. to 4 ha.)	14.88	20.22	41.21	25.18	16.55	18.65	45.10	28.48
Medium (4 ha. to 10 ha.)	9.16	12.45	54.47	33.28	7.89	8.89	45.45	28.70
Large (Above 10 ha.)	1.66	2.26	25.75	15.73	0.89	1.00	14.00	8.84
TOTAL	73.59	100.00	163.69	100.00	88.73	100.00	158.36	100.00

The net and gross irrigated area has found to be increased by 14.93 percent and 15.20 percent in the year 2009-10 as compared to 1999-2000. The area irrigated by cannel

(6.39%), well and tube wells (17.70%) and other sources (15.46%) has been found to be increased except tanks (-1.52%).

Table 1.13: Change in Source wise irrigated area in Madhya Pradesh (000, ha)

Year	1999-00	2009-10	Absolute Change	Relative Change
Canals	1002	1066	64.00	6.39
Tanks	132	130	-2.00	-1.52
Wells & tube-wells.	3712	4369	657.00	17.70
Other sources	815	941	126.00	15.46
Net irrigated area	5661	6506	845.00	14.93
Gross irrigated area.	5828	6714	886.00	15.20
% of net irrigated area to net area sown	37.6	43.2	5.60	
% of gross irrigated area to gross area sown	28.5	32.3	3.80	

As regards to changes occurred in crop wise irrigated area, the irrigated area under all the crops, viz. paddy (24.18%), maize (36.36%), barley (4.38%), gram (56.64%), oilseeds (34.16%), sugarcane (5.26%), cotton (29.90%), spices and condiments (8.55%) and vegetable (16.13%) increased in the year 2009-10 as compared to 1999-2000 except wheat (-1.38%)

Table 1.14: Change in Crop wise Irrigated area in Madhya Pradesh (000, ha)

CROPS	99-00	2008-09	Absolute Change	Relative Change
Paddy	244	303	59.00	24.18
Maize	11	15	4.00	36.36
Wheat	3399	3352	-47.00	-1.38
Barley	29	41	12.00	41.38
Total Cereals	3684	3711	27.00	0.73
Gram	941	1474	533.00	56.64
Others	138	241	103.00	74.64
Total Pulses	1079	1715	636.00	58.94
Oilseeds	322	432	110.00	34.16
Sugarcane	76	80	4.00	5.26
Cotton	194	252	58.00	29.90
Spices & Condiments	234	254	20.00	8.55
Fruits & Vegetables	186	216	30.00	16.13
Other Crops	39	54	15.00	38.46
ALL CROPS	**5814**	**6714**	900.00	15.48

In Madhya Pradesh economic activities shown structural changes over a period of time and primary sector is experiencing a decline in terms of share in Gross State Domestic Products (GSDP). The sectoral distribution of GSDP of Madhya Pradesh state at constant rate and current rate (2004-05) along with percentage distribution presented in tables 1.15 to 1.16. The data presented in table 1.15 showed that GSDP of Madhya Pradesh at constant rate (2004-05) has been increased from Rs. 11292689 lac in 2004-05 to Rs. 13598571 lac in 2007-08. Overall economy of Madhya Pradesh was found to be increased by 5.31 per

cent, 9.23 per cent and 4.69 per cent in the year 2005-06, 2006-07 and 2007-08 respectively over their previous year. The primary (-1.49) sector show negative per cent change, while secondary sector and tertiary sector increased with 5.93 and 7.52 per cent in the year 2007-08 as compared to 2006 -07. The primary, secondary and tertiary sector contributed 24.79 per cent, 29.18 per cent and 46.02 per cent (Table 1.16) respectively in GSDP of Madhya Pradesh (2007-08).

Table1.15: Gross State Domestic Products of Madhya Pradesh at constant price (2004 - 05)

Rs. Lac

Particulars	2004 - 05	2005 – 06	2006 – 07	2007 - 08	Percentage change over previous year		
					2005 - 06	2006 - 07	2007 – 08
Agriculture (including animal husbandry)	2753979	2973694	3055971	3001998	7.98	2.77	-1.77
Forestry & logging	342010	342784	336789	341840	0.23	-1.75	1.50
Fishing	27841	27399	29628	27626	-1.59	8.14	-6.76
Primary Sector	**3123830**	**3343877**	**3422388**	**3371464**	**7.04**	**2.35**	**-1.49**
Mining & quarrying	544934	549690	598917	665800	0.87	8.96	11.17
Manufacturing – Registering	760612	831841	1166644	1201646	9.36	40.25	3.00
Manufacturing - Un Registering	495117	513766	559692	603009	3.77	8.94	7.74
Construction	932423	1013164	1015929	1222070	8.66	0.27	20.29
Electricity, gas & water supply	332722	301425	405049	276044	-9.41	34.38	-31.85
Secondary Sector	**3065808**	**3209886**	**3746231**	**3968569**	**4.70**	**16.71**	**5.93**
Railways	198495	199365	246656	243531	0.44	23.72	-1.27
Transport by other means & Storage	332432	359100	388945	422881	8.02	8.31	8.73
Communication	132886	158537	189582	222562	19.30	19.58	17.40
Trade, hotels and restaurants	1534159	1565089	1765516	1904838	2.02	12.81	7.89
Banking & Insurance	410720	485558	581573	655046	18.22	19.77	12.63
Real estate, ownership of dwellings and business services	923724	978980	1038278	1103997	5.98	6.06	6.33
Public administration	554567	558118	535024	558514	0.64	-4.14	4.39
Other services	1016068	1033436	1075419	1147169	1.71	4.06	6.67
Tertiary Sector	**5103051**	**5338183**	**5820993**	**6258538**	**4.61**	**9.04**	**7.52**
Total	**11292689**	**11891946**	**12989612**	**13598571**	5.31	9.23	4.69

The share of primary sector in GSDP has been found to be decreased from 27.66 per cent (2004-05) to 24.79 per cent (2007-08), while the share of secondary sector and tertiary sector increased from 27.15 per cent (2004-05) to

29.18 per cent (2007-08) and 45.19 per cent (2004-05) to 46.02 per cent (2007-08) respectively. The share of agriculture sector has also been found to be decreased from 24.39 per cent (2004-05) to 22.08 per cent in GSDP of Madhya Pradesh.

Table1.16: Percentage contribution of different sectors in Gross State Domestic Products at Constant Rate (2004-05)

Particulars	**2004 – 05**	**2005 – 06**	**2006 - 07**	**2007 - 08**
Agriculture (including animal husbandry)	24.39	25.01	23.53	22.08
Forestry & logging	3.03	2.88	2.59	2.51
Fishing	0.25	0.23	0.23	0.20
Primary Sector	**27.66**	**28.12**	**26.35**	**24.79**
Mining & quarrying	4.83	4.62	4.61	4.90
Manufacturing – Registering	6.74	6.99	8.98	8.84
Manufacturing - Un Registering	4.38	4.32	4.31	4.43
Construction	8.26	8.52	7.82	8.99
Electricity, gas & water supply	2.95	2.53	3.12	2.03
Secondary Sector	**27.15**	**26.99**	**28.84**	**29.18**
Railways	1.76	1.68	1.90	1.79
Transport by other means & Storage	2.94	3.02	2.99	3.11
Communication	1.18	1.33	1.46	1.64
Trade, hotels and restaurants	13.59	13.16	13.59	14.01
Banking & Insurance	3.64	4.08	4.48	4.82
Real estate, ownership of dwellings and business services	8.18	8.23	7.99	8.12
Public administration	4.91	4.69	4.12	4.11
Other services	9.00	8.69	8.28	8.44
Tertiary Sector	**45.19**	**44.89**	**44.81**	**46.02**
Total	100.00	100.00	100.00	100.00

The contribution of agriculture, forestry, fishing, electricity, public administration, other services and real estate to GSDP has been found to be decreased, while mining and quarrying, manufacturing, construction, railways, transportation, communication, trade, hotel, restaurant, banking and insurance increased in the year 2007-08 over the year 2004-05.

1.5 Importance of selected crops in Madhya Pradesh

Wheat and Soybean crops have been considered for depth analysis of pre and post harvest losses in Madhya Pradesh as these crops have a remarkable position in the India's production basket.

1.5.1 Wheat

Wheat is an important cereal crop of Madhya Pradesh contributing 14.54 percent (4134 thousand ha) and 9.08 percent (7519.68 thousand t) of total area (28426.1 thousand ha) and total production (82785.64 thousand t) of India.

Madhya Pradesh ranked second after Uttar Pradesh as regards to the area and production of Wheat but, the average productivity of the crop in M.P. (1815.61 kg/ha) approximately half to the average yield of the country (2911.72 ka/ha) (Table 1.17).

Table 1.17: Present status of wheat in India (Average TE- 2010)

(Area, 000 ha; Prod. 000 ton; Yield kg/ha)

States	Area	Percentage to total	Production	Percentage To Total	Yield	Difference to India
Uttar Pradesh	9606.0	33.79	28691.00	34.66	2986.99	75.27
Madhya Pradesh	4134.0	14.54	7519.68	9.08	1815.61	-1096.11
Punjab	3519.3	12.38	15791.33	19.07	4487.26	1575.55
Haryana	2489.7	8.76	10979.40	13.26	4409.24	1497.53
Rajasthan	2389.4	8.41	7334.12	8.86	3072.79	161.08
Bihar	2151.7	7.57	4359.47	5.27	2025.08	-886.64
Maharashtra	1136.7	4.00	1852.33	2.24	1617.84	-1293.88
Gujarat	1081.0	3.80	2988.16	3.61	2736.85	-174.87
Uttarakhand	390.7	1.37	840.02	1.01	2152.43	-759.29
Himachal Pradesh	356.6	1.25	473.62	0.57	1326.03	-1585.69
West Bengal	313.2	1.10	828.52	1.00	2643.48	-268.24
Jammu & Kashmir	286.1	1.01	406.59	0.49	1424.53	-1487.19
Karnataka	269.0	0.95	259.00	0.31	966.42	-1945.30
Chhattisgarh	104.0	0.37	113.73	0.14	1090.45	-1821.27
Jharkhand	98.7	0.35	161.84	0.20	1640.32	-1271.40
Assam	51.1	0.18	56.97	0.07	1118.57	-1793.14
Delhi	21.3	0.08	92.71	0.11	4347.51	1435.79
Andhra Pradesh	11.3	0.04	13.00	0.02	1147.62	-1764.10
Sikkim	4.6	0.02	5.47	0.01	1167.36	-1744.36
Orissa	4.1	0.01	5.79	0.01	1434.76	-1476.96
Arunachal Pradesh	3.4	0.01	5.29	0.01	1558.36	-1353.36
Nagaland	2.2	0.01	3.28	0.00	1470.51	-1441.21
Manipur	0.7	0.00	1.75	0.00	0	-2911.72
Tripura	0.5	0.00	1.05	0.00	2002.97	-908.75
D & N Haveli	0.5	0.00	0.79	0.00	1854.70	-1057.02
Meghalaya	0.4	0.00	0.71	0.00	1771.40	-1140.32
Tamil Nadu	0.0	0.00	0.01	0.00	0	-2911.72
All India	**28426.1**	**100.00**	**82785.64**	**100.00**	**2911.72**	

The area production and productivity of wheat was recorded highest in Hoshangabad district among all the districts of the state. It accounts for 5.32 per cent of area and 8.76 per cent of production of wheat in the state with an average productivity of 3123.3 Kg/ha. The other important districts in terms of acreage were Vidisha (4.38 %), Raisen (4.15 %), Dhar (4.10%), Sehore (4.06%) and Sagar (3.68%).

Table 1.18: Area, Production & Yield of Wheat in different Districts of M.P.

(TN Average ending 2010)

Districts	Area		Production		Yield	
	(000 ha)	Percentage to Total	(000 ton)	Percentage to Total	(kg/ha)	Percentage Difference to M.P.
Hoshangabad	223.0	5.32	668.7	8.76	3123.3	3.52
Vidisha	183.6	4.38	277.5	3.64	1561.3	1.76
Raisen	173.9	4.15	282.4	3.70	1677.3	1.89
Dhar	172.1	4.10	384.6	5.04	2312.7	2.60
Sehore	170.2	4.06	272.3	3.57	1636.7	1.84
Sagar	154.2	3.68	188.2	2.47	1254.7	1.41
Rewa	152.8	3.64	140.9	1.85	955.7	1.08
Ujjain	139.6	3.33	281.3	3.69	2125.7	2.39
Satna	136.3	3.25	136.5	1.79	1032.3	1.16
Betul	124.7	2.97	396.4	5.20	3312.3	3.73
Shivpuri	115.0	2.74	194.8	2.55	1722.3	1.94
Datia	110.0	2.62	224.0	2.94	2088.3	2.35
Chhatarpur	109.5	2.61	153.3	2.01	1588.7	1.79
Seoni	107.5	2.56	91.3	1.20	886.0	1.00
Harda	107.1	2.55	167.7	2.20	1631.7	1.84
Ashok nagar	106.4	2.54	147.0	1.93	1435.0	1.62
Dewas	106.4	2.54	224.6	2.94	2220.7	2.50
Chhindwara	101.5	2.42	274.6	3.60	2764.7	3.11
Indore	95.4	2.27	199.6	2.62	2228.0	2.51
Jabalpur	91.1	2.17	152.2	2.00	1736.0	1.95
Guna	81.0	1.93	130.1	1.70	1670.3	1.88
Bhind	80.9	1.93	164.9	2.16	2094.3	2.36
Gwalior	80.5	1.92	176.8	2.32	2251.3	2.53
Morena	80.1	1.91	174.8	2.29	2273.3	2.56
Shajapur	79.1	1.89	173.7	2.28	2280.3	2.57
Tikamgarh	77.0	1.84	135.2	1.77	1680.3	1.89
Ratlam	72.0	1.72	214.5	2.81	3112.3	3.50
Bhopal	69.2	1.65	131.3	1.72	1973.0	2.22
Rajgarh	68.7	1.64	111.6	1.46	1678.7	1.89
Damoh	67.4	1.61	122.6	1.61	1889.3	2.13
Khandwa	67.4	1.61	114.5	1.50	1771.3	1.99
Khargone	65.1	1.55	168.4	2.21	2637.0	2.97
Sidhi	65.0	1.55	49.0	0.64	810.0	0.91
Panna	60.9	1.45	79.5	1.04	1343.7	1.51
Narsinghpur	60.8	1.45	172.2	2.26	2956.3	3.33
Katni	59.0	1.41	61.6	0.81	1069.7	1.20
Mandsour	58.3	1.39	138.2	1.81	2481.0	2.79
Sheopur Kalan	43.2	1.03	110.6	1.45	2639.7	2.97
Dindori	30.7	0.73	17.8	0.23	603.3	0.68
Barwani	30.5	0.73	54.4	0.71	1910.0	2.15
Neemuch	29.8	0.71	65.2	0.85	2276.7	2.56
Mandla	29.4	0.70	25.0	0.33	884.0	1.00
Jhabua	28.6	0.68	51.8	0.68	1890.7	2.13
Umaria	25.8	0.62	20.6	0.27	830.3	0.93
Shahdol	22.8	0.54	18.5	0.24	850.7	0.96
Singroli	21.5	0.51	21.3	0.28	686.3	0.77
Balaghat	14.8	0.35	15.0	0.20	1053.3	1.19
Anuppur	12.5	0.30	8.7	0.11	725.0	0.82
Burahanpur	10.6	0.25	19.8	0.26	1952.0	2.20
Alirajpur	9.2	0.22	16.7	0.22	1255.0	1.41
Non-reported	12.1	0.29	7.4	0.10	0.0	0.00
M.P.STATE	4194.1	100.00	7629.7	100.00		0

In terms of percentage share in production of wheat Betul (5.20%), Dhar (5.04 %), Raisen (3.70 %), Ujjain (3.69%), Vidisha (3.64%), and Sehore (3.57%) were the important districts of the state. The productivity of Wheat was found the highest in Betul district (3312.30 kg/ha) followed by Hoshangabad (3123.30 kg/ha) and Ratlam (3112.3 kg/ha) districts (Table 1.18).

1.5.2 Soybean

In India soybean is being grown in area of 9615.50 thousand hectares with, the production of 10869.00 thousand tones. The average productivity of the crop is 996.76 kg/ha. Madhya Pradesh being "Soya-State" accounts for 55.58 per cent of area and 58.05 per cent of production of soybean in the country with an average productivity of 891.46 kg/ha. Maharashtra state stands second in terms of soybean production in the country sharing 30.54 per cent of acreage and 28.43 per cent production, Rajasthan the third important state in terms of soybean production (8.70%) in the country. These three states together accounts for more than 94 per cent of area and production of the soybean in the country. (Table 1.19)

Table 1.19: Present status of soybean crop in India (Average TE- 2010)

States	Area (000'ha)	Percentage to Total	Production (000'ha)	Percentage to Total	Yield (Kg/ha)	Difference to India
Madhya Pradesh	5344.50	55.58	6309.00	58.05	891.46	-75.30
Maharashtra	2937.00	30.54	3090.00	28.43	1251.81	285.05
Rajasthan	791.10	8.23	946.00	8.70	1001.17	34.41
Karnataka	162.00	1.68	107.00	0.98	879.86	-86.90
Andhra Pradesh	142.00	1.48	180.00	1.66	987.73	20.97
Chhattisgarh	97.90	1.02	102.00	0.94	454.69	-512.08
Gujarat	84.70	0.88	65.00	0.60	809.52	-157.24
Nagaland	24.40	0.25	31.00	0.29	1259.37	292.61
Uttarakhand	9.90	0.10	15.00	0.14	553.94	-412.82
Uttar Pradesh	9.70	0.10	10.00	0.09	696.18	-270.58
Sikkim	4.00	0.04	4.00	0.04	809.52	-157.24
Arunachal Pradesh	2.80	0.03	4.00	0.04	1405.99	439.23
Manipur	1.50	0.02	1.00	0.01	0.00	-966.76
Mizoram	1.20	0.01	2.00	0.02	1176.38	209.62
Meghalaya	1.10	0.01	1.00	0.01	900.00	-66.76
Himachal Pradesh	0.60	0.01	1.00	0.01	1722.22	755.46
West Bengal	0.50	0.01	0.00	0.00	590.48	-376.29
Jharkhand	0.50	0.01	0.00	0.00	0.00	-966.76
Tamil Nadu	0.10	0.00	0.00	0.00	0.00	-966.76
Others	0.00	0.00	0.00	0.00	0.00	-966.76
Kerala	0.00	0.00	0.00	0.00	0.00	-966.76
All India	**9615.50**	**100**	**10869.00**	**100**	**966.76**	**-**

The area, production and productivity of soybean was highest in Ujjain district among all the major soybean-growing districts of the state. It accounts for 8.30 per cent of area and 5.26 per cent of production of soybean in the state with an average productivity of 1190 Kg/ha. The other important districts in terms of

acreage were, Shajapur (6.27 %), Dewas (5.71%), Sagar (5.53 %), Rajgarh (5.46%) and Sehore (5.42 %).

Table 1.20: Area of Soybean in different Districts of M.P. (TE Average 2010)

Division/District	Area sown		yield		Total production	
	000'ha	Percentage to Total	(kg/ha)	Percentage Diff. to M.P.	000't	Percentage to Total
Ujjain	4.42	8.30	1190	113.19	5.26	9.39
Mandsour	2.61	4.91	1022	97.21	2.67	4.76
Neemuch	1.24	2.33	1050	99.87	1.30	2.33
Ratlam	2.11	3.97	1105	105.10	2.33	4.17
Dewas	3.04	5.71	1147	109.03	3.49	6.23
Shajapur	3.34	6.27	1001	95.15	3.34	5.96
Bhopal	0.95	1.78	1082	102.85	1.02	1.83
Sehore	2.88	5.42	1021	97.08	2.95	5.26
Raisen	1.49	2.79	973	92.49	1.45	2.59
Vidisha	1.87	3.52	1065	101.24	2.00	3.57
Rajgarh	2.90	5.46	941	89.45	2.73	4.88
Betul	1.92	3.62	975	92.71	1.88	3.35
Hosangabad	1.97	3.70	1070	101.77	2.11	3.77
Harda	1.65	3.10	1097	104.31	1.81	3.24
Indore	2.25	4.22	1183	112.46	2.66	4.74
Dhar	2.49	4.69	1167	111.00	2.91	5.20
Jhabua	0.51	0.95	983	93.50	0.50	0.89
Alirajpur	0.10	0.19	990	94.14	0.10	0.18
Khargone	0.60	1.13	1034	98.35	0.62	1.11
Barwani	0.33	0.62	1013	96.35	0.33	0.59
Khandwa	1.41	2.66	1144	108.75	1.62	2.89
Burahanpur	0.15	0.28	1132	107.61	0.17	0.30
Jabalpur	0.04	0.08	965	91.73	0.04	0.07
Katni	0.01	0.03	978	93.03	0.01	0.03
Balaghat	0.11	0.20	1032	98.10	0.13	0.23
Chhindwara	1.69	3.17	1042	99.11	1.76	3.14
Mandla	0.02	0.04	937	89.06	0.02	0.03
Seoni	1.06	1.99	1027	97.62	1.09	1.95
Narsinghpur	0.98	1.84	968	92.01	0.95	1.69
Sagar	2.94	5.53	959	91.19	2.82	5.03
Damoh	0.53	1.00	972	92.46	0.52	0.93
Panna	0.09	0.18	963	91.60	0.09	0.16
Tikamgarh	0.33	0.62	978	93.03	0.33	0.58
Chattarpur	0.33	0.62	1012	96.20	0.33	0.59
Gwalior	0.02	0.03	908	86.37	0.01	0.03
Shivpuri	0.86	1.62	965	91.79	0.84	1.49
Guna	1.88	3.53	955	90.81	1.79	3.20
Ashoknagar	0.89	1.68	996	94.71	0.89	1.58
Datia	0.01	0.01	933	88.75	0.01	0.01
Morena	0.00	0.00	937	89.06	0.00	0.00
Sheopur Kalan	0.10	0.18	973	92.55	0.09	0.17
Bhind	0.00	0.00	632	60.06	0.00	0.00
Rewa	0.35	0.65	938	89.22	0.33	0.59
Sidhi	0.03	0.05	930	88.43	0.02	0.04
Satna	0.48	0.91	957	90.97	0.46	0.83
Singhroli	0.00	0.01	962	91.44	0.00	0.01
Shahdol	0.09	0.16	973	92.55	0.08	0.15
Anooppur	0.03	0.05	957	90.97	0.03	0.05
Umaria	0.04	0.07	965	91.76	0.03	0.06
Dindori	0.07	0.13	978	93.03	0.07	0.12
Total M.P.	**53.20**	**100.00**	**1052**	**100.00**	**56.01**	**100.00**

In terms of percentage share in production of soybean Dewas (6.23%), Shajapur (5.96 %), Sehore (5.26 %), Dhar (5.20%), Rajgarh (4.88%) and Indore (4.74 %) are the important districts of the state. The productivity of soybean was highest in Ujjain (1190 kg/ha) followed by Indore district (1183 kg/ha), Dhar (1167 kg/ha) and Dewas (1147 kg/ha) district. (Table 1.20)

1.6 Data Base and Methodology

The data, collection, sampling techniques, method of classification, tabulation and concepts used are described in detail in this sub head.

1.6.1 Selection of crops

Wheat and soybean crops have been considered for assessment of pre and post harvest losses in Madhya Pradesh as state has remarkable position in the area and production of wheat and soybean in India.

1.6.2. The Data

The primary, secondary and tertiary data have been collected for the study.

1.6.2.1 Primary data

The primary data were collected from the selected respondents of the study area by survey method with the help of interview schedule provided by the Project Coordinator of the study (Dr. Pramod Kumar, Prof. & Head, Agriculture Development & Rural Transformation Unit, ISEC, Bangalore).

The interview schedule covers all the informations related to the objectives of the study viz. general information of selected respondents, their operational holdings, structure of tenancy, source of irrigation, cropping pattern, percentage of HYVs area, crop productivity, marketed surplus, value of output and constraints faced in cultivation of crops. An assessment of incidence of pest and disease attacks and crop losses, method of pest and disease control, source of information of pest and disease control, production losses during harvest, threshing and winnowing, transportation and handling, storage etc. and suggestion of HHs to minimize their post harvest losses were also gathered with the help of schedule.

1.6.2.2 **Secondary data**

The secondary data related to area, production and yield of selected crops i.e. wheat and soybean for the period of 30 years from 1981 – 2010. These data were collected from Department of Farmers' Welfare and Agricultural Development, Madhya Pradesh, Bhopal, Directorate of Economics and Statistics

Madhya Pradesh, Bhopal and Land Record Office, Madhya Pradesh, Gwalior and Office of Madhya Pradesh Mandi Board, Bhopal (M.P.)

1.6.2.3 Tertiary Data

The tertiary data related to various cost and profitability parameters of selected crops for the years 1980-81, 1985-86, 1990-91, 1995-96, 2000-01, 2005-06, 2010-11 were also collected for the study, from Comprehensive Scheme for studying the Cost of Cultivation of Principal Crops for Madhya Pradesh and Chhattisgarh, Jawaharlal Nehru Agricultural University, Jabalpur (M.P.) which is published by Commission for Agriculture Cost and Prices, Ministry of Agriculture and Cooperation, New Delhi.

1.6.3. Sampling techniques

A multistage sampling technique has been used for selection of respondents of the study. At the first stage Hosangabad and Vidisha districts from Central Narmada Valley and Vindhyan Plateau for Wheat, and Ujjain and Raisen (Table 1.16) districts from Malwa Plateau and Vindhyan Plateau have been selected respectively for soybean crop as these districts has remarkable position in area and production in M.P in these agro-climatic regions.

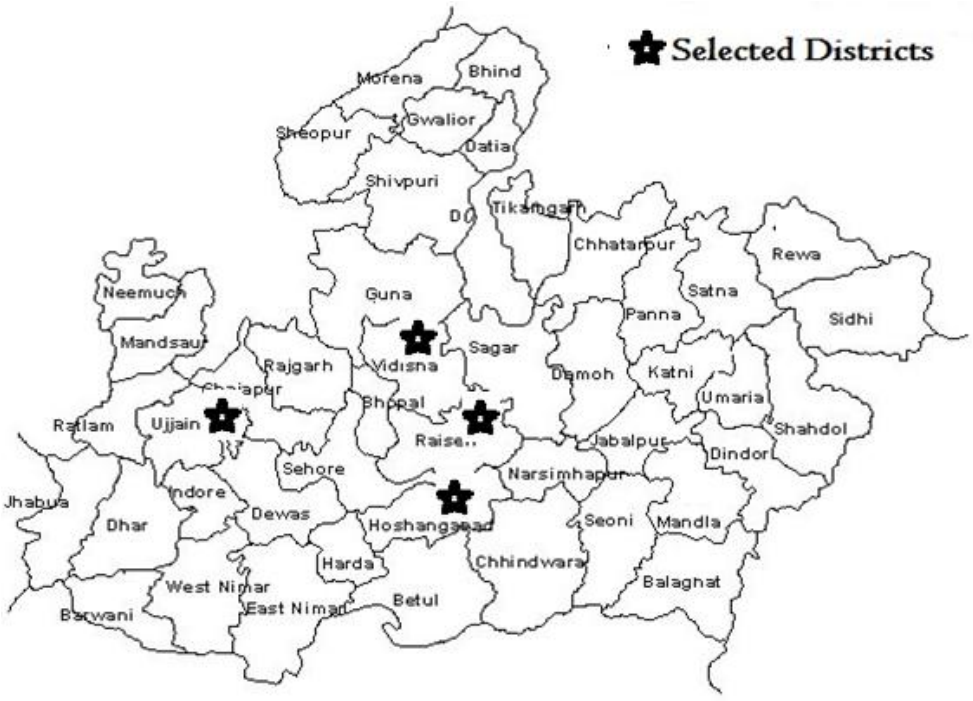

Fig. 1.2: Map of Madhya Pradesh showing selected districts

Further, 3 villages situated near by regulated market (in radius of 10 KM) and 3 villages situated away from the regulated market (>10 Km from regulated market) have been selected for the study (Table1.21).

Table 1.21: Selected Districts and villages for the study

Selected crops	Agro-climatic Regions	Selected districts	Selected villages	
			In radius of 10 km	**> 10 km**
Wheat	Central Narmada Valley	Hoshangabad	Bekour	Pipariya Chhatrsal
			Bagalkhedi	Mahua kheda
			Samakeshli	Baskhapa
	Vindhyan Plateau	Vidisha	Mirzapur	Adampur
			Rangai	Bhatni
			Davar	Bhairowkhedi
Soybean	Malwa Plateau	Ujjain	Matana	Ganvadi
			Munjakheda	Piploda
			Semaliya (nasar)	Narvar
	Vindhyan Plateau	Raisen	Kotpar	Chingwara kalan
			Kamton	Arjni
			Kinagi	Tulsipar

A list of all the farmers of the selected village has been prepared and classified them in marginal (below 2 acre) , small (2- 4 acre), medium (4-10 acre) and large (above 10 acre) categories according to their size of operational holdings and 20 farmers were selected randomly from each category for the study (Table 1.22).

Table 1.22: Number of respondents in different categories of farms in selected districts

Selected crops	Selected districts	Size of farms				
		Marginal	Small	Medium	Large	Total
Wheat	Hoshangabad	20	20	20	20	80
	Vidisha	20	20	20	20	80
	Total	40	40	40	40	160
Soybean	Ujjain	20	20	20	20	80
	Raisen	20	20	20	20	80
	Total	40	40	40	40	160
Grand total		80	80	80	80	320

Hence, the sample size comprises of 20 (farmers) X 4 (farm size) X 2 (districts/ agro-climatic regions) X 2 (crops) = 320 households related to 4 different size groups of 4 different districts.

1.6.4 Classification, Tabulation and Analysis of Data

The collected data have been classified, tabulated and analyzed in the light of stated objectives of the study using statistical package of social science

(SPSS). The analysis of data done in light of suitable statistical tools such as mean, percentage, trend, growth, absolute change, relative change, regression analysis etc.

1.6.5 Concepts Used

A) Cost Concept

Cost A_1 = Actual expenses in farm incurred by the farmer

1). Value of hired human labour.
2). Value of hired bullock labour.
3). Value of owned bullock labour.
4). Value of owned machinery labour.
5). Hired machinery charges.
6). Value of seeds (both farm produced & Purchased).
7). Value of insecticides & pesticides.
8). Value of manure (owned and purchased).
9). Value of fertilizer.
10). Depreciation on implements and farm buildings.
11). Irrigation charges.
12). Land revenue, ceases and other taxes.
13). Interest on working capital.
14). Miscellaneous expenses (artisans, etc).

Cost A_2 = Cost A1 + rent paid for leased in land.
Cost B_1 = Cost A1 + interest on value of owned fixed capital assets (Excluding land).
Cost B_2 = Cost B1 + rental value of owned land (net of land revenue) & Rent paid for leased in land.
Cost C_1 = Cost B1 + imputed value of family labour.
Cost C_2 = Cost B2 + imputed value of family labour.

B) Profitability concepts

Gross Return = value of main product + Value of by – product

Net return over Cost A_1= Gross Return – Cost A_1

Net return over Cost A_2= Gross Return – Cost A_2

Net return over Cost B_1= Gross Return – Cost B_1

Net return over Cost B_2= Gross Return – Cost B_2

Net return over Cost C_1= Gross Return – Cost C_1

Net return over Cost C_2= Gross Return – Cost C_2

C) Size of farms

Marginal = below 2 acre

Small = 2 to 4 acre

Medium = 4 to 10 acre

Large = above 10 acre

1.7 Organization of the Study

This study is organized into six chapters. Chapter one covers the introductory part of the study followed by area, production and yield of selected crops (Wheat and Soybean) in the State (chapter II). Household characteristics, cropping pattern and production structure of wheat and soybean growers covered under chapter three. Chapter four deals with the assessment of pre harvest losses. Assessment of post harvest losses has been discussed in chapter five, while concluding remarks and policy suggestions are given in chapter six followed by references and annexure.

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CHAPTER II

AREA, PRODUCTION & YIELD OF SELECTED CROPS IN MADHYA PRADESH

This chapter includes trend and growth in area, production & yield and changes in cost and profitability of selected crops i.e. Wheat and Soybean in Madhya Pradesh and review related to post harvest losses.

2.1 Trend & Growth in Area, Production & Yield of Selected Crops

The trend and growth of area, production and yield of selected crops i.e. Wheat and Soybean have been analysed by using time series secondary data related to the last 30 years (1980-81 to 2009-10)

2.1.1. Wheat

The trend and growth of area, production and yield of wheat has been presented in the Fig.2.1 and Table 2.1. It is observed from the figure that the area of wheat showed a positive and increasing trend with a magnitude of 29.44 thousand ha per year over the last 30 years. The area of wheat has been found to be increased from 3341.17 thousand ha (The base year) to 4090.90 thousand ha (The current year) showed a relative change of 29.06 percent with the fluctuation of 11.27 per cent (CV) and a simple growth of 0.77% per year and compound growth of 0.78 per cent per year during last 30 years (Table 2.1).

The production of wheat also showed a positive and increasing trend with a magnitude of 151.38 thousand tones per year over the last 30 years. The production of wheat has been found to be increased from 3348.40 thousand t (The base year) to 7468.03 thousand t (The current year) showed a relative change of 175.64 percent with the fluctuation of 28.35 per cent (CV) and a simple growth of 2.60 % per year and compound growth of 2.86 per cent per year during last 30 years (Table 2.1).

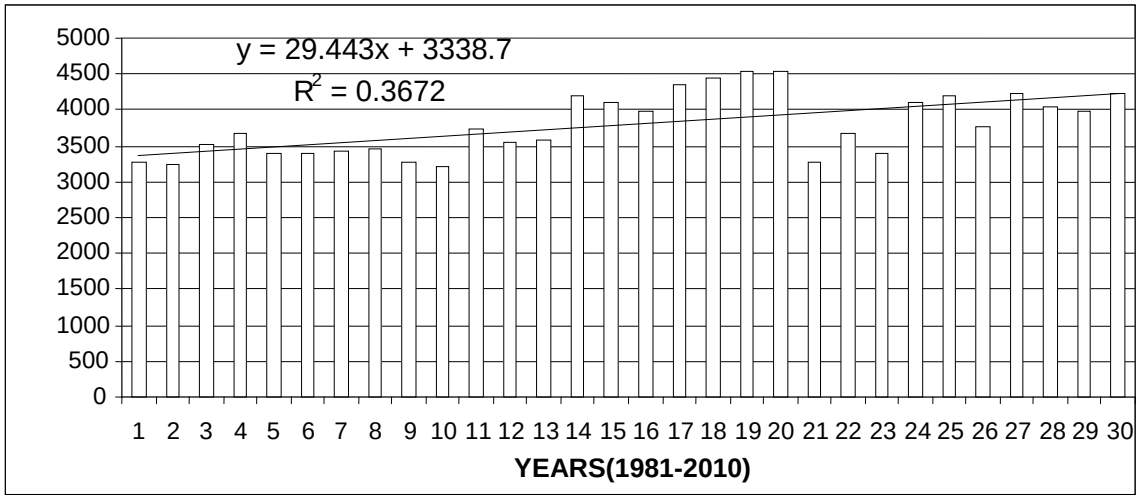
The yield of wheat also showed a positive and increasing trend with a magnitude of 28.21 kg/ha per year over the last 30 years. The yield of wheat has been found to be increased from 1000.47 kg/ ha (The base year) to 1823.21 kg/ha (The current year) showed a relative change of 113.58 per cent with the fluctuation of 18.65 per cent (CV)

and a simple growth of 1.87 % per year and compound growth of 2.01 per cent per year during last 30 years (Table 2.1).

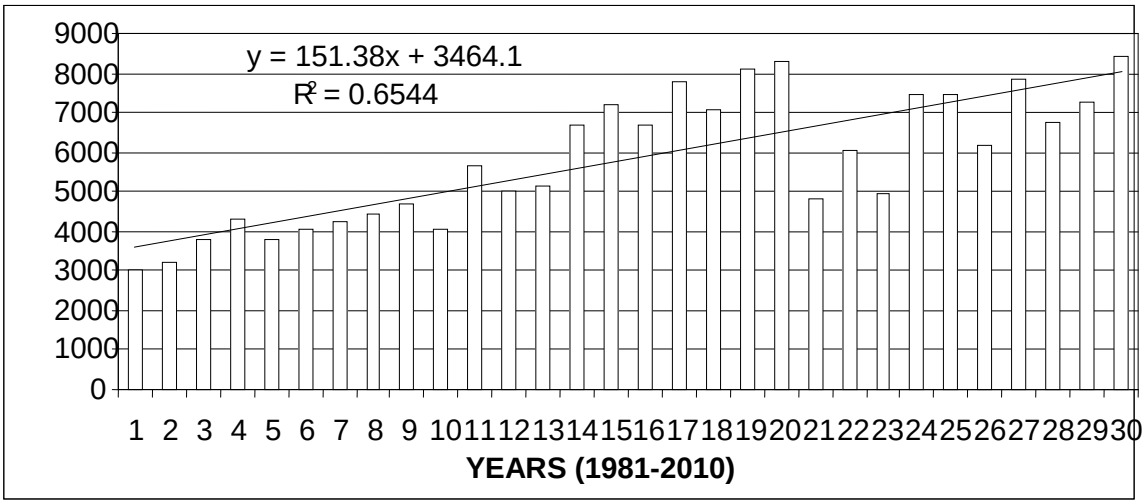
Table 2.1: Trend and Growth in Area, Production and Yield of Wheat in M.P.

S.No.	Years	Area (000, ha.)	Production (000, tone)	Yield (kg/ha)
1	**1980-81**	3284.00	3048.40	928.26
2	**1981-82**	3236.10	3223.30	996.04
3	**1982-83**	3503.40	3773.50	1077.10
4	**1983-84**	3685.60	4303.60	1167.68
5	**1984-85**	3404.80	3820.40	1122.06
6	**1985-86**	3407.58	4035.15	1330.00
7	**1986-87**	3415.60	4249.90	1244.26
8	**1987-88**	3452.40	4440.70	1286.26
9	**1988-89**	3276.13	4721.80	1441.27
10	**1989-90**	3208.03	4046.30	1261.30
11	**1990-91**	3747.80	5639.00	1504.62
12	**1991-92**	3545.70	4994.30	1408.55
13	**1992-93**	3586.70	5138.00	1432.51
14	**1993-94**	4194.20	6664.20	1588.91
15	**1994-95**	4108.80	7194.90	1751.10
16	**1995-96**	3987.90	6658.40	1669.65
17	**1996-97**	4360.40	7788.00	1786.07
18	**1997-98**	4449.40	7041.00	1582.46
19	**1998-99**	4547.90	8078.40	1776.29
20	**1999-00**	4522.70	8264.70	1827.38
21	**2000-01**	3257.81	4841.29	1486.06
22	**2001-02**	3683.23	6026.66	1636.24
23	**2002-03**	3395.57	4961.02	1461.03
24	**2003-04**	4119.03	7479.48	1815.83
25	**2004-05**	4201.26	7447.55	1772.69
26	**2005-06**	3776.50	6192.30	1639.69
27	**2006-07**	4220.60	7840.40	1857.65
28	**2007-08**	4057.30	6729.30	1658.57
29	**2008-09**	3977.10	7272.20	1828.52
30	**2009-10**	4238.30	8402.60	1982.54
b (regression coefficient)		29.44	151.38	28.21
a (constant)		3338.69	3464.13	1073.37
The Base Year 1981 (TE 1983)		3341.17	3348.40	1000.47
The Current year 2010 (TE 2010)		4090.90	7468.03	1823.21
Absolute Change		954.30	5354.20	1054.28
Relative Change		29.06	175.64	113.58
Standard Deviation		427.73	1647.43	281.78
Coefficient of variance (%)		11.27	28.35	18.65
Simple Growth Rate (%)		0.77	2.60	1.87
Compound Growth Rate (%)		0.78	2.86	2.01

AREA (000 ha)



PRODUCTION (000 t)



PRODUCTIVITY (kg/ha)

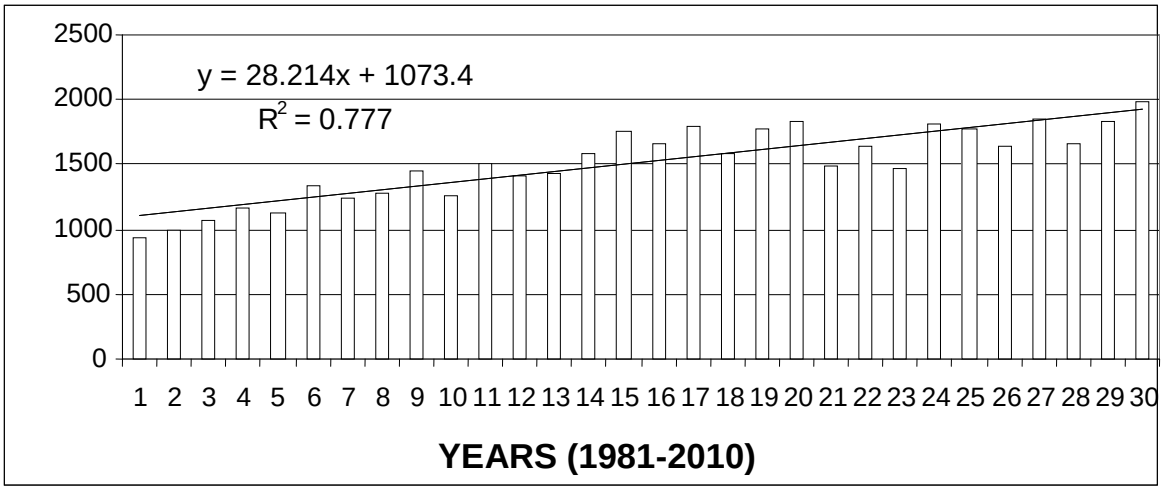


Fig 2.1: Trend of Area, Production and Productivity of Wheat in M.P. (1980 – 81 to 2009 - 10)

2.1.2 Soybean

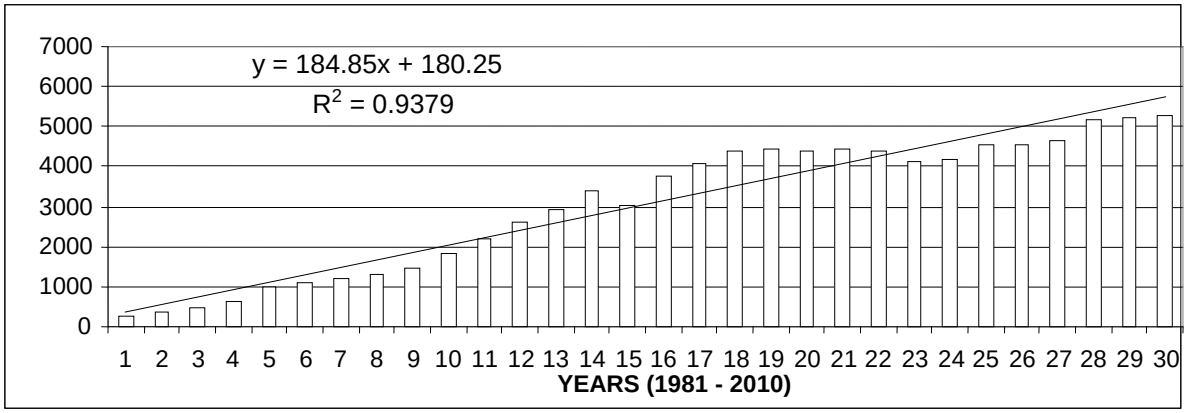
The trend and growth of area, production and yield of Soybean has been presented in the Fig.2.2 and Table 2.2 It is observed from the figure that the area of soybean showed a positive and increasing trend with a magnitude of 184.85 thousand ha per year over the last 30 years. The area of Soybean has been found to be increased from 343.67 thousand ha (The base year) to 5224.40 thousand ha (The current year) showed a relative change of 1420.19 percent with the fluctuation of 55.18 per cent (CV) and showed a simple growth of 6.07 % per year and compound growth of 9.43 per cent per year during last 30 years.

Table 2.2: Trend and Growth in Area, Production and Yield of Soybean in M.P.

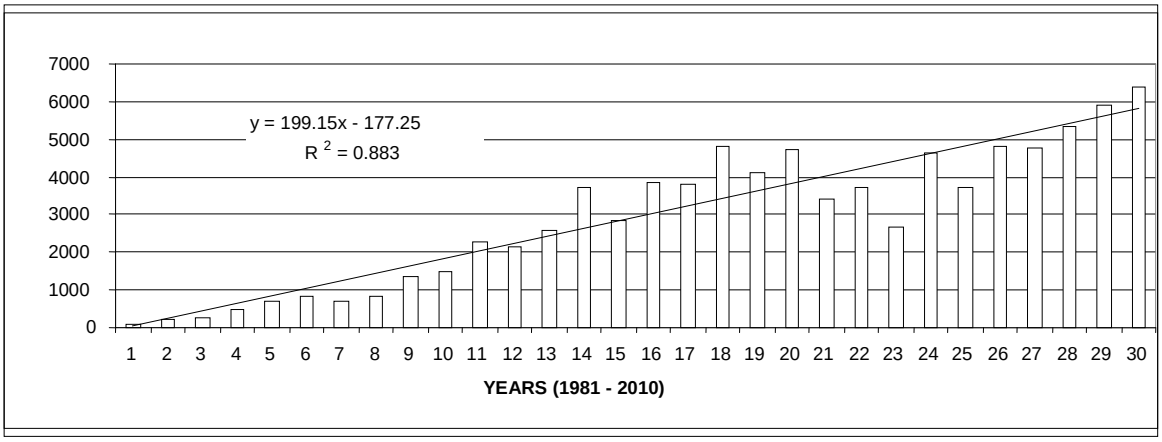
(Area 000 ha. Prodn 000 tone, Yield kg/ha.)

S.No.	Years	Area	Production	Yield
1	**1980-81**	237.70	96.04	404.04
2	**1981-82**	340.10	233.80	687.44
3	**1982-83**	453.20	278.80	615.18
4	**1983-84**	606.80	491.50	809.99
5	**1984-85**	1000.60	691.30	690.89
6	**1985-86**	1088.90	825.00	757.65
7	**1986-87**	1208.00	709.40	587.25
8	**1987-88**	1322.90	822.70	621.89
9	**1988-89**	1468.70	1368.50	931.78
10	**1989-90**	1834.40	1508.70	822.45
11	**1990-91**	2201.50	2277.30	1034.43
12	**1991-92**	2635.40	2163.10	820.79
13	**1992-93**	2907.60	2592.80	891.73
14	**1993-94**	3378.00	3736.70	1106.19
15	**1994-95**	3044.70	2862.00	939.99
16	**1995-96**	3778.90	3858.30	1021.01
17	**1996-97**	4097.60	3793.80	925.86
18	**1997-98**	4385.00	4800.20	1094.69
19	**1998-99**	4426.20	4118.50	930.48
20	**1999-00**	4398.57	4733.04	1076.04
21	**2000-01**	4424.58	3411.39	771.01
22	**2001-02**	4400.50	3712.69	843.70
23	**2002-03**	4148.78	2652.87	639.43
24	**2003-04**	4165.73	4623.75	1109.95
25	**2004-05**	4545.35	3736.65	822.08
26	**2005-06**	4536.50	4793.40	1056.63
27	**2006-07**	4651.90	4769.20	1025.22
28	**2007-08**	5145.80	5346.10	1038.92
29	**2008-09**	5237.60	5900.00	1126.47
30	**2009-10**	5289.80	6381.50	1206.38
b (regression coefficient)		184.85	199.15	15.28
a (constant)		180.25	-177.25	643.40
The Base year 1981 (TE 1983)		343.67	202.88	568.89
The Current year 2010 (TE 2010)		5224.40	5875.87	1123.92
Absolute Change		4880.73	5672.99	555.04
Relative Change		1420.19	2796.23	97.57
Standard Deviation		1680.31	1865.80	195.74
Coefficient of variance (%)		55.18	64.13	22.24
Simple Growth Rate (%)		6.07	6.84	1.74
Compound Growth Rate (%)		9.43	11.52	1.91

AREA (000 ha)



PRODUCTION (000 t)



PRODUCTIVITY (kg/ha)

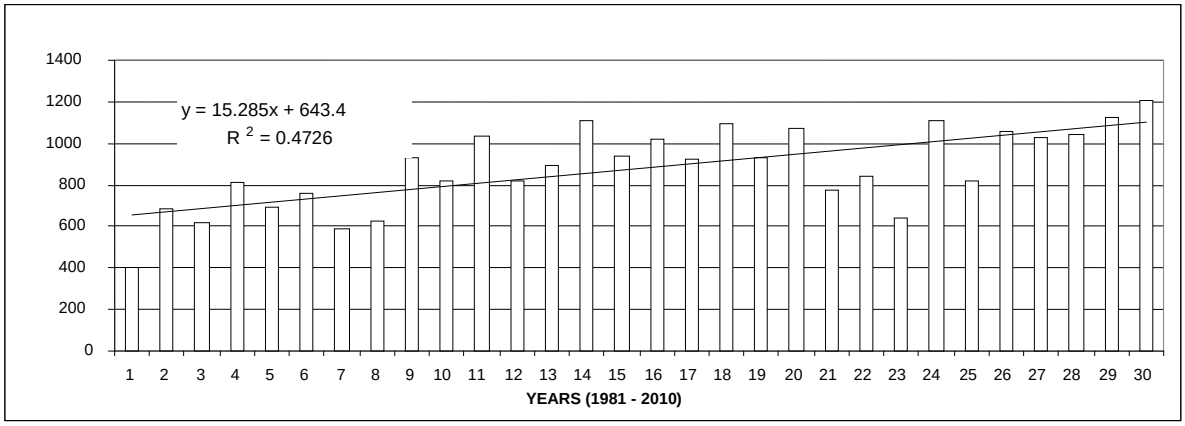


Fig 2.2: Trend of Area, Production and Productivity of Soybean in M.P. (1980-81 to 2009-10)

The production of soybean also showed a positive and increasing trend with a magnitude of 199.15 thousand t per year over the last 30 years. The Production of Soybean has been found to be increased from 202.88 thousand t (The base year) to 5875.87 thousand t (The current year) showed a relative change of 2796.23 percent with the fluctuation of 64.13 per cent (CV) and a simple growth of 6.84 % per year and compound growth of 11.52 per cent per year during last 30 years.

The yield of soybean also showed a positive and increasing trend with a magnitude of 15.28 kg/ha per year over the last 30 years. The yield of Soybean has been found to be increased from 568.89 kg/ ha (The base year) to 1123.92 kg/ha (The current year) showed a relative change of 97.57 per cent with the fluctuation of 22.24 per cent (CV) and a simple growth of 1.74 % per year and compound growth of 1.91 per cent per year during last 30 years (Table2.2).

2.2 Changes in Cost & Profitability of Selected Crops:

The changes occurred in cost & profitability of selected crops has been observed from the tertiary data obtained from the various issues of Commission for Agriculture Price and Cost. The changes in these parameters have been observed from 1980-81 to 2009-10 considering 5 years intervals i.e. 1980-81, 1984-85, 1989-90,1994-95,1999-2000,2004-05 and 2009-10.

2.2.1 Wheat:

The expenses related to all input variables has been found to be increased except expenses on manures in the year 2009-10 as compared to 1980-81. (Table 2.3) Due to this fact the cost of cultivation of the crop has been found to be increased approximately 1000 per cent more in the year 2009-10 over the year 1980-81. As regards to the profitability of the crop the gross income received by the farmers increased by 1203.56 per cent from Rs. 2577.16 per ha (1980-81) to Rs.33594.70/ha (2009-10). With the results of all these the net income over the cost A_1, A_2, B_1, B_2,C_1 and C_2 also showed 1373.21, 1373.21, 1446.15, 1545.73,1144.08 and 1535.58 per cent change respectively in the year 2009-10 over the year 1981-81 (Table 2.4).

Table 2.3: Cost of Cultivation of Wheat based on various cost concepts in Madhya Pradesh

(Rs/ha)

Particulars	1980-81	1984-85	1989 - 90	1994 - 95	1999 - 00	2004 - 05	2009 - 10	AC	RC
Seed	209.99	209.73	366.98	616.03	984.04	997.84	1887.74	1677.75	798.96
Fertilizer	162.77	155.69	319.88	857.76	997.02	1241.34	1338.31	1175.54	722.20
Manure	1.43	8.69	16.74	8.53	13.06	16.45	0	-1.43	-100.00
Human Labour	293.99	375.58	601.92	1341.88	2187	2260.03	3964.64	3670.65	1248.56
Animal Labour	244.69	285.14	379.43	533.02	530.51	671.14	601.14	356.45	145.67
Machine Labour	46.77	65.7	232.58	665.1	1109.67	1533.38	3155.9	3109.13	6647.70
Insecticides	0.15	0.1	2.57	0.23	0	7.02	25.48	25.33	16886.67
Irri. Charges	107.41	176.27	398.77	756.83	957.14	1961.5	1657.25	1549.84	1442.92
int. on working capital	28.81	32.48	60.67	123.8	169.15	226.15	318.14	289.33	1004.26
Fixed costs	907.84	1042.78	1588.12	3572.76	5310.19	5781.19	11269.15	10361.31	1141.32
Rental value of owned land	637.97	714.04	1113.26	2197.75	3842.67	4231.64	9148.43	8510.46	1333.99
Rent paid for leased in	0	1.95	0	0	0	14.6	0	0	0
Land Revenue	6.32	4.88	6.25	5.97	5.85	5.71	5.43	-0.89	-14.08
Dep. On implements	80.02	88.43	149.29	450.86	280.41	339.36	401.08	321.06	401.22
Int. on fixed capital	183.53	233.48	319.32	918.17	1181.26	1189.88	1714.21	1530.68	834.02
Cost A_1	1037.02	1165.12	2157.73	4542.61	5868.38	7807.91	10905.16	9868.14	951.59
Cost A_2	1037.02	1167.07	2157.73	4542.61	5868.38	7822.51	10905.16	9868.14	951.59
Cost B_1	1220.54	1398.6	2477.05	5460.78	7049.64	8997.80	12619.37	11398.83	933.91
Cost B_2	1858.52	2114.59	3590.31	7658.53	10892.31	13244.03	21767.80	19909.28	1071.24
Cost C_1	1365.88	1636.17	2792.30	6277.48	8416.63	10449.82	15069.33	13703.45	1003.27
Cost C_2	2003.85	2352.16	3905.55	8475.23	12259.30	14696.06	24217.75	22213.9	1108.56

AC = Absolute change RC = Relative change (%)

Table 2.4: Profitability indicators of wheat crop in M.P.

(Rs/ha)

Years	Value of main product	Value of by - product	Gross Return	Returns over the Costs					
				A_1	A_2	B_1	B_2	C_1	C_2
1980 –81	2076.39	500.77	2577.16	1540.14	1540.14	1356.62	718.64	1211.28	573.31
1984 - 85	2302.22	578.04	2880.26	1715.14	1713.19	1481.66	765.67	1636.17	528.10
1989 - 90	3554.07	923.76	4477.83	2320.10	2320.10	2000.78	887.52	1685.53	572.28
1994 - 95	7365.91	1488.46	8854.37	4311.76	4311.76	3393.59	1195.84	2576.89	379.14
1999 - 00	13356.19	2014.48	15370.7	9502.29	9502.29	8321.03	4478.36	6954.04	3111.37
2004 - 05	14757.74	2221.53	16979.3	9171.36	9156.76	7981.47	3735.24	6529.45	2283.21
2009 - 10	31189.46	2405.25	33594.7	22689.55	22689.55	20975.34	11826.91	15069.33	9376.96
AC	29113.07	1904.48	31017.6	21149.41	21149.41	19618.72	11108.27	13858.05	8803.65
RC	1402.10	380.31	1203.56	1373.21	1373.21	1446.15	1545.73	1144.08	1535.58

AC = Absolute change RC = Relative change (%)

2.2.1 Soybean

The expenses related to all input variables were found to be increased approximately 2000 percent in the year 2009-10 as compared to 1980-81. (Table 2.5) Due to this fact the cost of cultivation of the crop found to be increased approximately 2000 per cent more in the year 2009-10 over the year 1980-81.

Table2.5: Cost of Cultivation of Soybean based on various cost concepts, Madhya Pradesh.

(Rs/ha)

Particulars	1980-81	1984-85	1989 - 90	1994 - 95	1999 - 00	2004 - 05	2009 – 10	AC	RC
Seed	133.37	260.08	583.45	1017.09	1053.54	1714.64	2396.53	2263.16	1696.90
Fertilizer	44.24	114.97	246.67	521.22	575.26	687.58	651.43	607.19	1372.49
Manure	22.63	28.35	203.27	67.36	139.34	264.44	509.87	487.24	2153.07
Human Labour	175.87	389.68	634.68	1312.46	2181.25	2602.98	4774.86	4598.99	2614.99
Animal Labour	130.09	258.79	280.45	525.21	647.76	876.87	1132.62	1002.53	770.64
Machine Labour	0	78.74	211.3	503.41	609.79	996.7	2534.13	2534.13	0.00
Insecticides	0	0.96	9.66	78.88	131.29	232.61	730.65	730.65	0.00
Irri. Charges	4.13	5.72	22.5	1.14	0.77	79.51	0	-4.13	-100.00
Int. on working capital	13.36	29.07	63.13	105.09	129.07	186.56	313.88	300.52	2249.40
Fixed costs	440.21	941.87	1446.91	2709.99	2971.25	4359.94	8423.86	7983.65	1813.6
Rental value of owned land	261.5	647.97	1054.98	2202.09	2177.6	3391.67	7249.24	6987.74	2672.18
Rent paid for leased in	0	0	0	0	0	0	0	0	0.00
Land revenue	15.99	5.35	6.56	4.75	5.41	4.19	3.88	-12.11	-75.73
Dep. On implements	38.58	89.94	181.67	178.47	210.37	248.89	366.48	327.9	849.92
Int. on fixed capital	124.14	118.61	335.52	324.69	577.87	715.19	804.26	680.12	547.87
Cost A_1	495.79	1054.50	2239.41	3651.21	4475.10	6409.45	10728.46	10232.67	2063.91
Cost A_2	495.79	1054.50	2239.41	3651.21	4475.10	6409.45	10728.46	10232.67	2063.91
Cost B_1	0.00	1253.12	2475.37	3975.90	5052.97	7124.64	11532.72	11532.72	0.00
Cost B_2	881.43	1901.09	3530.35	6177.99	7230.57	10516.32	18781.96	17900.53	2030.85
Cost C_1	0.00	1460.26	2647.04	4639.77	6261.72	8613.75	14236.49	14236.49	0.00
Cost C_2	963.90	2108.23	3702.02	6841.85	8439.32	12005.42	21485.73	20521.83	2129.04

AC = Absolute change RC = Relative change (%)

As regards to the profitability of the crop the gross income received by the farmers was found to be increased by 2512.46 per cent from Rs. 1109.95 per ha (1980-81) to Rs.28997.00/ha (2009-10). With the results of all these the net income over the cost A_1, A_2, B_1, B_2,C_1 and C_2 also showed 2874.55, 2874.55, 1473.43, 4370.07, 1229.83 and 5042.92 per cent change respectively in the year 2009-10 over the year 1980-81(Table 2.6).

Table 2.6: Profitability indicators of Soybean crop in M.P

(Rs/ha)

Years	Value of main product	Value of by product	Gross Return	Returns over the Costs					
				A_1	A_2	B_1	B_2	C_1	C_2
1980 - 81	1042.90	67.05	1109.95	614.16	614.16	1109.95	228.52	1109.95	146.05
1984 - 85	2399.14	214.14	2613.28	1558.78	1558.78	-143.17	712.19	1153.02	505.05
1989 - 90	3974.59	277.94	4252.53	2013.12	2013.12	1777.16	722.18	1605.49	550.51
1994 - 95	8351.86	456.48	8808.34	5157.13	5157.13	4832.44	2630.35	4168.57	1966.49
1999 - 00	8143.89	566.52	8710.41	4235.31	4235.31	3657.44	1479.84	2448.69	271.09
2004 - 05	12883.41	683.29	13566.7	7157.25	7157.25	6442.06	3050.38	4952.95	1561.28
2009 - 10	27494.83	1502.14	28997	18268.51	18268.51	17464.25	10215.01	14760.48	7511.24
AC	26451.93	1435.09	27887	17654.35	17654.35	16354.3	9986.49	13650.53	7365.19
RC	2536.38	2140.33	2512.46	2874.55	2874.55	1473.43	4370.07	1229.83	5042.92

AC = Absolute change RC = Relative change (%)

2.3 Post Harvest Losses: A Review

The various studies have been conducted on post harvest losses, some of them are reviewed and found that the storage losses are most important losses and it varies from 2.03 to 9.52 per cent at farmers' level (Krishnamurthy 1968), 0.60 to 9.70 per cent in wheat crop in Uttar Pradesh (Girish et al. 1974) and quite significant at farm level (Ali et al. 1988) in wheat crop. The losses during storage were observed as 1 – 2.6 per cent at warehouse and FCI go-downs and in grain market the storage losses were observed as 0.30 to 0.60 per cent (Singh et al. 1988). The average maximum loss of 6 to 8 per cent was found at farm level due to storage alone in some of the traditional structures used in the tribal areas of M.P. /C.G. the post harvest losses were found as high as 10 to 35 per cent in food grains (Alam et al. 2003). The Storage losses due to rodents were found to be 23.57 g wheat grain/house/day which was estimated 0.71 kg/month and 8.62 kg annually. The overall annual losses in wheat due to rodent were found to be 106.81 kg (5.37%) (Jain et al. 1999).The percentages of losses during threshing and transportation were found to be 2 – 4 per cent and 0.8 per cent respectively at farm level.

The losses during handling, weighing, transport and storage were found to be 0.3, 0.1, 0.15 and 0.3 per cent respectively at farm level (Ali et al. 1988). The Threshing losses were observed as 0.98 and 2.10 per cent for wheat and Soybean. The transportation losses were observed as 1.74, 0.96 and 0.98 per cent for transportation by head load, bullock cart and by tractor trolley respectively. The average cleaning loss was observed as 0.39 per cent (Singh *et al*1988). The Post harvest loss of agricultural crops was around 15 per cent in grains (Andales *et al.* 2000).

The overall post harvest losses on sample farms were around 7%, and maximum losses occurred during threshing and winnowing. The post harvest losses were found to

be increased with an increase in area under crop and time of storage, while they decreased with improvement in type of storage and method of storage (Nag *et al.*2000).The post harvest losses at farm level were estimated to be 3.28 kg/qtl for wheat crop. The post harvest losses were found to be maximum in wheat (17.81%) as compared to rice, millet, sorghum, maize, Pigeon pea, gram, pea, lentil, black gram, green gram, mustard, toria (lahi), groundnut and sesame etc. (Kumar and Gupta 2011).

There is enough scope for minimizing harvest and post harvest losses in these crops. Area, yield, time of storage and marketed surplus have positive influence on harvest and post harvest losses. Shortage of power supply during peak operation periods, shortage of labour at the time of harvesting and lack of technical knowledge are among the constraints identified in proper handling of farm products (Fulley et al. 2006). Hence, reducing the post harvest losses as much as possible is a vital concerning issue in achieving food security of the country.

2.4 Summary of the chapter:

The area production and productivity of both selected crops i.e. wheat and soybean found to be increased in Madhya Pradesh. The area, production and yield of wheat increased with a linear growth of 0.77, 2.60 and 1.87 per cent per year respectively, while the area, production and yield of Soybean increased with linear growth of 6.07, 6.89 and 1.74 per cent per year respectively in last 30 years (1981 - 2010).

The expenses in all the input variables used in cultivation of wheat and soybean and found to be increased approximately 1000, 2000 per cent respectively in the year 2009 – 10 as compared to 1980 – 81, except expenses on manures (wheat), with the results of this the gross and net income were found to be increased manifolds.

The review of different study revealed that the post harvest losses incurred in the wheat and soybean varies between 6 to 9.70 per cent. Amongst all the post harvest losses, storage losses were found to be main component followed by threshing, winnowing and transportation losses. Shortage of power supply during peak operation periods, shortage of labour at the time of harvesting and lack of technical knowledge of post harvest techniques were the major constraints identified in proper handling of farm products. Hence, reducing the post harvest losses as much as possible is a vital concerning issue in achieving food security of the country.

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CHAPTER III

HOUSEHOLDS CHARACTERISTICS, CROPPING PATTERN AND PRODUCTION STRUCTURE

This chapter deals with the profile of selected respondents belongs to different size of farms. The demographic profile, operational holdings, nature of tenancy, source of irrigation, cropping pattern, area under High Yielding Varieties (HYVs), average yield of major crops, percentage of output marketed and value of output and marketed surplus at different size of HHs (respondents) are taken into consideration in this chapter. As the study concerned with two crops i.e. wheat and soybean the information related to above aspects are presented in annexure 1.

3.1 Demographic Profile of selected House holds

The household size, number of earners, proportion of male/female/children, average age, education status, social back ground (SC/ST/OBC/General), annual income and their distance from the main market are the features which were observed for an average household (HH) of different size of farms and presented in Table 3.1. It is observed from the data that an average HH had a family of 7 members, out of which 2 were found earner. The percentage of male, female, children to total family member were found to be of 36.58, 29.80 and 31.43%. On an average 85.94 per cent of HHs were found to be head of the family and remaining 14.06 per cent their family members, who were in farming business. The HHs belonged to age group above 40years, 25 to 40 years and less than 25 years were found to be 59.06, 35.63 and 5.31per cent respectively. The majority of HHs had education to secondary level (31.88%) followed by primary (25%), illiterate (29.06%), graduate & above (16.25%) and higher secondary (7.81%). The majority of the total HHs belonged to Other Backward Class (55.94%) followed by General (30.94%), Schedule Caste (11.25%) and Scheduled tribes (1.88%). The annual earning of an average HH was Rs. 1.09 lac and found to be increased with the size of farm from marginal (Rs. 0.31 lacs) to large (Rs. 2.59 lacs). The HHs of the study area covered an average distance of about 14 Km. to sell their produce.

Table 3.1: Demographic profile of the selected farmers (% 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 numbers of earners		2	2	2	3	2
Proportion of Male/Female/Children (%)	Male >15	37.91	34.20	39.70	34.53	36.58
	Female >15	31.28	29.46	31.16	27.29	29.80
	Children <15	30.81	36.33	30.04	28.52	31.43
Identity of respondent (%)	Head	80.00	93.75	83.75	86.25	85.94
	Others	20.00	6.25	16.25	13.75	14.06
Average age of the respondent (% households)	Less than 25	7.50	1.25	5.00	7.50	5.31
	Between 25 to 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 (% households)	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 (% households)	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)		0.31	0.48	0.99	2.59	1.09

3.1.1 Operational Holdings

An average HH of the study area holds 11.32 acres of land, which was found to be 1.80, 4.28, 10.10 and 29.12 acres in marginal, small, medium and large size farms receptively (Table 3.2). It was also observed that all the HHs cultivated their whole owned land and none of farmers found to leased out their land to other cultivators, 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 there land to other cultivator. On an average only 1.52 acres of land was found to be leased in by an average HH of the study area. The cultivator belongs to medium (3.03 acres) size of farm leased in maximum acres of land followed by large (1.67 acres), small (1.12 acres) and marginal (0.26 acres). The 10.67 acres (83.43%) land was under irrigation out of total net operated area (12.79 acre) at overall level. The percentage irrigated area was found to be more in large (88.96%) followed by marginal (79.82%), small (78.57%) and medium (73.04%) size farms.

The marginal farmers (195.68%) of the study area were found to use their land resource more intensively as compared to small (189.00%), medium (187.54%), and large (185.47%) size of farm. An average HH found to be use their 89.42% of total net area sown in twice a year (Table 3.2). On an average 89.42 per cent of total net sown are was found to be double cropped by HH.

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

Farm size	Owned land	Un cultivated land	Leased-in	Leased - out	NOA	Irrigated area	GCA	Cropping intensity
Marginal	1.80	0.00	0.26	0.00	2.06	1.64 (79.82)	36.04	195.68
Small	4.28	0.00	1.12	0.00	5.39	4.24 (78.57)	91.68	189.00
Medium	10.10	0.00	3.03	0.00	13.05	9.53 (73.04)	235.24	187.54
Large	29.12	0.00	1.67	0.00	30.64	27.26 (88.96)	627.95	185.47
Total	11.32	0.00	1.52	0.00	12.79	10.67 (83.43)	247.73	189.42

Figures in parenthesis show percentage to net operated area (NOA)

3.1.2 Nature of Tenancy

The nature of tenancy was found to be at fixed rent in cash which was Rs. 7777 per acre per year at overall level and ranged between Rs. 6050/- per acre (marginal) to Rs. 8521 per acre (small). On an average 13.75 per cent HHs leased in land from other farmers, which was found to be (12.76%) of their net operated land and ranged between 5.72 per cent (large) to 17.51 per cent (small) in different size of farms (Table 3.3).

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

Farm size	Crop sharing	Crop and cost sharing	Fixed rent in cash	Others	Total	% share of tenancy in NOA	Rent amount Rs. Per acre
Marginal	0	0	7.50	0.00	7.50	10.81	6050
Small	0	0	13.75	0.00	13.75	17.51	8521
Medium	0	0	18.75	0.00	18.75	17.01	8179
Large	0	0	15.00	0.00	15.00	5.72	8356
Overall	0	0	13.75	0.00	13.75	12.76	7777

3.1.3 Source of irrigation

The maximum area was found to be irrigated by tube well (electric + diesel) (67.19%) followed by canal (16.37%), canal + tube well (15.46%) and tanks (0.99%) (Table3.4). 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 is also observed from the data that the majority of marginal and small farmers were found to be depended on canal, while majority of medium and large farmers on tube wells

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

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

3.1.4 Cropping Pattern

Soybean was found to be main crop of the kharif (rainy) season, in which 46.81 per cent of gross cropped area was covered at overall level. Wheat (40.78%) was the second most important crop of the study area grown by cultivator in the rabi (winter) season. Rice (5.07%), gram (8.19%), lentil (1.31%), tur (1.52%) and Jowar (0.80%) were found to be others crops which were also found to be grown by the cultivators in the study area (Table 3.5). Some of the farmers also found to cultivate maize (0.06%), potato (1.17%) and barseem (0.23%) in the study area. It is also observed that Jowar was found to be cultivated by medium farmers in the study area.

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

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Soybean	49.58	45.57	46.28	45.82	46.81
Rice	0.00	6.53	7.73	6.02	5.07
Jowar	0.00	0.00	3.19	0.00	0.80*
Maize	0.00	0.00	0.16	0.09	0.06**
Tur	1.89	1.37	0.48	2.35	1.52
Rabi crops					
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
Berseem	0.00	0.00	0.16	0.76	0.23
Gross cropped area	100	100	100	100	100

* grow only by the one HH, ** grown only by 4 HH of medium & large size group

3.1.5 Area under HYVs

The percentage of area sown under HYVs was found to be 73.29, 82.21, 100, 100 and 100 per cent in case of rice, gram, wheat, potato and soybean respectively, while in case of lentil, cultivators still cultivate local varieties of lentil, due to bold seed quality (Table 3.6).

Table 3.6: Percentage of area under HYV seeds

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Soybean	100.00	100.00	100.00	100.00	100.00
Rice	0.00	100.00	97.90	95.27	73.29
Jowar	0.00	0.00	0.00	0.00	0.00
Maize	0.00	0.00	0.00	0.00	0.00
Tur	0.00	0.00	0.00	0.00	0.00
Rabi crops					
Wheat	100.00	100.00	100.00	100.00	100.00
Gram	68.02	86.34	87.34	87.14	82.21
Lentil	0.00	0.00	0.00	0.00	0.00
Potato	0.00	0.00	100.00	100.00	100.00

The percentage of area under HYVs was found to be same with minor variations in different size of farms.

3.1.6 Average Yield of major Crops

The average yield of selected household of different size of farms was also observed and presented in Table 3.7. It is observed from the data that wheat (13.91 q/acre) gave highest yield in the area under study followed by rice (8.57 q/acre), potato (5.84q/acre), soybean (4.53 q/acre), gram (4.33 q/acre), tur (2.84 q/acre) and lentil (1.97 q/acre). The yield level, of these crops was found to be same with minor variation in different size of farms. Although, medium farmers harvested more yield of crops as compared to other farmers except in case of tur and potato.

Table 3.7: Average yield of major crops grown by the selected households

(Quintal per acre)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Soybean	3.92	4.45	5.08	4.68	4.53
Rice	0.00	10.29	12.02	11.96	8.57
Jowar	0.00	0.00	3.00	0.00	0.75*
Maize	0.00	0.00	0.00	3.00	0.75**
Tur	2.30	2.20	2.09	4.79	2.84
Rabi crops					
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
Berseem	0.00	0.00	6.00	0.00	1.50

* grow only by the one HH, ** grown only by 4 HHs of large size group.

3.1.7 Output marketed by the selected households

The magnitude of marketed surplus to the total production was found to be high in oilseeds followed by pulses and cereals (Table 3.8). At overall level 87.68 per cent of soybean production was marketed followed by gram (80.10 %), lentil (77.62 %), wheat (69.80 %), rice (57.15 %), tur (53.58%) and potato (46.24%). The percentage of output marketed by the selected HHs in different size of farms was found to be similar with minor variation.

Table 3.8: Percentage of output marketed by the selected households

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Soybean	89.36	85.72	87.84	87.83	87.68
Rice	0.00	74.75	72.39	81.45	57.15
Jowar	0.00	0.00	0.00	0.00	0.00
Maize	0.00	0.00	0.00	0.00	0.00
Tur	44.47	44.65	43.50	81.70	53.58
Rabi crops					
Wheat	66.41	67.86	71.26	73.68	69.80
Gram	74.90	82.57	81.33	81.58	80.10
Lentil	66.67	86.96	73.53	83.33	77.62
Potato	0.00	0.00	88.50	96.44	46.24

3.1.8 Value of output and marketed surplus

An average HH of the area under study got Rs. 361052.36/- per farm in which the value of marketed surplus was found to be Rs. 290371.62 per farm. At overall level 80.42 per cent of total income was received through output marketed. As the size of farms increases the percentage of output marketed found to be increased from 72.45 (marginal) to 83.83 per cent (large). The value of output per household and value of marketed surplus also found to be increased with the size of farms (Table 3.9). An average HH received an income of only Rs. 15787.18 per acre in which the value of marketed surplus was found to be Rs. 12112.94 (Table 3.9).

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

	Value of output (main + byproduct)		Value of marketed surplus		% of output marketed
	Rs Per household	Rs Per acre	Rs Per household	Rs Per acre	
Marginal	63731.38	15823.48	46173.75	11565.01	72.45
Small	161206.91	15550.71	120839.41	11786.17	74.96
Medium	422307.63	17003.88	326364.18	13244.39	77.28
Large	796963.53	14770.65	668109.12	11856.20	83.83
Overall	361052.36	15787.18	290371.62	12112.94	80.42

3.2: Summary of the chapter

The socio economic characteristics of sample farmers revealed that:

An average household had a family of 7 members, out of which 2 were found to be earner and the percentage of male, female and children to total family member were found to be of 36.58, 29.80, and 31.43 per cent. On an average 85.94 per cent of HHs were found to be head of the family and remaining 14.06 per cent were their family members, who operated the farming business. The majority of HHs belonged to age group above 40 years (59.06%) followed by age group between 25 to 40 years (35.63%) and less then 25 years (5.31%) and had an education status up to secondary (31.88%) followed by primary (25.00%), illiterate (19.06%), graduate & above (16.25%) and higher secondary (7.81%). The annual earning of an average HH was found to be Rs. 1.09 lacs, and increased with the increase in size of farm from marginal (Rs. 0.31 lacs) to large (Rs. 2.59 lacs). An average HH holds 11.32 acres of land, which 1.80, 4.28, 10.10 and 29.12 acres was found to be in marginal, small, medium and large size farms receptively and all the HHs cultivated their total owned land and none of them found to lease out their land to other cultivators. The 83.43% land was found under irrigation out of total net operated area (12.79 acre). On an average HH leased-in 1.52 acres of land. The marginal farmers (195.68%) were found to use their land more intensively as compared to small (189.00%), medium (187.54%), and large (185.47%) farmers. An

average HH found to use 89.42% of total net area sown in twice a year. The nature of tenancy was found to be at fixed rent in cash (Rs. 7777 per acre per year) and ranged between Rs. 6050/- per acre (marginal) to Rs. 8521 per acre/year (small). At overall level 13.75 per cent of total HH leased in land from other farmers, which was found to be 12.76% of their net operated land and ranged between 5.72 per cent (large) to 17.51 per cent (small) in different size of farms. Tube well (electric + diesel) (67.19%) followed by canal (16.37%), canal + tube well (15.46%) and tanks (0.99%) were found to be major source of irrigation in the area under study. Out of total HHs 62.81 per cent tube well were found to be operated by electricity, while 4.38 per cent operated with diesel. The majority of marginal and small HH were depended on canal, while medium and large wheat growers depended on tube wells. Soybean (46.81%), Wheat (40.78%) was important crops of the study area grown by HH *kharif* (rainy) and *rabi* (winter) seasons respectively. Gram (8.19%), Rice (5.07%), tur (1.52%), lentil (1.31%), potato (1.17%) and jowar (0.80%) were found to be others crops. The percentage of area sown under HYVs was found to be 73.29, 82.21, 100, 100 and 100 per cent in case of rice, gram, wheat, potato and soybean respectively, while in case of lentil cultivator still used local varieties of lentil, due to bold seed quality (Table 3.6).

Wheat (13.91q/acre) gave highest yield followed by rice (8.57q/acre), potato (5.84q/acre), soybean (4.53q/acre), gram (4.33q/acre), tur (2.84q/acre) and lentil (1.97q/acre) at average size farm. The magnitude of marketed surplus to the total production was found to be high in oilseeds followed by pulses and cereal crops. In case of soybean an average HH marketed 87.68 per cent of production, while 80.10, 77.62, 69.80, 57.15, 53.58 and 46.24 per cent of production of gram, lentil, wheat, Rice, tur, and potato was marketed. An average HH got Rs. 361052.36/- per farm and received 80.42 per cent of total income from marketed surplus. It is also observed that as the size of farms increases the percentage of output marketed found to be increased from 72.45 per cent (marginal) to 83.83 per cent (large).

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CHAPTER IV

ASSESSMENT OF PRE HARVEST LOSSES

This chapter deals with the pre harvest losses and constraint faced by the farmers in the cultivation of selected crops i.e. wheat and soybean, incidence of major pest and diseases, crop loss due to these insect pest and adoption method of control these insect pest and disease.

4.1 Constraints faced by the cultivators in cultivation of crop

The deficiency of water for irrigation (90.63%) followed by high cost of input (81.25%), incidence of pest and diseases (8.75%), low price of output (6.87%), and poor seed quality (3.13%) were found to be most important constraints in cultivation of wheat. Hence, it is clear that deficiency of water for irrigation, and high cost of input were found to be most important constraints, while incidence of pest and disease control, poor quality of seed and low price of output were the least important constraints in cultivation of wheat (Table 4.1). The majority of HHs reported that poor quality of seeds (76.88%), water deficiency (61.25%), pest and disease problem (50.00%) and low output price (69.38%) were least important constraints while high cost of input (60.00%) was the most important constraints in cultivation of soybean.

Table 4.1: Constraints faced in cultivation of reference crop (percentage of households)

S.N.	Constraints	Most important	Important	Least important	Constraint faced.	Most important	Important	Least important
		Wheat (160)			**Soybean (160)**			
1	Poor seed quality	3.13	5.63	91.25	Poor seed quality	8.13	15.00	76.88
2	Water deficiency	90.63	5.63	3.75	Water deficiency	10.00	28.75	61.25
3	Pest and disease problems	8.75	11.25	80.00	Pest and disease problems	16.88	33.13	50.00
4	High cost of inputs	81.25	13.75	5.00	High cost of inputs	60.00	18.13	21.88
5	Low output price	6.875	4.375	88.75	Low output price	10.00	20.63	69.38

4.2 Identification of pests and disease attack

The 94.38 percent HHs of the study area were found to be able to distinguish pest and diseases attack in wheat crop, out of them 79.47 and 5.96 per cent HHs able to distinguish pest and disease attack by qualitative and quantitative assessment in cultivation of wheat crop separately and remaining (14.57%) HHs can assess the attack by both ways (qualitative & quantitative) (Table 4.2).

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

Description		Wheat	Soybean
HH able to distinguish pests and disease attack		94.38	100
Assessment about the severity of the attack	Quantitative assessment	5.96	67.50
	Qualitative assessment	79.47	15.00
	Both	14.57	17.50

All the HHs able to distinguish pest and disease attack in cultivation of soybean crop. The majority of them assess the severity of the attack by quantitative assessment (67.50%), while 15% of HHs by quantitative analysis in cultivation of soybean crop (Table 4.2) and 17.50 per cent can assess by both (qualitative & quantitative) ways.

4.3 Incidence of major pests and disease

The majority of HHs reported that the attack of major pest i.e. aphids (48.13%), termite (65.00%) and rat (44.38%) was not so important in cultivation of wheat. The majority of them also reported that the frequency of attack of aphid (100%) was found in every season, while the attack of termite (45%) and rat (43.75%) was found once in two seasons and once in three seasons respectively in the area under study. The majority of HHs also reported the production losses by aphid (86.25%), termite (94.38%) and rat (88.75%) were found to be below 5% in cultivation of wheat.

As regards to rank of severity of major diseases of wheat; rust, smut and leaf blight were found to be major diseases of wheat in the study area. But the majority of them reported that these were found to be of least important in the study area. The majority of them reported that the frequency of rust attack was found to be once in two seasons (78.13%) followed by every year (16.88%) and once in three years (5.00%). The majority of the HHs reported that the attack of leaf blight was found to be once in three season (46.25%) followed by once in two season (41.25%) and every season (12.00%) in cultivation of wheat. The production losses occurred from these diseases were found to be less then 5% from the attack of rust, smut and leaf blight as reported by 97.50%, 88.13% and 95.00% HHs respectively. As regards to infestation of weeds the *Phalaris minor,* and broad leaf weeds i.e. *motha , hirankhuri, badi dudhi, chhoti dudhi, sarson, chitchita* etc. were the major weeds of wheat but their severity was not found under important category as reported by about 86% HHs. Their frequency of attack was found in every season but the production losses were found below 5% as reported by the majority (95.00%) of HHs (Table 4.3).

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

Name of the pest/disease/weed	Rank of severity*			Frequency of attack**			Production loss***				
	1	2	3	1	2	3	1	2	3	4	5
Major Pests											
Aphid	20.00	32.00	48.13	100.00	-	-	86.25	13.75	0.00	0.00	0.00
Termite	15.00	20.00	65.00	37.50	45.00	17.50	94.38	5.63	0.00	0.00	0.00
Rat	16.88	38.75	44.38	19.38	36.88	43.75	88.75	6.88	4.38	0.00	0.00
Major Diseases											
Rust	0.00	8.13	91.88	16.88	78.13	5.00	97.50	1.88	0.63	0.00	0.00
Smut	0.00	0.00	100.00	36.25	43.75	20.00	88.13	11.88	0.00	0.00	0.00
Leaf Blight	0.00	0.00	100.00	12.50	41.25	46.25	95.00	3.13	1.88	0.00	0.00
Major Weeds											
Phalaris minor	1.88	11.88	86.25	100.00	0.00	0.00	91.25	8.75	0.00	0.00	0.00
Broad Leaf Weeds (*motha, hirankhuri, badi dudhi, chhoti dudhi, chitchita* etc.)	0.00	19.38	80.63	100.00	0.00	0.00	95.00	5.00	0.00	0.00	0.00

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

In soybean Girdle beetle and caterpillar were found to very important pest of soybean in the study area as their rank of severity was found to be of very important as reported by 91.25% (Girdle beetle) and 57.50% (caterpillar) of HHs.

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

Name of the pest/disease/weed	Rank of severity*			Frequency of attack**			Production loss***				
	1	2	3	1	2	3	1	2	3	4	5
Major Pests											
Girdle Beetle	91.25	6.25	2.50	96.25	3.75	0.00	11.25	78.75	3.75	3.75	2.50
Caterpillar	57.50	27.50	15.00	73.75	26.25	0.00	85.00	3.75	6.25	3.75	1.25
Major Diseases											
Wilt	50.00	42.50	7.50	31.25	48.75	20.00	88.75	7.50	1.25	2.50	0.00
Mosaic	58.75	28.75	12.50	53.75	32.50	13.75	86.25	11.25	2.50	0.00	0.00
Root Rot	73.75	5.00	21.25	47.50	16.25	36.25	91.25	7.50	0.00	1.25	0.00
Major Weeds											
Samel	63.75	13.13	23.13	100.00	0.00	0.00	91.25	6.25	2.50	0.00	0.00
Dudhi	77.50	8.75	13.75	98.75	1.25	0.00	88.75	8.75	2.50	0.00	0.00
Motha	92.50	6.25	1.25	100.00	0.00	0.00	95.63	4.38	0.00	0.00	0.00
Krishnneel	60.00	36.25	3.75	73.75	22.50	3.75	100.00	0.00	0.00	0.00	0.00

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

As regards to the diseases of soybean, it was observed that root rot (73.75%), mosaic (58.75%) and wilt (50.00%) were found to be major diseases of soybean as reported by the majority of HHs. The frequency of attack was found to be every season for mosaic and root rot as reported by 53.75% and 47.50% of HHs, while in case of wilt its frequency occurred once in a two season (48.75%) as reported by the majority of HHs.

But the losses occurred by these diseases were found not more than 5% as reported by the more than 85% of HHs.

As regards to the infestation of weeds in cultivation of soybean; *Samel, Dudhi, Motha and Krishaneel* were found to be very important weeds of the soybean as reported by 63.75%, 77.30%, 92.50% and 60% HHs respectively. The frequency of all these weeds was found to be every season but the production losses were found to be less than 5% as majority of HHs were using the weedicide to control these weeds in soybean field.

4.4 The magnitude of crop loss due to pests, disease and weed infestation in Wheat.

The magnitude of crop losses due to pest, diseases and weeds infestation was also observed for wheat & soybean and presented in Table 4.5 & 4.6 respectively. It is observed from the data that on an average size of farm the losses over normal (13.87q/ac) and actual (12.64 q/ac) production were found to be 8.89 and 9.75per cent respectively in wheat (table 4.5).

Table 4.5: The magnitude of crop loss in wheat due to pests, disease and weed Infestation.

(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

As the size of farm increased the percentage of losses over actual and normal production were found to be increased from 6.89% (marginal) to 13.56% (large) over actual production and from 7.40% (marginal) to 15.68% (large) over normal production of wheat.

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

(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 magnitude of crop losses due to pest diseases and weeds infestation in soybean was also observed and presented in Table 4.6. It is observed from the data that on

an average size of farm 12.93 and 11.37 per cent losses were recorded over actual (5.60 q/ac) and normal (6.31 q/ac) production respectively. As the size of farm increased the percentage of losses were found to be increased from 8.73 (marginal) to 16.51% (large) over actual production and from 8.03 (marginal) to 14.17per cent (large) over normal production of soybean.

4.5 Pre harvest losses in different agro climatic regions

The pre harvest losses in different agro climatic regions of Madhya Pradesh related to wheat and soybean were also observed and presented in table 4.7 & 4.8

Table 4.7: The magnitude of crop loss in wheat due to pests, disease and weed Infestation in different agro climatic regions (q/acre).

	Vindhyan Plateau					Central Narmada Valley				
Description	Marginal	Small	Medium	Large	Total	Marginal	Small	Medium	Large	Total
Actual production with attack	14.00	14.00	15.00	10.00	13.25	12.48	12.00	14.00	9.00	11.87
Normal production without attack	15.08	15.24	16.84	11.48	14.66	13.40	13	15.48	10.5	13.10
Loss of output	1.08	1.24	1.84	1.48	1.41	0.92	1.00	1.48	1.50	1.23
Percentage loss over actual production	7.71	8.86	12.27	14.80	10.91	7.37	8.33	10.57	16.67	10.74
Percentage loss over normal production	7.16	8.14	10.93	12.89	9.78	6.87	7.69	9.56	14.29	9.60

It is observed from the data the pre harvest losses of wheat were found to be more in Vindhyan plateau i.e. 10.91& 9.78 per cent over actual production (13.25q/acre) and normal production (14.66q/acre) respectively, as compared to central narmada valley (10.74 & 9.60 per cent over actual production (11.87q/acre) and normal production (13.10q/acre). The percentage loss over actual and normal production was found to be directly proportionate to the size of farms in both the agro climatic regions (table 4.7).

As regards to the pre harvest losses of soybean these also found to be more in Vindhyan plateau 14.15 & 12.34 per cent respectively over actual production (5.28q/acre) over normal production (6.02q/acre) as compared to Malawa plateau 12.43& 10.92per cent over actual production (5.92q/acre) over normal production (6.62q/acre) of soybean. The percentage loss over actual and normal production was also found to be directly proportionate to the size of farms in soybean both the agro climatic regions.

Table 4.8: The magnitude of crop loss in Soybean due to pests, disease and weed Infestation in different agro climatic regions (q/acre).

Description	Vindhyan Plateau					Malawa Plateau				
	Marginal	Small	Medium	Large	Total	Marginal	Small	Medium	Large	Total
Actual production with attack	6.06	5.06	5.00	5.00	5.28	7.00	6.00	5.00	5.66	5.92
Normal production without attack	6.70	5.71	5.74	5.92	6.02	7.50	6.53	5.84	6.62	6.62
Loss of output	0.64	0.65	0.74	0.92	0.74	0.50	0.53	0.84	0.96	0.71
Percentage loss over actual production	10.56	12.85	14.80	18.40	14.15	7.14	8.83	16.80	16.96	12.43
Percentage loss over normal production	9.55	11.38	12.89	15.54	12.34	6.67	8.12	14.38	14.50	10.92

4.6 Cost of Chemical methods adopted for pests and disease control

The cost of chemical methods adopted for pest and disease control (Rs/acre) for wheat and soybean have been observed at different size of farms and presented in table 4.9 and 4.10. It is observed from the data that none of The HHs found to be applied insecticides in their wheat crop to control infestation of insect was reported to be under the economic threshold level in wheat.

As regards to cost incurred in control of weeds in cultivation of wheat an average HH found to invest Rs 299.60/acre in weedicide. Amongst different size of farms cost of weedicide found to be the highest at medium size of farm (Rs 307.25 /acre) followed by large (Rs 306.57 /acre), small (Rs 302.10 /acre) and marginal (Rs 282.47/acre).

Table 4.9: Cost of Chemical methods adopted in wheat for pests and disease control

(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

Generally hand-weeding was found in practice to control weeds in wheat. As wheat is a winter season crop and infestation of weeds not a burning problem. *Phalaris minor* was one of the common weed of the wheat in the study area, which seems like wheat. Hence, hand weeding is the only option to solve the problem.

As regards to cost of fungicides, an average HH invested Rs 51.33/acre as seed – treatment with fungicides viz. Bavistin, Thairum and Carbandazim etc. in the study area. As the size of farm increases the cost of fungicides found to be increased from marginal (Rs 31.44/acre) to large (Rs73.88/acre).

The cost of chemical in soybean crop for control of pest and disease was found to be more as compared to wheat crop. The control of weeds is the major problem in cultivation of soybean. As soybean is a rainy season crop various types of weeds are found to emerge in soybean field. Chemical control (weedicide) was found to be most popular and only method to control weeds in the area under study. As hand weeding is not possible due to moisture in the soil (black cotton soil). An average HH invested Rs 411.60/acre to control weeds in soybean (table 4.10). The cost of weedicide has been found to be increased with the size of farms from Rs 393.59/acre (marginal) to Rs 419.48/acre (large).

The incidence of insect in soybean was found to be very common in study area and all the HHs were found to use insecticide to control insects for cultivation of soybean. An average HH invested Rs 555.29/acre in insecticide. Medium farmers (Rs 568.78/acre) were found to be invested more in insecticide as compared to marginal (Rs 542.00/acre), small (Rs 545.72/acre) and large (564.66/acre) farmers.

Table 4.10: Cost of Chemical methods adopted in soybean for pests and disease control

(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 seed treatment with fungicide was also found to be common in the study area in cultivation of soybean. An average HH invested Rs 97.69/acre in fungicide. The cost of seed treatment was found to be some what more in medium (Rs 105.00/acre) followed by large (Rs 102.00/acre), small (Rs 94.00/acre), and marginal (Rs 89.25/acre) farms.

4.7 Biological methods adopted for pests and disease control

None of the households followed the biological method for control of insect, pest and diseases in the area under study.

4.8 Extension services on pests and disease control management

The data related to extension services on pest and disease control management for selected crops i.e. wheat and soybean have been presented in table 4.11. It is clear from the data that only 77.50% and 26.25% HHs were found to be seeking advice related to control of pest and disease in soybean and wheat crop. Private input dealers were found to be most important source of seeking advice on pest and disease control management as reported by 64.29% of HHs followed by agricultural university/ KVKs (7.14%) and TV/Radio service/News paper (4.76%), while government extension agent were found to be important source of seeking advice as reported by 76.19% of HHs followed by private input dealers (21.43%), agricultural university/ KVKs (19.05%) and TV/radio service/news paper (16.67%) in case of wheat. It is also observed that fellow farmers were found to be least important for seeking advice to control on pest and disease. The similar trend was noticed for soybean also.

Table 4.11: Extension services on pests and disease control management

(Percentage of HH)

Particulars	**Wheat**				**Soybean**			
Percentage of HH seeking advice	26.25				77.50			
	Rank of sources				Rank of sources			
Sources of advice	Most imp	Important	Least imp	Details of advice	Most imp	Important	Least imp	Details of advice
Government extension agent	0.00	76.19	23.81	Plant geometry, soil testing	4.03	4.03	91.94	Plant geometry, soil testing, inputs
Private input dealer	64.29	21.43	14.29	Proper Plant protection measures, seeds	71.77	15.32	12.90	Proper Plant protection measures, seeds
Fellow farmers	0.00	0.00	100.00	Fertilizer & Manures application	21.77	45.97	32.26	Fertilizer & Manures application
TV/Radio service/Newspaper	4.76	16.67	78.57	Govt. schemes for agriculture	0.00	15.32	84.68	Govt. schemes for agriculture
Agricultural University/KVK	7.14	19.05	73.81	Varietals & Machinery info	11.29	8.87	79.84	Varietals & Machinery info
Any other	0.00	0.00	0.00		0.00	0.00	0.00	

Hence, it can be concluded that private input dealers were found to be most important whereas, govt. extension agent and fellow farmers were found to be important and least important extension services on pest and disease control management as reported by majority of HHs of study area.

4.9: Households Suggestions to minimize pre-harvest losses

The sample households related to soybean and wheat crops were by and large same but there frequency somewhat differ. The suggestions of sampled soybean and wheat growers with respect to minimize pre-harvest losses are presented in table 4.12.

Table 4.12: Households Suggestions to minimize pre-harvest losses

S.No.	Suggestions	No. of Respondents			
		Soybean Growers		Wheat Growers	
		(n =160)	%	(n =160)	%
1	Proper technical guidance about pest & disease control measure including integrated pest management techniques	156	97.50	118	73.75
2	Timely availability of recommended pesticides & weedicides	153	95.63	111	69.38
3	Subsidy on insecticide, pesticide & weedicide and plant protection equipments viz. light traps, sprayer, duster etc.	76	47.50	74	46.25
4	Organized skill orientation programme regarding to pest and disease control	78	48.75	89	55.63
5	Timely availability of plant protection equipments viz. sprayer, duster etc. at village level on rental basis	153	95.63	74	46.25

It is observed from the data that the majority of sample soybean growers were suggested Proper technical guidance about pest & disease control measure including integrated pest management techniques (97.50%) followed by timely availability of recommended pesticides & weedicides (95.63%), timely availability of plant protection equipments viz. sprayer, duster etc. at village level on rental basis (95.63%), subsidy on insecticide, pesticide & weedicide and plant protection equipments viz. light traps, sprayer, duster etc. (47.50%) and organized skill orientation programme regarding to pest and disease control (48.75%). These suggestions were also reported by wheat growers with minor variations.

4.10: Summary of the chapter

The constraints faced by the wheat and soybean growers in identification, incidence, attack and control of insect and weeds with source of information received from different sources have been observed during the course of investigation and found that:

The deficiency of water for irrigation, and high cost of input were found to be most important constraints, while incidence of pest and their control, poor quality of seed and low price of output were the least important constraints in cultivation of wheat in the area under study. The 94.38 percent of wheat growers of the study area were found to be able to distinguish pest and diseases attack and 79.47 per cent of them could not distinguish pest and disease attack by qualitative assessment. Only 5.96% of wheat growers able to assess the pest and disease attack by quantitative assessment in cultivation of wheat. The attack of major pest i.e. aphids (48.13%), termite (65.00%) and rat (44.38%) was not so important in cultivation of wheat. The frequency of attack of aphid (100%) was found in every season, while the attack of termite (45%) and rat (43.75%) was found once in two seasons and once in three seasons respectively in the area under study and incurred the loss of grain below 5% in cultivation of wheat. The rust, smut and leaf blight were the major diseases of wheat in the study area. But the majority of them reported that these were least important. The rust was found to occur once in two seasons (78.13%) followed by every year (16.88%) and once in three years (5.00%). The attack of leaf blight found to occur once in three season (46.25%) followed by once in two season (41.25%) and every season (12.00%) in cultivation of wheat. As regards to infestation of weeds the *Phalaris minor,* and broad leaf weeds i.e. *motha, hirankhuri, badi dudhi, chhoti dudhi, sarson, chitchita* etc. were the major weeds of wheat but found less severe as reported by about 86% HHs. The frequency of attack of weeds was found in every season but the production losses were found below 5% as reported by the majority of HHs. As the size of farm increased the percentage of losses over actual and normal production were found to be increased from 6.89% (marginal) to 13.56% (large) over actual production and from 7.40% (marginal) to 15.68% (large) over normal production of wheat. None of the HHs used insecticides to control infestation of insect not crossed the economic threshold level in wheat. An average HH found to invest Rs 299.60/acre in weedicide. Cost of weedicide found to be the highest at medium size of farm (Rs 307.25 /acre) followed by large (Rs 306.57 /acre), small (Rs 302.10 /acre), and marginal (Rs 282.47/acre) farms. Generally hand-weeding is found in practice to control weeds in wheat. As wheat is a winter season

crop and infestation of weeds is not a burning problem. *Phalaris minor* is a common weed of the wheat in the study area, which seems like wheat hence, hand weeding is the only option to solve the problem. An average wheat grower invested Rs 51.33/acre on seed treatment with fungicides viz. Bavistin, Thairum and Carbandazim etc. As the size of farm increases the cost of fungicides found to be increased from marginal (Rs 31.44/acre) to large (Rs73.88/acre) farm.

As regards to soybean the high cost of input (60.00%) was found to be important constraint in the cultivation of soybean. The cent percent soybean growers able to distinguish pest and disease attack in cultivation of soybean crop. The majority (67.50%) of them assess the severity of the attack by quantitative assessment. Only 15% of HHs able to assess the pest and disease attack by qualitative analysis in cultivation of soybean crop. In soybean Girdle beetle and caterpillar were found to be very important pest of soybean in the study area as their rank of severity was found to be of very important as reported by 91.25% (Girdle beetle) and 57.50% (caterpillar) of HHs. The root rot (73.75%), mosaic (58.75%) and wilt (50.00%) were found to be major diseases of soybean as reported by the majority of HHs. The frequency of attack was found to be every season for mosaic and root rot as reported by 53.75% and 47.50% of HHs, while in case of wilt, it occurred once in a two season (48.75%) as reported by the majority of HHs. But the losses occurred by these diseases was found not more than 5% as reported by the more than 85% of HHs. *Samel, Dudhi, Motha and Krishaneel* were found to be very important weeds of the soybean as reported by 63.75, 77.30, 92.50 and 60 per cent of soybean growers respectively. The frequency of all these weeds were found to be every season but the production losses were found to be less then 5% as majority of soybean growers apply weedicide to control these weeds in their field. On an average size of farm the losses occurred were found to be 13.50 and 11.83 percent over actual (5.59 q/ac) and normal (6.33 q/ac) production in soybean. As the size of farm increases the percentage of actual and normal production were found to be increased from 10.10 (marginal) to 16.51per cent (large) over actual production and from 9.17 (marginal) to 14.71per cent (large) over normal production of soybean. The control of weeds was found the major problem in cultivation of soybean. Chemical control (weedicide) found to be most popular and only method to control weeds in the area under study, as hand weeding is not possible due to moisture in the soil (black cotton soil). An average soybean grower invested Rs 411.60/acre to control weeds in soybean. The cost of weedicide found to be increased with the size of farms from Rs 393.59/acre (marginal) to Rs 419.48/acre (large).

The incidence of insect in soybean was found to be very common in study area and all the HHs were found to use insecticide to control insects. An average soybean grower found to invest Rs 555.29/acre in insecticide. Medium farmers (Rs 568.78/acre) invested more in insecticides as compared to marginal (Rs 542.00/acre), small (Rs 545.72/acre) and large (564.66/acre) farmers. An average soybean grower invested Rs 97.69/acre in fungicide. The cost of seed treatment was found to be somewhat more in medium (Rs 105.00/acre) followed by large (Rs 102.00/acre), small (Rs 94.00/acre), and marginal (Rs 89.25/acre) farms.

None of the soybean and wheat grower followed the biological method for control of insect, pest and diseases due to lack of unavailability in the area under study. The cost of chemical in soybean crop for control of pest and disease was found to be more as compared to wheat crop. The 77.50 and 26.25per cent HHs were found to be seeking advice related to control of pest and disease respectively for soybean and wheat crop. Private input dealers were found to be most important source of seeking advice on pest and disease control management as reported by 64.29per cent of HHs followed by agricultural university/ KVKs (7.14%) and TV/Radio service/News paper (4.76%), while government extension services were found to be important source of seeking advice on plant geometry and soil testing as reported by 76.19% of HHs followed by private input dealers (21.43%), agricultural university/ KVKs (19.05%) and TV/radio service/news paper (16.67%).

The majority of sample HHs related to soybean were suggested proper technical guidance about pest & disease control measure including integrated pest management techniques (97.50%) followed by timely availability of recommended pesticides & weedicides (95.63%), timely availability of plant protection equipments viz. sprayer, duster etc. at village level on rental basis (95.63%), subsidy on insecticide, pesticide & weedicide and plant protection equipments viz. light traps, sprayer, duster etc. (47.50%) and organized skill orientation programme regarding to pest and disease control (48.75%) for more adoption of plant protection technologies in cultivation of crops in their fields. These suggestions were also reported by wheat growers with minor variations.

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CHAPTER V

ASSESSMENT OF POST HARVEST LOSSES

This chapter deals with the assessment of harvest and post harvest losses, viz. quantity lost at different stages of harvest i.e. threshing, winnowing, transportation and handling, and storage related to the reference crops (wheat and soybean) in different locations of the study.

5.1 Harvest and Post – Harvest Losses

The cultivators of study area were found to preferred early (78.04%) and mid (21.96%) verities of wheat. All the HHs who have sown mid varieties used to preferred harvested their produce manually. The HHs who used to sown early varieties of wheat were found to prefer manual (73.61%) and mechanical (26.39%) method of harvesting. As regards rank of losses reported by the HHs; 48.75 & 51.25 per cent and 40.62 & 59.38 per cent HHs reported the medium and low rank of losses in early and medium varieties respectively. The estimation of losses were found to be more in mid varieties (2.84kg/q) as compared to early varieties (2.79kg/q) of wheat (Table 5.1).

Table 5.1: Quantity lost at different stages of harvest – Wheat (%)

Stages of harvest and variety		Early	Mid
		HYV	HYV
Area harvested per HH (acres)		8.28	2.33
Percentage area harvested (early, mid and late)		78.04	21.96
Area manually harvested (%)		73.61	100.00
Area mechanically harvested (%)		26.39	-
Rank of loss (% of households)	High	0.00	0.00
	Medium	48.75	40.62
	Low	51.25	59.38
Quantity lost during harvest	Kg per acre of harvest	38.66	39.46
	Kg per quintal of harvest	2.79	2.84
	Loss % of harvest amount	2.79	2.84

As regards to quantity lost at different stages of harvest related to soybean, all the HHs were found to be cultivated early varieties of soybean *viz*, JS9305 and JS – 335. The 68.37% and 31.63 % of HHs of soybean preferred mechanical and manual method of harvesting respectively.

The majority of HHs also reported that the rank of loss was low (51.25%) followed by medium (28.75%) and high (20.00%). The quantity of lost during harvest was found to be 7.45% (7.45kg/q) (Table 5.2). The harvest losses were found to be more in soybean (7.45kg/q) as compared to wheat (2.84 kg/q).

Table 5.2: Quantity lost at different stages of harvest – Soybean (%)

Stages of harvest and variety		Early		Mid		Late
		HYV	Local	HYV	Local	HYV
Area harvested per HH (acres)		10.64	-	-	-	-
Percentage area harvested (early, mid and late)		100	-	-	-	-
Area manually harvested (percentage)		31.63	-	-	-	-
Area mechanically harvested (percentage)		68.37	-	-	-	-
Rank of loss (percentage of households)	High	20.00	-	-	-	-
	Medium	28.75	-	-	-	-
	Low	51.25	-	-	-	-
Quantity lost during harvest	Kg per acre of harvest	35.55	-	-	-	-
	Kg per quintal of harvest	7.45	-	-	-	-
	Loss % of harvest amount	7.45	-	-	-	-

5.2 Threshing & winnowing losses

The quantity lost during threshing and winnowing related to wheat and soybean have been presented in table 5.3. It is observed from the data that all the HHs whether related to wheat or soybean threshed their harvested produce through mechanical thresher cum winnower. The quantity lost during threshing and winnowing found to be more in soybean (2.34 kg/q) as compared to wheat (0.34kg/q) (Table 5.3).

Table 5.3: Quantity lost during threshing and winnowing (%)

Stages of harvest and variety		Wheat		Soybean	
		Local	HYV	Local	HYV
Area/quantity mechanically threshed (percentage of HH)		-	100.00	-	100.00
Rank of loss (percentage of households)	High	-	0.00	-	7.50
	Medium	-	23.13	-	15.00
	Low	-	76.88	-	77.50
Quantity lost during threshing	Average loss (Kg per acre)	-	4.68	-	11.19
	Average loss (Kg per qtl)	-	0.34	-	2.34
	Loss % of threshed amount	-	0.34	-	2.34
Area/quantity manually winnowed (percentage of HH)		-	-	-	-
Rank of loss (percentage of households)	High	-	-	-	-
	Medium	-	-	-	-
	Low	-	-	-	-
Quantity lost during winnowing	Average loss (Kg per acre)	-	-	-	-
	Average loss (Kg per qtl)	-	-	-	-
	Loss % of winnowed amount	-	-	-	-

5.3 Transportation losses

The quantity lost during transportation and handling related to wheat and soybean has been presented in Table 5.4 and 5.5. The majority of HHs preferred tractor trolley (49.44%) followed by bullock cart (14.56%) to transport and handling their wheat from threshing floor to market and ranked their losses during transportation in low category followed by medium and high. The average loss during transportation was found to be 0.18kg/q and observed more in bullock cart (0.23kg/q) as compared to tractor trolley (0.19kg/q). The average loss during handling of grains of wheat has been found to be

0.40kg/q and found more in tractor trolley (0.42kg/q) as compared to bullock cart (0.37 kg/q) (Table 5.4).

Table 5.4: Quantity lost during transportation and handling –Wheat

Mode of transportation		Bullock cart	Trolley	Total
Average quantity transported (qtls per hh)		14.56	49.44	64.00
Average distance covered (kms)		12.04	12.04	12.04
Transportation cost (Rs per quintal)		9.34	15.00	12.17
Rank of loss (percentage of HH)	High	4.76	3.87	4.32
	Medium	16.08	7.10	11.59
	Low	79.16	89.03	84.10
Quantity lost during transport	Average loss (Kg per qtl of amount transported)	0.23	0.19	0.18
	% of amount transported	1.58	0.38	0.92
Quantity lost during handling	Average loss (Kg per qtl of amount handled)	0.37	0.42	0.40
	% of amount handled	0.03	0.01	0.02

As regards to soybean an average soybean grower used to cover 15.86 km distance, to market his 50.98 q of produce. Here, also the majority of HHs reported low (88.75%) followed by medium (7.50%) and high (3.75%) rank of loss during transportation of produce from threshing floor to market. An average HH reported 0.23 kg/q loss during transportation of soybean produce from threshing floor to market. The average loss during handling of soybean was found to be 0.34kg/q in the study area (Table 5.5).

Table 5.5: Quantity lost during transportation and handling: Soybean

Mode of transportation		Trolley
Average quantity transported (qtls per HH)		50.98
Average distance covered (kms)		15.86
Transportation cost (Rs per quintal)		30
Rank of loss (% of HH)	High	3.75
	Medium	7.5
	Low	88.75
Quantity lost during transport	Average loss (Kg per qtl of amount transported)	0.23
	% of amount transported	0.0045
Quantity lost during handling	Average loss (Kg per qtl of amount handled)	0.34
	% of amount handled	0.0067

5.4 Storage losses

The data related to quantity lost during storage for wheat and soybean has been presented in Table 5.6. It is observed from the data that the HHs of the study area only used *kachha* and *pucca* house to store grains. Out of total quantity (42.14q) stored for wheat the maximum was found to be stored in kachha house (30.14q) as compared to pucca house (12.00q). The *kothi* /bin *kachha*, *pucca*, followed by gunny bags / plastic bags, and open space were found to be mode of storage in the study area. An average HH of the study area stored their grains approximately for the period of 190 days. All the HHs

reported that rank of loss at low level, the quantity lost during the storage was mainly due to rodent (8.46 kg/q) and fungus (1.13kg/q). The cost of storage was found to be Rs. 4.19 per quintal in the study area.

Out of the total quantity of the soybean (43.55q/HH), an average HH stored 72.97% (31.78q) of soybean grain in *kachha* house and 27.03% (11.77q) in *pucca* house. The maximum quantity of soybean grain was found to be stored in open space followed by gunny / plastics bags and *kothi* bin, *kachha*, *pucca* irrespective of *kachha & pucca* house. None of the HHs was found to store their soybean grains in steel drums etc. An average HH of the study area found to store soybean grains for a period 87 to 93 days. The majority of them reported low followed by medium rank of loss in storage of soybean grains.

The maximum quantity lost during storage was found due to weigh loss followed by rodents and fungus. An average HH spent Rs. 4.72 and Rs. 9.20 per quintal to store their soybean grains in *kachha* and *pucca* house respectively.

Table 5.6: Quantity lost during storage

Place of storage*		Wheat		Soybean	
		1	2	1	2
Mode of storage (percentage of amount stored	Open	13.40	11.24	68.84	79.28
	Gunny/plastic bag	24.64	18.95	22.15	13.93
	Kothi/bin kuchha, Pucca	61.96	69.81	9.01	6.79
	Steel drums	0.00	0.00	0.00	0.00
	Others	0.00	0.00	0.00	0.00
Amount stored (Qtls per hh)		30.14	12.00	31.78	11.77
Percentage of hh who dried before storing		0.00	0.00	0.00	0.00
Average number of days stored (per hh)		192.00	186.00	87.00	93.00
Rank of loss in storage	High	0.00	0.00	5.00	0.00
	Medium	0.00	0.00	22.50	45.00
	Low	100.00	100.00	72.50	55.00
Quantity lost during storage (kgs per quintal of storage)	Due to weight loss	0.00	0.00	2.35	1.98
	Due to rodents	9.00	7.92	0.15	0.64
	Due to fungus	1.58	0.68	0.07	0.00
Storage cost Rs. per quintal		4.82	3.56	4.72	9.20

Note: * Kachha house =1; Pucca house =2; Scientific godown/warehouse =3; others =4

The capacity utilization of storage by the HHs for wheat and soybean has been presented in Table 5.7. It is observed from the data that amongst different mode of storage capacity the capacity utilization of *kothi /bhukari* /bin *kachha* (84.00%) was found to be more as compared to gunny / plastic bags (36.74%) and open place (17.31%) for storage of wheat grains by the HHs of the study area. Whereas, approximately 40.00% capacity utilization of different mode of storage were found to be utilized by the HHs for

soybean grains for *kothi* / bin *kachha*, gunny/ plastics bags and open space. As regards to *kothi* / bin *pucca* the HHs utilized its 14.80% capacity for soybean grains.

Table 5.7: Capacity utilization of storage by the households

Mode of storage	Wheat			Soybean		
	Capacity (qtls)	Actual storage (qtls)	Capacity utilization (%)	Capacity (qtls)	Actual storage (qtls)	Capacity utilization (%)
Open	30	5.19	17.31	30	12.54	41.80
Gunny Plastic bag	25	9.18	36.74	20	8.56	42.80
Kothi/bukhari/bin kachha	10	8.40	84.00	50	20.97	41.94
Kothi/bukhari/bin made of cement	50	19.36	38.72	10	1.48	14.80
Steel drums	0.00	0.00	0.00	0.00	0.00	0.00
Others	0.00	0.00	0.00	0.00	0.00	0.00

The total post harvest losses per quintal of grains at different size of farms for wheat and soybean have been presented in Table 5.8. It is observed from the data that on an average 8.61 kg/q and 12.56 kg/q grains were lost in case of wheat and soybean grain respectively.

The maximum quantity of loss was recorded in storage (56%) followed by harvest (33%), handling (5%) threshing & winnowing (4%), and transportation (2%) of grains in wheat (Fig.5.1). While, in case of soybean the maximum quantity lost in harvest (56%), followed by storage (20%), threshing & winnowing (19%), handling (3%), and transportation (2%) of grains in Soybean (Fig 5.2). The data also revealed that the quantity lost in wheat grains found more in large (9.78kg/q), followed by small (8.46kg/q), medium (8.10kg/q), and marginal (8.09 kg/q) farms. The quantity soybean grains losses were found more in large (14.50kg/q) followed by small (12.53kg/q), marginal (11.76kg/q), and medium (11.42kg/q).

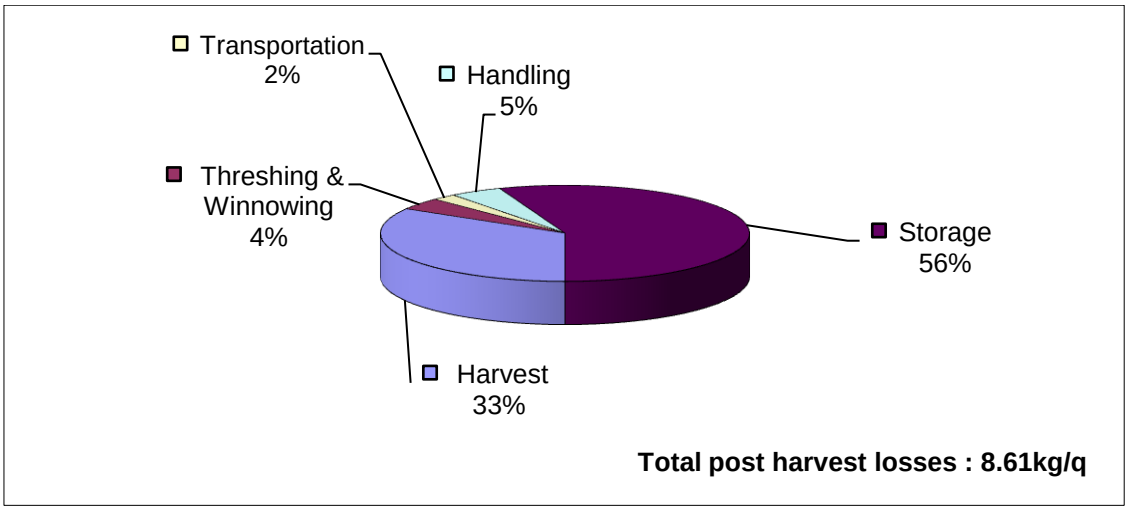

Fig 5.1: Percentage Post harvest losses in different stages of wheat production.

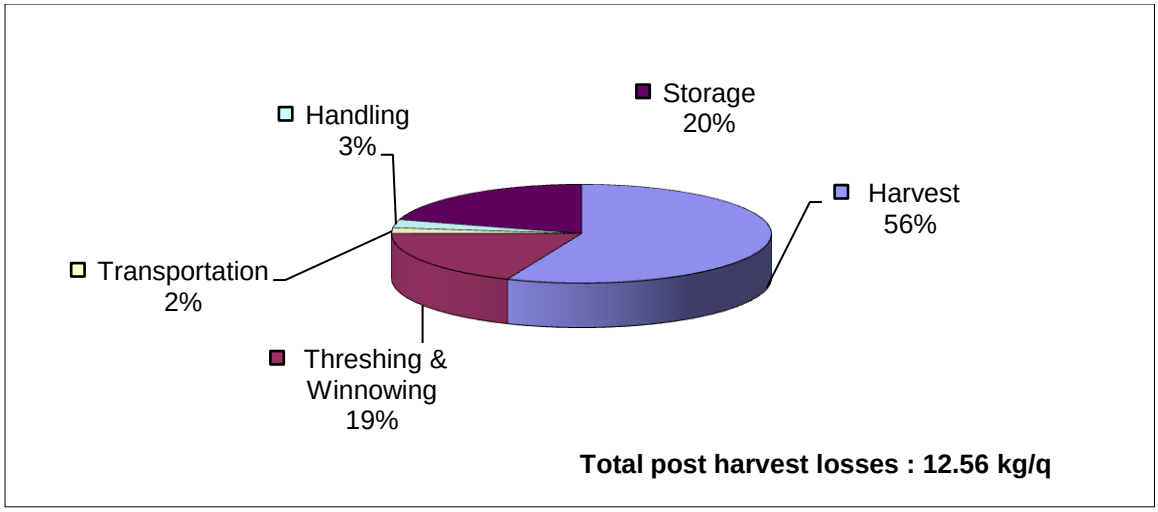

Fig 5.2: Percentage Post harvest losses in different stages of soybean production.

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

Particulars	Wheat					Soybean				
	Marginal	Small	Medium	Large	Total	Marginal	Small	Medium	Large	Total
Harvest	2.59	2.78	2.42	3.73	2.88	7.25	7.42	6.10	7.53	7.08
Threshing & winnowing	0.28	0.32	0.29	0.51	0.35	2.18	2.30	1.98	2.95	2.35
Transportation	0.16	0.18	0.18	0.21	0.18	0.20	0.22	0.23	0.26	0.23
Handling	0.36	0.38	0.40	0.44	0.40	0.32	0.33	0.34	0.36	0.34
Storage	4.68	4.77	4.79	4.90	4.79	1.82	2.26	2.78	3.40	2.57
Total post harvest loss (kg per qtl)	8.09	8.46	8.10	9.78	8.61	11.76	12.53	11.42	14.50	12.56
Total post harvest loss (kg per acre)*	115.04	119.47	130.84	107.48	118.21	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.

5.5 Post harvest losses in different Agro climatic regions

The total post harvest losses in different agro climatic regions of Madhya Pradesh related to wheat and soybean were also observed and presented in table 5.9 & 5.10.

Table 5.9: Post harvest losses (Kg/q) of wheat in different agro climatic zones

Post Harvest Losses	Central Narmada Valley					Vindhyan plateau				
	Marginal	Small	Medium	Large	overall	Marginal	Small	Medium	Large	overall
Harvest	2.05	2.36	2.14	3.06	2.40	3.46	3.60	2.79	4.75	3.65
Threshing & Winnowing	0.21	0.27	0.25	0.42	0.29	0.38	0.39	0.33	0.65	0.44
Transport	0.14	0.17	0.19	0.22	0.18	0.18	0.18	0.17	0.22	0.19
Handling	0.34	0.38	0.38	0.45	0.39	0.38	0.42	0.41	0.45	0.42
Storage	4.68	4.77	4.79	4.90	4.79	4.71	4.82	4.82	4.90	4.81
Total post harvest Loss (kg/q)	7.42	7.95	7.74	9.05	8.04	9.11	9.41	8.52	10.97	9.50
Total post harvest Loss (kg/acre)*	129.86	131.84	141.65	120.09	130.86	99.66	109.63	119.60	95.53	106.11

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

It is observed from the data that post harvest losses of wheat were found to be more in Vindhyan plateau (9.50 kg/q) as compared to Central Narmada Valley (8.04 kg/q). Amongst different size of farms the post harvest losses were found to be maximum in large size of farm (9.05 kg/q) followed by small (7.95 kg/q), medium (7.74 kg/q), and marginal (7.42 kg/q) farms in Central Narmada Valley, while in Vindhyan Plateau the post harvest losses were found to be more in large size of farms (10.97 kg/q) followed by small (9.41 kg/q), marginal (9.11 kg/q) and medium (8.52 kg/q). The post harvest losses occurred at various stages were found to be maximum in storage (51%) followed by harvest (38%), threshing and winnowing (5%), handling (4%) and transport (2%) in Vindhyan Plateau while the maximum quantity loss has been found to be in storage (59%) followed by harvest (30%), handling (5%), threshing and Winnowing (4%), and transportation (2%) in case of Central Narmada Valley.

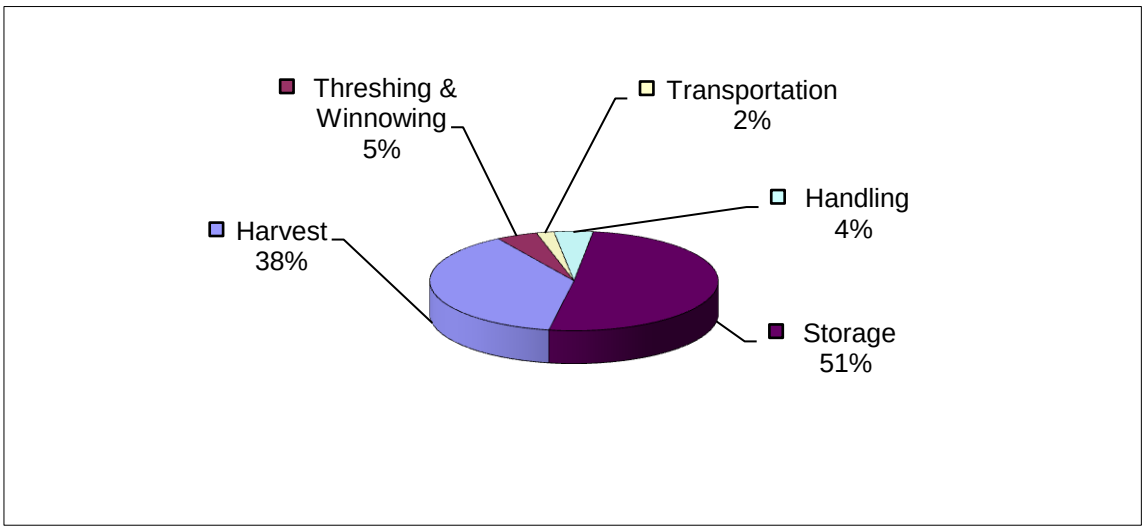

Fig 5.3: Percentage Post harvest losses in different stages of wheat production in Vindhyan Plateau. (9.50 kg/q)

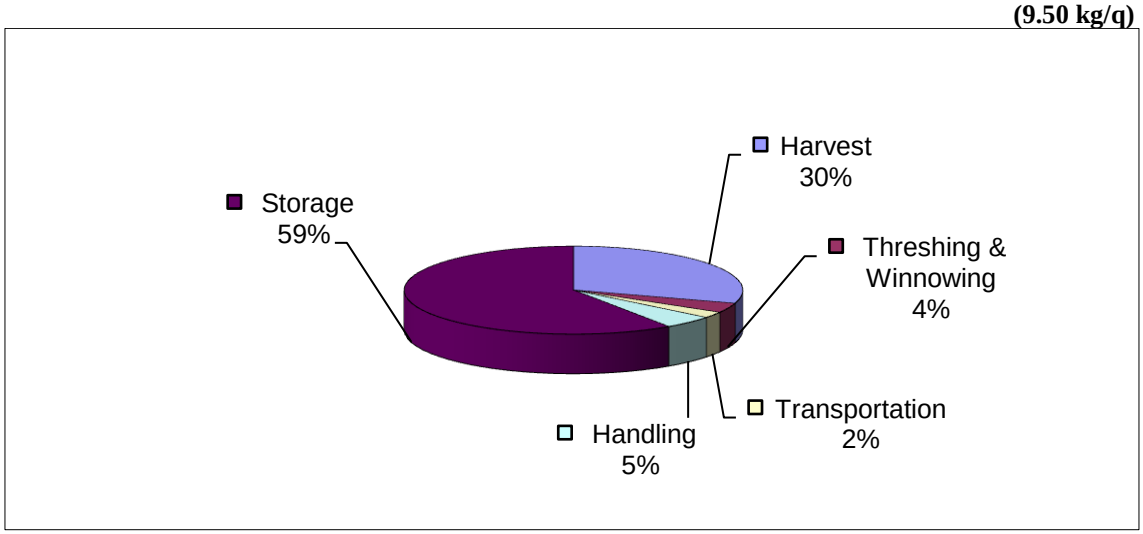

Fig 5.4: Percentage post harvest losses in different stages of wheat production in Central Narmada Valley (8.04kg/q)

As regard to soybean the post harvest losses were also found to be more in Vindhyan Plateau (14.62 kg/q) as compared to Malwa Plateau (10.96 kg/q). Amongst different size of farms the post harvest losses were found to be maximum in large size of farms (12.97 kg/q) followed by marginal (10.72 kg/q), small (10.68 kg/q), and medium (9.48 kg/q) in Malwa Plateau, while in Vindhyan Plateau the losses were found to be more in large size of farms (16.45 kg/q) followed by small (15.22 kg/q), medium (13.70 kg/q), and marginal (13.11 kg/q) farms.

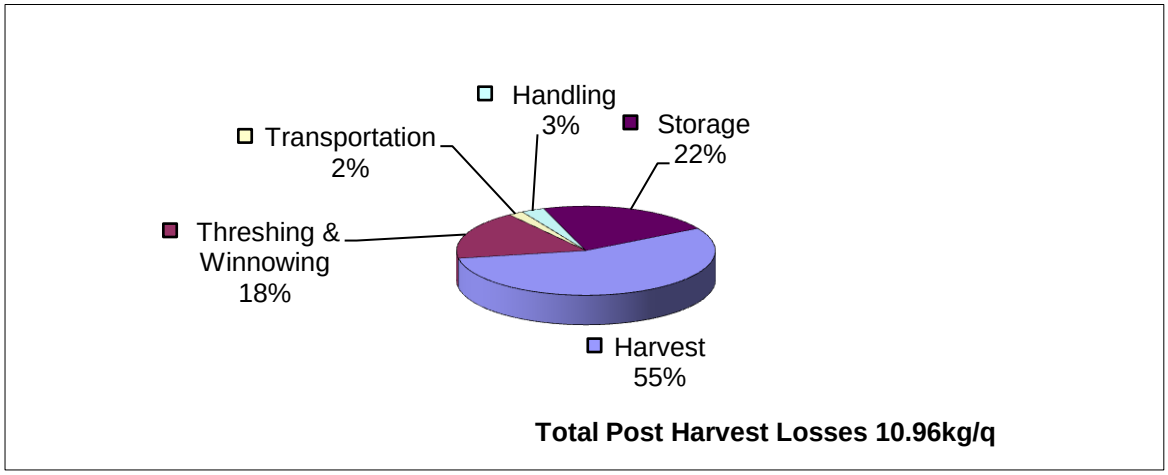

Fig 5.5: Percentage Post harvest losses in different stages of soybean production in Malwa plateau

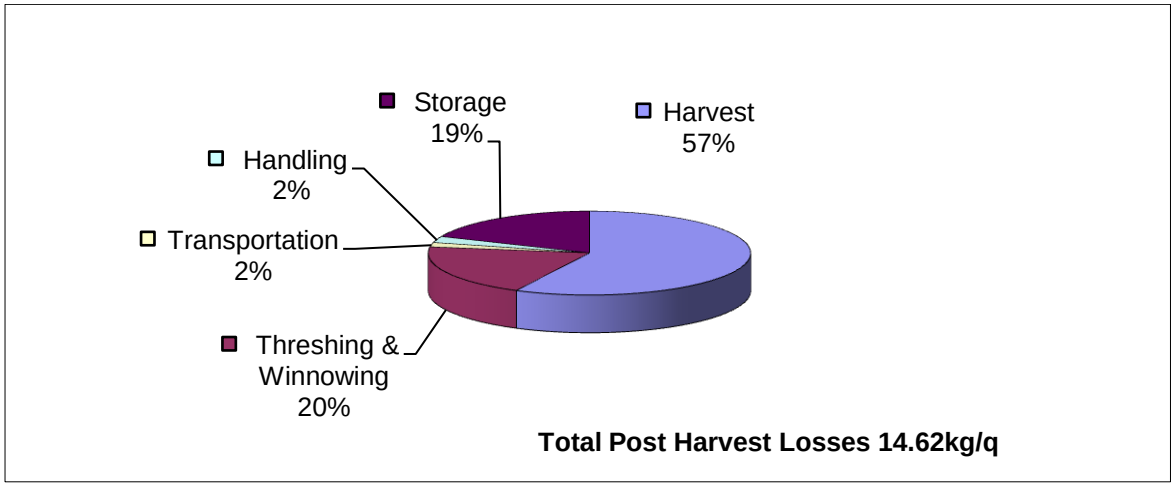

Fig 5.6: Percentage Post harvest losses in different stages of soybean production in Vindhyan plateau

The post harvest losses occurred at various stages were found to be maximum in harvest (55%) followed by storage (22%), threshing and winnowing (18%), handling (3%) and transportation (2%) in Malwa Plateau, the maximum quantity loss has been found to be in harvest (57%) followed by threshing & winnowing (20%), storage (19%), handling (2%), and transportation (2%) in Vindhyan Plateau.

Table 5.10 Post harvest losses (Kg/q) of Soybean in different agro climatic zones

Post harvest losses	Malwa Plateau					Vindhyan Plateau				
	Marginal	Small	Medium	Large	Total	Marginal	Small	Medium	Large	Total
Harvest	6.36	6.03	5.37	6.60	6.09	8.35	9.48	7.04	8.74	8.40
Threshing & Winnowing	1.78	1.92	1.59	2.45	1.94	2.67	2.86	2.47	3.59	2.90
Transport	0.18	0.20	0.20	0.25	0.21	0.22	0.24	0.26	0.27	0.25
Handling	0.30	0.31	0.31	0.35	0.32	0.33	0.34	0.36	0.37	0.35
Storage	2.10	2.22	2.00	3.32	2.41	1.54	2.30	3.56	3.48	2.72
Total post harvest loss (kg/q)	10.72	10.68	9.48	12.97	10.96	13.11	15.22	13.70	16.45	14.62
Total post harvest loss (kg/acre)*	51.11	56.24	59.20	70.53	59.27	50.48	53.86	66.10	70.02	60.12

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

5.6: Quantitative aspects of storage.

The quantitative aspects of storage structure and pest control measures adopted by selected HHs related to wheat and soybean were also observed and presented in table 5.11.

5.6.1: **Wheat**

The majority of HHs reported that they used metal/cemented (53.75%) roof of storage structure followed by crop by product (40.00%) and grass thatched (6.25%). The wall of storage structure was found to be made up of mud (61.25%) followed by bricks / cemented (38.75%) as reported by majority of HHs. The majority of HHs also reported that floor of storage structure was found to be made of earth (63.13%) and concrete (36.88%). As regards to the height of platform the maximum HHs reported that it was less than 6 inches (82.35%) to 6 – 12 inches (17.65%).

As regards the physical condition of roof, wall, guard and floor, the cent-percent of HHs reported that their storage structures roof was good roof (100%), with good condition of walls (100%) and have no rat guard (100%). The average cost of kachha / cemented storage structure was found to be Rs 50000/- per HH. The majority of HHs reported that they repaired their storage structure in every two year (51.25%) to 2 – 5 years (48.75%). In walls and rat guard no maintenance was found to be required as reported all the HHs. All the HHs reported that they never followed sun drying, smoking, admixing with ash and other plant material in their storage structure, while only 32.41% HH reported that they removed infested grains from storage and destroyed it annually.

Table 5.11: Some quantitative aspects of storage (percentage of households)

Description		Wheat	Soybean
1. Nature of storage structure			
Roof made of	Grass thatched	6.25	23.75
	Crop by product	40.00	36.25
	Plastic cover	0.00	0.00
	Metal/cemented	53.75	40.00
	Asbestos sheet	0.00	0.00
	Others	0.00	0.00
Walls made of	Burnt bricks/cemented	38.75	48.75
	Woven basket	0.00	0.00
	Mud	61.25	51.25
	Crib	0.00	0.00
	Open wall	0.00	0.00
	Others	0.00	0.00
Floor made of	Concrete	36.88	45.00
	Earth	63.13	55.00
	Woven basket	0.00	0.00
	Wooden	0.00	0.00
	Others	0.00	0.00
Percentage of households having platform		42.50	33.75
Height of the platform	Less than 6 inches	82.35	68.52
	6-12 inches	17.65	31.48
	Above 12 inches	0.00	0.00
	Others	0.00	0.00
2. Physical condition of storage			
Roof	Leaking root	0.00	0.00
	Good roof	100.00	100.00
Walls	Damaged wall	0.00	0.00
	Good condition walls	100.00	100.00
Guards	Rat guard installed	0.00	
	No rat guards	100.00	100.00
Floor	Cemented good condition roof	30.00	43.75
	Broken floor, mud coming out	70.00	56.25

Cont……..

Description		Wheat	Soybean
1. Cost of storage			
The average age of the storage structure (years per household)		6.00	5.80
Cost of permanent storage, e.g., steel drums etc. (Rs per household)		0.00	0.00
Cost of kutcha or cemented house for storage (Rs. Per household)		49987.75	29789.92
2. Maintenance status – Frequency of repair of grain storage			
Roof	Every year	0.00	0.00
	Every two years	51.25	0.00
	2-5 Years	48.75	7.50
	No maintenance required	0.00	56.25
Walls	Every year		16.25
	Every two years		23.75
	2-5 Years		8.75
	No maintenance required	100.00	51.25
Rat guards	Every year		
	Every two years		
	2-5 Years		
	No maintenance required	100.00	100.00
3. Storage pests control measures			
Sun drying	Monthly		
	Quarterly		
	By-annual		
	Annual		
	Never	100.00	100.00
Removal of infested grain from storage and destroying it	Monthly		
	Quarterly		
	By-annual		
	Annual	32.41	
	Never		100.00
Admixing with ash and other plant materials	Monthly		
	Quarterly		
	By-annual		
	Annual		
	Never	100.00	100.00
Smoking	Monthly		
	Quarterly		
	By-annual		
	Annual		
	Never	100.00	100.00
Others	Monthly		
	Quarterly		
	By-annual		
	Annual		
	Never	100.00	100.00

5.6.2: Soybean

The maximum HHs related to soybean were found to use metal/cemented (40.00%) roof of storage structure followed by crop by product (36.25%) and grass thatched (23.75%). The HHs reported that the wall of storage structure was found to be made up of mud (51.25%) followed by bricks / cement (48.75%). The floor of storage structure was found to be made up of earth (55.00%) and concrete (45.00%). All the HHs reported that the height of the platform as reported by the HH was less than 6 inches (68.52%) to 6 – 12 inches (31.48%). The physical condition of roof, walls, guard and floor, their storage structure's roof was good with good condition of walls and have no rat guard. The average cost of kachha / cemented storage structure was found to be Rs. 29789.92/- per HH. The maximum HHs reported that no maintenance is required (56.25%) and (7.25%) reported that the maintenance is required in every 2 – 5 years.

The walls and rat guard required no maintenance as reported by the majority of HHs. All the HHs reported that they never followed sun drying, admixing with ash, smoking and other pest control measures; others plant material in their storage structure.

5.7: Households Suggestions to minimize post harvest losses

The sample households related to soybean and wheat crops were by and large same but there frequency somewhat differ. The suggestion of sampled soybean and wheat growers with respect to minimize post harvest losses are presented in table 5.12.

Table 5.12: Households Suggestions to minimize post harvest losses

S.No.	Suggestions	No. of Respondents (n =160)			
		Soybean Growers		Wheat Growers	
		(n =160)	%	(n =160)	%
1	Proper care during harvesting, threshing & winnowing	148	92.50	121	75.63
2	Careful handling of grains at various post harvest stages (handling, weighing, transportation, storage,)	136	85.00	152	95.00
3	Immediate marketing after harvesting to avoid weight loss	118	73.75	156	97.50
4	Proper storage condition	76	47.50	111	69.38
5	Sun drying of grains every three months	74	46.25	153	95.63
6	Mix insecticides to avoid pest	131	81.88	143	89.38
7	Installation of rat guards	78	48.75	89	55.63
8	Timely supervision of store grains	79	49.38	119	74.38
9	Store fumigation for proper pest control	46	28.75	146	91.25

In order to minimize post harvest losses the suggestions of sample soybean growers mainly concentrated around proper care during harvesting, threshing & winnowing (92.50%), careful handling of grains at various post harvest stages (handling, weighing, transportation, storage etc.) (85.50%), immediate marketing after harvesting to avoid weight loss (73.75%), proper storage condition (47.50%), sun drying of grains every three months (46.25%), mix pesticides to avoid pest (81.88%), installation of rat guards (48.75%), timely supervision of store grains (49.38%) and fumigation in storage structure for proper pest control (28.75%). These suggestions were also reported by wheat growers with minor variations.

5.8: Summary of the chapter

As regards to post harvest losses related to wheat and soybean it was found during the course of investigation that:

The cultivators of study area found to be preferred early (78.04%) and mid (21.96%) verities of wheat. All the selected growers who were found to be preferred mid varieties and harvested their produce manually. The wheat growers who sown early varieties of wheat majority of them (73.61%) were found to be preferred mechanical method of harvest. The estimation of losses was found to be more in mid varieties (2.84kg/q) as compared to early varieties (2.79kg/q) of wheat. The HHs whether related to wheat or soybean threshed their harvested produce through mechanical thresher cum winnower. The majority of wheat growers were found to be preferred tractor trolley (49.44%) followed by bullock cart (14.56%) to transport and handling their wheat grains from threshing floor to market. The majority of wheat growers whether preferred tractor trolley or bullock cart ranked losses low to medium during transportation of grains. The average loss during transportation was found to be 0.18kg/q and observed more in bullock cart (0.23kg/q) as compared to tractor trolley (0.19kg/q). The average loss during handling of grains of wheat has been found to be 0.40kg/q and found also more in tractor trolley (0.42kg/q) as compared to bullock cart (0.37 kg/q). The maximum quantity was found to be stored in kachha house (30.14q) as compared to pucca house (12.00q). The kothi /bin kachha, pucca, followed by gunny bags / plastic bags, and open space had been found to be mode of storage in the study area. An average wheat grower of the study area stored their grains approximately for the period of 190 days. All the wheat growers reported that rank of loss at low level, the quantity lost during the storage was mainly due to rodent (8.46 kg/q) and fungus (1.13kg/q). The cost of storage was found to be Rs. 4.19 per quintal in the study area. The majority of wheat growers reported that they used metal/cemented (53.75%) roof of storage structure followed by crop by product (40.00%)

and grass thatched (6.25%). The wall of storage structure was found to be made up of mud (61.25%) followed by bricks / cemented (38.75%). They also reported that floor of storage structure was found to be made of earth (63.13%) and concrete (36.88%) and their was good roof (100%), with good condition of walls (100%) and has no rat guard (100%). The average cost of kachha / cemented storage structure was found to be Rs 49987.75/- per HH. The majority of wheat growers reported that they repaired their storage structure in every two years (51.25%) to 2 – 5 years (48.75%). All the wheat growers reported that they never followed sun drying, smoking, admixing with ash and other plant material in their storage structures and only 32.41% of them reported that they removed infested grains from storage and destroyed it annually. On an average 8.61kg/q had been found to be lost for wheat grain. The maximum quantity of loss had been found to be in the storage (56%) followed by harvest (33%), handling (5%) threshing & winnowing (4%), and transportation (2%) of grains in wheat. The quantity losses of wheat grains has been found some what more in large (9.05kg/q), followed by small (7.95kg/q), medium (7.74kg/q), and marginal (7.42 kg/q). Amongst different mode of storage capacity the capacity utilization of kothi /bhukari /bin kachha (84.00%) has been found to be more as compared to gunny / plastic bags (36.74%) and open place (17.31%) for storage of wheat grains.

All the soybean growers were found to be cultivated early varieties of soybean *viz*, JS 93-05 and JS–335. The majority of them were found to prefer mechanical method (68.37%) followed by manual method (31.63%) of harvest. An average soybean grower found to be covered 15.86 km distance to market his 50.98 q produce. Here, also the majority of soybean growers reported low (88.75%) followed by medium (7.50%) and high (3.75%) rank of loss during transportation of produce from threshing floor to market. An average soybean grower reported 0.23 kg/q loss during transportation of soybean produce from threshing floor to market. The average loss during handling of soybean had been found to be 0.34kg/q in the study area. Out of the total quantity of the soybean (43.55q/HH), an average soybean grower stored 31.78q (72.97%) of soybean grains in kachha house and 11.77q (27.03%) in pucca house. The maximum quantity of soybean grains was found to be stored in open space followed by gunny/plastics bags and *kothi* bin, *kachha, pucc*a irrespective of kachha & pucca house. None of the soybean growers was found to be stored their soybean grains in steel drums. An average soybean grower of the study area found to store their soybean grain for the period of 87 to 93 days only. The majority of them reported low followed by medium rank of loss in storage of soybean

grains. The maximum quantity lost during storage was found due to weigh loss followed by rodents and fungus. Average soybean growers spent Rs. 4.72 per quintal and Rs. 9.20 per quintal to store their soybean grains in *kachha* and *pucca* house, respectively. Whereas, only approximately 40 per cent of capacity utilization of different mode of storage were found to be utilize by the soybean growers for soybean grains for kothi/bin kachha, gunny/ plastics bags and open space. As regards to kothi/bin pucca the HHs was found to be utilized its 14.80% capacity for soybean grains. On an average 12.56 kg/q had been found to be lost for soybean grain. The maximum quantity had been found to be lost in harvest (56%), followed by storage (20%), threshing & winnowing (19%), handling (3%), and transportation (2%) of grains in Soybean. The quantity loss of soybean grain was found to be some what more in large (14.50kg/q) followed by small (12.53kg/q), marginal (11.76kg/q), and medium (11.42kg/q) farms. The majority of soybean growers found to be used metal/cemented (40.00%) roof of storage structure followed by crop by product (36.25%) and grass thatched (23.75%). The wall of storage structure was found to be made up of mud (61.25%) followed by bricks/cement (38.75%) as reported by the majority of soybean growers. The majority of them also reported that the floor of storage structure was found to be made of earth (55.00%) and concrete (45.00%). As regards to the height of the platform the majority of the soybean growers reported that it was less than 6 inches (68.52%) to 6–12 inches (31.48%). As regards the physical condition of roof, walls, guard and floor, the majority of soybean growers reported that their storage structure's roof was good (100.00%), with good condition of walls (100.00%) but not rat guard (100.00%).The average cost of kachha / cemented storage structure was found to be Rs. 29789.92/- per HH. The soybean HHs reported that they repaired their storage structure in every 2 years (40.00%) followed by 2 – 5 years (56.25%). The walls and rat guard required no maintenance as reported by the majority of soybean growers. All the soybean growers reported that they never followed sun drying, admixing with ash, smoking and other pest control measures and others plant material in their storage structure.

The harvest losses were found to be more in soybean (7.44kg/q) as compared to wheat (2.82 kg/q). The quantity losses during threshing and winnowing have also been found to be more in soybean (2.34 kg/q) as compared to wheat (0.34kg/q). As regards to the post harvest losses in different agro climatic regions the post harvest losses of wheat were found to be more in Vindhyan plateau (9.50 kg/q) as compared to Central Narmada

Valley (5.04 kg/q), whereas, The post harvest losses were found to be more in Vindhyan Plateau (14.62 kg/q) as compared to Malwa Plateau (10.96 kg/q) also in soybean.

In order to minimize post harvest losses the suggestions of that reported by sample soybean growers mainly concentrated around proper care during harvesting, threshing & winnowing (92.50%), careful handling of grains at various post harvest stages (handling, weighing, transportation, storage etc.) (85.50%), immediate marketing after harvesting to avoid weight loss (73.75%), proper storage condition (47.50%), sun drying of grains every three months (46.25%), mix pesticides to avoid pest (81.88%), installation of rat guards (48.75%), timely supervision of store grains (49.38%) and fumigation in storage structure for proper pest control (28.75%). These same suggestions were also reported by wheat growers with minor variations during the time of investigation.

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CHAPTER VI

CONCLUDING REMARKS AND POLICY SUGGESTIONS

The estimation of crop loss due to pests and diseases is a complex subject. It is in fact, difficult to assess the loss caused by the individual pest as a particular crop may be infested by the pest complex in the farmers' field conditions. Further, extent of crop loss either physical or financial depends on the type of variety, stage of crop growth, pest population and weather conditions. Nevertheless, the crop loss estimates have been made and updated regularly at global level. The worldwide yield loss due to various types of pest was estimated at as: 37.4 per cent in rice, 28.2 per cent in wheat, 31.2 per cent in maize and 26.3 per cent in soybean (Oerke, 2007). At all India level, crop loss estimates due to insect pests have been provided by Dhaliwal *et al* (2010), 25 per cent losses 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 by Reddy and Zehr (2004). Further, a number of studies have established the strong relationship between pest infestation and yield loss in various crops in India (Nair, 1975; Dhaliwal and Arora, 1994; Muralidharan, 2003; Rajeswari *et al*, 2004; Muralidharan and Pasalu, 2006; Rajeswari and Muralidharan, 2006, Nag et.al. 2000, Solanki et al, 2011,).To estimate the crop loss, most of the existing studies have adopted experimental treatment approach (with or without pest attack through artificial infestation) or fields with natural infestation wherein half of the field is protected against the pest while the other half is not. But, the results obtained from artificial infestation or natural infestation in the selected plots/fields will not be appropriate for extrapolation over a geographical area (Groote, 2002). It is for the reason that the estimated crop losses under these conditions may not represent the actual field conditions of farmers. Alternatively, the estimates collected directly from the farmers through sample survey may be reliable and could be used for extrapolation in similar geographical settings. However, the farmers' estimates are likely to be subjective and these should be validated with expert estimates of the state department of agriculture.

Consider all these facts in mind the present study has been formulated with following objectives:

1. To estimate the physical and financial losses caused by pests and diseases in wheat 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 wheat and soybean under different agro climatic conditions of Madhya Pradesh.
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.

Wheat and soybean crops have been considered for assessment of pre and post harvest losses in Madhya Pradesh as state has remarkable position in the area and production of these crops in India. The primary, secondary and tertiary data has been collected for the study. The primary data were collected from the selected respondents of the study area with survey method with the help of interview schedule provided by the project coordinator of the study. The secondary data related to area, production and yield of selected crops i.e. wheat and soybean were collected for the period of 30 years from 1981 – 2010. These data were collected from Department of Farmers' Welfare and Agricultural Development, Madhya Pradesh, Bhopal, Directorate of Economics and Statistics Madhya Pradesh, Bhopal and Land Record Office, Madhya Pradesh, Gwalior and Office of Madhya Pradesh Mandi Board, Bhopal (M.P.). The tertiary data related to various cost and profitability parameters of selected crops for 1980 – 81, 1985 – 86, 1990 – 91, 1995 – 96, 2000 – 01, 2005 – 06, 2010 – 11, were collected from the Comprehensive Scheme for studying the Cost of Cultivation of Principal Crops for Madhya Pradesh and Chhattisgarh, Jawaharlal Nehru Agricultural University, Jabalpur (M.P.) and published by Commission for Agricultural Cost and Prices, Ministry of Agriculture and Cooperation, New Delhi.

A multistage sampling technique has been used for selection of respondents of the study. At the first stage Hosangabad & Vidisha districts from Central Narmada Valley and Vindhyan Plateau agro-climatic regions for Wheat, and Ujjain and Raisen districts for soybean from Malwa Plateau and Vindhyan Plateau respectively have been selected as these districts have remarkable position in area and production of Wheat and soybean in M.P. Further, 3 villages near by the regulated market (in radius of 10 KM) and 3 villages far away from the regulated market (>10 Km from regulated market) have been selected

for the study. A list of all the farmers of the selected village has been prepared and classified them in marginal (below 2 acre) , small (2- 4 acre), medium (4-10 acre) and large (above 10 acre) categories according to their size of operational holdings and 20 farmers were selected randomly in each category and for each crop for the study.

The collected data has been classified, tabulated and analyzed in the light of stated objectives of the study using statistical package of social science (SPSS). The analysis of data was done in light of suitable statistical tools such as mean, percentage, trend, growth, absolute change, relative change, regression analysis etc.

The specific findings of the study are as under:

- The area production and productivity of both the selected crops i.e. wheat and soybean found to be increased in Madhya Pradesh. The area, production and yield of wheat increased with a linear growth of 0.77 per cent , 2.60 per cent and 1.87 per cent per year respectively, while the area, production and yield of Soybean increased with linear growth of 6.07 per cent, 6.89 per cent and 1.74 per cent per year respectively in last 30 years (1981 - 2010).
- The expenses in all the input variables used in cultivation of wheat and soybean found to be increased approximately 1000 to 2000 per cent respectively in the year 2009 – 10 as compared to 1980 – 81 except expenses on manures (wheat), with the result of this the gross income and net income at variable cost found to be increased manifolds.
- The review on various studies related to post harvest losses revealed that the loss varies between 6 to 9.70 per cent. Amongst all the post harvest losses, storage losses were found to be a main component followed by threshing, winnowing and transportation losses.
- The socio economic characteristics of sample farmers have been revealed and found that:
    - An average **HH** had a family of 7 members, out of which 2 were found earner and the percentage of male, female and children to total family member were found to be of 36.58, 29.80 and 31.43 per cent. On an average 85.94 per cent of HHs were found to be head of the family and remaining 14.06 per cent their family members, who were in farming business. The majority of HHs belonged to age group above 40 years (59.06%) followed by age group between 25 to 40 years (35.63%) and less than 25 years (5.31%) and had an education status up to secondary (31.88%) followed by primary (25%),

illiterate (29.06%), gradate and above (16.25%) and higher secondary (7.81%). The majority of the total HHs belonged to Other Backward Class (OBC) (55.94%) followed by General (30.94%), Schedule Caste (11.25%) and Schedule Tribes (1.88%). The annual earning of an average HH was found to be Rs. 1.09 lac and found to be increased with the increase in size of farm from marginal (Rs. 0.31 lac) to large (Rs. 2.59 lac). The HHs of the study area covered an average distance of about 14 Km. to sell their produce. An average HH holds 11.32 acres of land, which was found to be 1.80, 4.28, 10.10 and 29.12 acres in marginal, small, medium and large size farms receptively and all the HHs cultivated their total owned land and none of them found to leas out their land to other cultivators. In case of lease in only 1.52 acres of land was found to be leased in by an average HH of the study area. The 10.67 acres (83.43%) land was under irrigation out of total net operated area (12.79 acre). The marginal farmers (195.68%) were found to use their land more intensively as compared to small (189.00%), medium (187.54%) and large (185.47%) size of farm. An average HH found to use 89.42% of total net area sown in twice a year. The nature of tenancy was found to be at fixed rent in cash (Rs. 7777/ per acre per year) at overall level and ranged between Rs. 6050/- per acre (marginal) to Rs. 8521per acre (small). At overall level 13.75 per cent of total HHs leased in land to other farmers, which was found to be 12.76% of their net operated land and ranged between 5.72 per cent (large) to 17.51 per cent (small) in different size of farms. Tube well (electric + diesel) (67.19%) followed by canal (16.37%), canal + tube well (15.46%) and tanks sources (0.99%) were found to major source of irrigation in the study area. On an average 62.81per cent tube wells were found to be operated by electricity, while 4.38 per cent operated with diesel. The majority of marginal and small farmers were depended on canal, whereas majority of medium and large farmers on tube wells. Soybean (46.81%), Wheat (40.78%) were important crops of the study area grown by HHs in *kharif* (rainy) and *rabi* (winter) seasons respectively. Gram (8.19%), Rice (5.07%), tur (1.52%), lentil (1.31%), and potato (1.17%) were found to be others crops. An average HH of the study area used 73.29 per cent (Rice) to 100 per cent (Soybean) seeds of HYVs in their total area of cultivation. While in case of lentil, cultivators still use local varieties of lentil, due to its bold seed quality. Wheat (13.91 q/acre)

gave highest yield followed by rice (8.57 q/acre), potato (5.84 q/acre), soybean (4.53 q/acre), gram (4.33 q/acre), tur (2.84 q/acre) and lentil (1.97 q/acre). The magnitude of marketed surplus to the total production was found to be high in oilseeds followed by pulses and cereal crops. In case of soybean an average HH marketed 87.68% of production in the market, while he marketed 80.10, 77.62, 69.80, 57.15, 53.58 and 46.24 per cent of production respectively for gram, lentil, wheat, rice, tur and potato. An average HH got Rs. 361052.36/- per farm and received 77.41 per cent of total income from marketed of farm products. It is also observed that as the size of farms increases the percentage of output marketed found to be increased from 69.75 per cent (marginal) to 91.82 per cent (large). An average HH got Rs. 361052.36/- per farm and received 80.42 per cent of total income from marketed surplus. It is also observed that as the size of farms increases the percentage of output marketed found to be increased from 72.45 per cent (marginal) to 83.83 per cent (large).

- The constraints faced by the wheat and soybean growers in identification, incidence, attack and control of insect and weeds with source of information received from different sources have been observed during the course of investigation and found that:
    - The deficiency of water for irrigation, and high cost of input were found to be most important constraints, while incidence of pest and their control, poor quality of seed and low price of output were the least important constraints in cultivation of wheat in the area under study. The 94.38 percent of wheat growers of the study area were found to be able to distinguish pest and diseases attack and 79.47 per cent of them could not distinguish pest and disease attack by qualitative assessment. Only 5.96% of wheat growers able to assess the pest and disease attack by quantitative assessment in cultivation of wheat. The attack of major pest i.e. aphids (48.13%), termite (65.00%) and rat (44.38%) was not so important in cultivation of wheat. The frequency of attack of aphid (100%) was found in every season, while the attack of termite (45%) and rat (43.75%) was found once in two seasons and once in three seasons respectively in the area under study and incurred the loss of grain below 5% in cultivation of wheat. The rust, smut and leaf blight were the major diseases of wheat in the study area. But the majority of them reported

that these were least important. The rust was found to occur once in two seasons (78.13%) followed by every year (16.88%) and once in three years (5.00%). The attack of leaf blight found to occur once in three season (46.25%) followed by once in two season (41.25%) and every season (12.00%) in cultivation of wheat. As regards to infestation of weeds the *Phalaris minor*, and broad leaf weeds i.e. *motha, hirankhuri, badi dudhi, chhoti dudhi, sarson, chitchita* etc. were the major weeds of wheat but found less severe as reported by about 86% HHs. The frequency of attack of weeds was found in every season but the production losses were found below 5% as reported by the majority of HHs. As the size of farm increased the percentage of losses over actual and normal production were found to be increased from 6.89% (marginal) to 13.56% (large) over actual production and from 7.40% (marginal) to 15.68% (large) over normal production of wheat. None of The HHs used insecticides to control insect as the infestation of insect not crossed the economic threshold level in wheat. An average HH found to invest Rs 299.60/acre in weedicide. Cost of weedicide found to be the highest at medium size of farm (Rs 307.25 /acre) followed by large (Rs 306.57 /acre), small (Rs 302.10 /acre), and marginal (Rs 282.47/acre). Generally hand-weeding is found in practice to control weeds in wheat. As wheat is a winter season crop and infestation of weeds is not a burning problem. *Phalaris minor* is a common weed of the wheat in the study area, which seems like wheat hence, hand weeding is the only option to solve the problem. An average wheat grower invested Rs 51.33/acre on seed treatment with fungicides viz. Bavistin, Thairum and Carbandazim etc. As the size of farm increases the cost of fungicides found to be increased from marginal (Rs 31.44/acre) to large (Rs73.88/acre).

- As regards to soybean the high cost of input (60.00%) was found to be important constraint in the cultivation of soybean. The cent percent soybean growers able to distinguish pest and disease attack in cultivation of soybean crop. The majority (67.50%) of them assess the severity of the attack by quantitative assessment. Only 15% of HHs able to assess the pest and disease attack by qualitative analysis in cultivation of soybean crop. In soybean Girdle beetle and caterpillar were found to be very important pest of soybean in the study area as their rank of severity was found to be of very important as

reported by 91.25% (Girdle beetle) and 57.50% (caterpillar) of HHs. The root rot (73.75%), mosaic (58.75%) and wilt (50.00%) were found to be major diseases of soybean as reported by the majority of HHs. The frequency of attack was found to be every season for mosaic and root rot as reported by 53.75% and 47.50% of HHs, while in case of wilt, it occurred once in a two season (48.75%) as reported by the majority of HHs. But the losses occurred by these diseases was not found more than 5% as reported by the more than 85% of HHs. *Samel, Dudhi, Motha and Krishaneel* were found to be very important weeds of the soybean as reported by 63.75, 77.30, 92.50 and 60 per cent of soybean growers, respectively. The frequency of all these weeds were found to be every season but the production losses were found to be less then 5% as majority of soybean growers apply weedicide to control these weeds in their field. On an average size of farm the losses occurred were found to be 13.50 and 11.83 percent over actual (5.59 q/ac) and normal (6.33 q/ac) production in soybean. As the size of farm increases the percentage of actual and normal production were found to be increased from 10.10% (marginal) to 16.51% (large) over actual production and from 9.17% (marginal) to 14.71% (large) over normal production of soybean. The control of weeds is the major problem in cultivation of soybean. Chemical control (weedicide) found to be most popular and only method to control weeds in the area under study, as hand weeding is not possible due to moisture in the soil (black cotton soil). An average soybean grower invested Rs 411.60/acre to control weeds in soybean. The cost of weedicide found to be increased with the size of farms from Rs 393.59/acre (marginal) to Rs 419.48/acre (large). Incidence of insect in soybean was found to be very common in study area and all the farmers were found to use insecticide to control insects. An average soybean grower found to invest Rs 555.29/acre in insecticide. Medium farmers (Rs 568.78/acre) used more insecticides as compared to marginal (Rs 542.00/acre), small (Rs 545.72/acre) and large (564.66/acre). An average soybean grower invested Rs 97.69/acre in fungicide. The cost of seed treatment was found to be some what more in medium (Rs 105.00/acre) followed by large (Rs 102.00/acre), small (Rs 94.00/acre), and marginal (Rs 89.25/acre) farms.

- None of the soybean and wheat grower followed the biological method for control of insect, pest and diseases in the area under study. The cost of chemical in soybean crop for control of pest and disease was found to be more as compared to wheat crop. The 77.50% and 26.25% HHs were found to be seeking advice related to control of pest and disease respectively for soybean and wheat crop. Private input dealers were found to be most important source of seeking advice on pest and disease control management as reported by 64.29% of HHs followed by agricultural university/ KVKs (7.14%) and TV/Radio service/News paper (4.76%), while government extension agent were found to be important source of seeking advice on plant geometry and soil testing as reported by 76.19% of HHs followed by private input dealers (21.43%), agricultural university/ KVKs (19.05%) and TV/radio service/news paper (16.67%). It is observed from the data that the majority of sample soybean growers were suggested proper technical guidance about pest & disease control measure including integrated pest management techniques (97.50%) followed by timely availability of recommended pesticides & weedicides (95.63%), timely availability of plant protection equipments viz. sprayer, duster etc. at village level on rental basis (95.63%), subsidy on insecticide, pesticide & weedicide and plant protection equipments viz. light traps, sprayer, duster etc. (47.50%) and organized skill orientation programme regarding to pest and disease control (48.75%) for proper adoption of plant protection measures in their fields. These suggestions were also reported by wheat growers with minor variations.
- As regards to post harvest losses related to wheat and soybean it was found during the course of investigation that:
    - The cultivators of study area found to be preferred early (78.04%) and mid (21.96%) verities of wheat. All the wheat growers who were found to be sown mid varieties preferred harvested their produce manually. The wheat growers who sown early varieties of wheat, majority of them (73.61%) were found to be preferred mechanical method of harvest. The estimation of losses was found to be more in mid varieties (2.84kg/q) as compared to early varieties (2.79kg/q) of wheat. The HHs whether related to wheat or soybean threshed their harvested produce through mechanical thresher cum winnower. The majority of wheat growers were found to be preferred tractor trolley (49.44%) followed by bullock cart (14.56%) to transport and handling their wheat from threshing floor to market. The majority of wheat growers whether preferred

tractor trolley or bullock cart ranked losses low to medium during transportation of grains. The average loss during transportation was found to be 0.18kg/q and observed more in bullock cart (0.23kg/q) as compared to tractor trolley (0.19kg/q). The average loss during handling of grains of wheat has been found to be 0.40kg/q and found more in tractor trolley (0.42kg/q) as compared to bullock cart (0.37 kg/q). The maximum quantity was found to be stored in kachha house (30.14q) as compared to pucca house (12.00q). The kothi /bin kachha, pucca, followed by gunny bags / plastic bags, and open space had been found to be mode of storage in the study area. An average wheat grower of the study area stored their grains approximately for the period of 190 days. All the wheat growers reported that rank of loss at low level, the quantity lost during the storage was mainly due to rodent (8.46 kg/q) and fungus (1.13kg/q). The cost of storage was found to be Rs. 4.19 per quintal in the study area. The majority of wheat growers reported that they used metal/cemented (53.75%) roof of storage structure followed by crop by product (40.00%) and grass thatched (6.25%). The wall of storage structure was found to be made up of mud (61.25%) followed by bricks / cemented (38.75%) as reported by majority of wheat growers. They also reported that floor of storage structure was found to be made of earth (63.13%) and concrete (36.88%). The majority of wheat growers reported that their storage structures roof was good roof (100%), with good condition of walls (100%) and has no rat guard (100%). The average cost of kachha / cemented storage structure was found to be Rs 49987.75/- per HH. The majority of wheat growers reported that they repaired their storage structure in every two years (51.25%) to 2 – 5 years (48.75%). All the wheat growers reported that they never followed sun drying, smoking, admixing with ash and other plant material in their storage structures and only 32.41% of them reported that they removed infested grains from storage and destroyed it annually. On an average 8.61kg/q had been found to be lost for wheat grain. The maximum quantity of loss had been found to be in the storage (56%) followed by harvest (33%), handling (5%) threshing & winnowing (4%), and transportation (2%) of grains in wheat. The quantity losses of wheat grains has been found some what more in large (9.05kg/q), followed by small (7.95kg/q), medium (7.74kg/q), and marginal (7.42 kg/q). Amongst different mode of storage capacity the capacity

utilization of kothi /bhukari /bin kachha (84.00%) has been found to be more as compared to gunny / plastic bags (36.74%) and open place (17.31%) for storage of wheat grains by the HHs of the study area.

- All the soybean growers were found to be cultivated early varieties of soybean *viz*, JS 93-05 and JS–335. The majority of them were found to prefer mechanical method (68.37%) followed by manual method (31.63%) of harvest. An average soybean grower found to be covered 15.86 km distance to market his 50.98 q produce. Here, also the majority of soybean growers reported low (88.75%) followed by medium (7.50%) and high (3.75%) rank of loss during transportation of produce from threshing floor to market. An average soybean grower reported 0.23 kg/q loss during transportation of soybean produce from threshing floor to market. The average loss during handling of soybean had been found to be 0.34kg/q in the study area. Out of the total quantity of the soybean (43.55q/HH), an average soybean grower stored 31.78q (72.97%) of soybean grains in kachha house and 11.77q (27.03%) in pucca house. The maximum quantity of soybean grains was found to be stored in open space followed by gunny/plastics bags and *kothi* bin, *kachha, pucc*a irrespective of kachha & pucca house. None of the soybean growers was found to be stored their soybean grains in steel drums etc. An average soybean grower of the study area found to store their soybean grain for the period of 87 to 93 days. The majority of them reported low followed by medium rank of loss in storage of soybean grains. The maximum quantity lost during storage was found due to weigh loss followed by rodents and fungus. An average soybean growers spent Rs. 4.72 per quintal and Rs. 9.20 per quintal to store their soybean grains in *kachha* and *pucca* house, respectively. Whereas, only approximately 40 per cent of capacity utilization of different mode of storage were found to be utilize by the soybean growers for soybean grains for kothi/bin kachha, gunny/ plastics bags and open space. As regards to kothi/bin pucca the HHs was found to be utilized its 14.80% capacity for soybean grains. On an average 12.56 kg/q had been found to be lost for soybean grain. The maximum quantity had been found to be lost in harvest (56%), followed by storage (20%), threshing & winnowing (19%), handling (3%), and transportation (2%) of grain in Soybean. The quantity loss of soybean grain was found to be some what more in large (14.50kg/q) followed

by small (12.53kg/q), marginal (11.76kg/q), and medium (11.42kg/q). The majority of soybean growers found to be used metal/cemented (40.00%) roof of storage structure followed by crop by product (36.25%) and grass thatched (23.75%). The wall of storage structure was found to be made up of mud (61.25%) followed by bricks/cement (38.75%) as reported by the majority of soybean growers. The majority of them also reported that the floor of storage structure was found to be made of earth (55.00%) and concrete (45.00%). As regards to the height of the platform the majority of the soybean growers reported that it was less than 6 inches (68.52%) to 6–12 inches (31.48%). As regards the physical condition of roof, walls, guard and floor, the majority of soybean growers reported that their storage structure's roof was good (100.00%), with good condition of walls (100.00%) and have not rat guard (100.00%).The average cost of kachha / cemented storage structure was found to be Rs. 29789.92/- per HH. The majority of soybean growers reported that they repaired their storage structure in 2 – 5 years (56.25%) followed by every 2 years (40.00%). The walls and rat guard required no maintenance as reported by the majority of soybean growers. All the soybean growers reported that they never followed sun drying, admixing with ash, smoking and other pest control measures and others plant material in their storage structure.

The harvest losses were found to be more in soybean (7.44kg/q) as compared to wheat (2.82 kg/q). The quantity losses during threshing and winnowing have also been found to be more in soybean (2.34 kg/q) as compared to wheat (0.34kg/q). As regards to the post harvest losses in different agro climatic regions the post harvest losses of wheat were found to be more in Vindhyan plateau (9.50 kg/q) as compared to Central Narmada Valley (5.04 kg/q), whereas, The maximum post harvest losses were found to be more in Vindhyan Plateau (14.62 kg/q) as compared to Malwa Plateau (10.96 kg/q) also in soybean. In order to minimize post harvest losses the suggestions of sample soybean growers mainly concentrated around proper care during harvesting, threshing & winnowing (92.50%), careful handling of grains at various post harvest stages (handling, weighing, transportation, storage etc.) (85.50%), immediate marketing after harvesting to avoid weight loss (73.75%), proper storage condition (47.50%), sun drying of grains every three months (46.25%), mix pesticides to avoid pest (81.88%), installation of rat guards (48.75%), timely supervision of store grains (49.38%) and fumigation in storage

structure for proper pest control (28.75%). These suggestions were also reported by wheat growers with minor variations.

Policy Implication:

- As it is clear that the majority of respondents had lack of technical know how of post harvest technology specially storage techniques. They never found to be followed sun drying, admixing with ash, smoking and other pest control measures in their storage structure. Even they were not found to be followed rat guard and removed infested grain from their storage grain. Hence, efforts should be made to popularize post harvest technology amongst the farmers so that they could able to take advantage of time, place, form and possession utility of the product and earn more by reducing the pre and post harvest losses occurred in their products.
- As high cost of input, lack of irrigation, water and electricity were found to be most important constraints in the area under study and the majority of farmers were found to be depended on private dealers. Hence, ever increasing prices of farm inputs especially pesticides and fungicides should be curtailed by keeping a check on the prices being charged by the private pesticide dealers to stop exploitation of the farmers.
- There is a need of imparting new training programmes to farmers for timely and cheaper control of insect-pest and disease attack to minimize the production losses specifically biological plant protection measures as none of the farmer was found to be adopted these measures in cultivation of crops.
- Timeliness in harvesting of wheat and soybean crops should be ensured for minimizing the harvest losses and untimely harvesting by the farmers should be discouraged by penalizing for the lapse.
- It was observed during the course of investigation that wheat harvester/combiner used in soybean harvesting with adjustment in the machine, this enhanced the losses in soybean hence, to minimization of post harvest losses in soybean there is a need to popularized separate harvester/combiner specific for soybean.

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ANNEXURE 1

General information of selected wheat and soybean growers

A. WHEAT GROWERS

Table 1: Demographic profile of the selected farmers (% of households)

Characteristics		Marginal	Small	Medium	Large	Total
No of HH		40.00	40.00	40.00	40.00	160.00
Household size (numbers)		6	7	6	8	7
Average numbers of earners		3	2	2	2	2
Proportion of Male /Female /Children (%)	Male >15 years	39.47	34.63	44.23	44.21	40.64
	Female >15 years	30.00	29.59	29.94	22.52	28.01
	Children <15 years	30.53	35.78	25.82	33.26	31.35
Identity of Respondent (%)	Head	82.50	95.00	95.00	82.50	88.75
	Others	17.50	5.00	5.00	17.50	11.25
Average age of the respondent (% households)	Less than 25	7.50	2.50	5.00	7.50	5.63
	Between 25 to 40	27.50	40.00	22.50	40.00	32.50
	Above 40	65.00	57.50	72.50	52.50	61.88
Highest Education status of a family member (% households)	Illiterate	30.00	25.00	10.00	12.50	19.38
	Up to primary	27.50	27.50	10.00	12.50	19.38
	Up to secondary	32.50	32.50	37.50	40.00	35.63
	Higher secondary	2.50	7.50	10.00	12.50	8.13
	Graduate and above	7.50	7.50	32.50	22.50	17.50
Caste (% households)	SC	7.50	0.00	5.00	0.00	3.13
	ST	0.00	0.00	0.00	0.00	0.00
	OBC	72.50	52.50	62.50	60.00	61.88
	General	20.00	47.50	32.50	40.00	35.00
Distance from the main market (km)		5.95	16.10	15.80	10.30	12.04
Annual family income (Rs)		0.32	0.48	1.03	2.65	1.12

Table 2: Characteristics of operational holdings (acres per household)

Farm size	Owned land	Un cultivated land	Leased-in	Leased -out	NOA	Irrigated area	GCA	Cropping intensity (%)
Marginal	1.98	0.00	0.44	0.00	2.41	1.79 (74.27)	4.68	194.19
Small	4.26	0.00	1.90	0.00	6.16	4.00 (64.93)	11.86	192.53
Medium	8.62	0.00	5.67	0.00	14.28	8.28 (57.98)	26.98	189.00
Large	27.60	0.00	2.32	0.00	29.62	26.38 (89.06)	53.64	181.12
Overall	10.61	0.00	2.58	0.00	13.12	10.11 (76.59)	24.29	189.21

Figures in parenthesis show percentage to net operated area

Table 3: Nature of tenancy in leasing-in land (% households)

Farm size	Crop sharing	Crop and cost sharing	Fixed rent in cash	Others	Total	% share of tenancy in NOA	Rent amount Rs. Per acre
Marginal	0.00	0.00	10.00	0.00	10.00	16.50	7100
Small	0.00	0.00	20.00	0.00	20.00	27.77	11735
Medium	0.00	0.00	30.00	0.00	30.00	30.74	11198
Large	0.00	0.00	20.00	0.00	20.00	8.21	11833
Overall	0.00	0.00	20.00	0.00	20.00	20.80	10466

Table 4: Source of irrigation of net irrigated area (%)

Farm size	Only canal	Canal + tube-well	Only electric tube-well	Only diesel tube-well	Tanks	Open well	Others
Marginal	27.50	7.50	15.00	32.50	0.00	0.00	0.00
Small	32.50	7.50	47.50	0.00	0.00	0.00	0.00
Medium	20.13	20.13	54.74	0.00	0.00	0.00	0.00
Large	15.00	37.50	32.50	2.50	0.00	0.00	5.00
Overall	23.78	18.16	37.43	8.75	0.00	0.00	1.25

Table 5: Cropping pattern of selected farmers (% of GCA for the whole year)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Soybean	50.14	45.56	42.29	42.14	45.03
Rice	0.00	6.21	12.16	8.58	6.74
Jowar	0.00	0.00	3.19	0.00	0.80*
Tur	0.00	0.00	0.00	3.92	0.98**
Rabi crops					
Wheat	46.62	43.88	45.65	41.39	44.38
Gram	2.64	6.04	3.35	8.26	5.07
Lentil	0.60	1.67	1.07	1.92	1.31
Gross cropped area	100	100	100	100	100

* grow only by the one HH, ** grown only by 4 HH of large size group

Table 6: Percentage of area under HYV seeds

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Soybean	100.00	100.00	100.00	100.00	100.00
Rice	0.00	100.00	95.80	90.54	71.59
Jowar	0.00	0.00	0.00	0.00	0.00
Tur	0.00	0.00	0.00	0.00	0.00
Rabi crops					
Wheat	100.00	100.00	100.00	100.00	100.00
Gram	50.00	90.27	89.87	92.87	80.75
Lentil	0	0	0	0	0.00

Table 7: Average yield of major crops grown by the selected households

(Quintal per acre)

Name of the crops	Marginal	Small	Medium	Large	Total
Kharif crops					
Soybean	3.54	4.49	4.62	4.52	4.29
Rice	0.00	11.94	14.31	13.86	10.03
Jowar	0.00	0.00	3.00	0.00	0.75*
Tur	0.00	0.00	0.00	3.37	0.84**
Rabi crops					
Wheat	14.22	14.12	16.16	10.99	13.87
Gram	3.17	3.94	4.47	4.16	3.94
Lentil	1.67	2.01	2.26	1.92	1.97

* grow only by the one HH, ** grown only by 4 HHs of large size group.

Table 8: Percentage of output marketed by the selected households

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Soybean	91.54	90.06	88.59	87.81	89.50
Rice	0.00	70.28	74.50	73.62	54.60
Tur	0.00	0.00	0.00	82.76	82.76
Rabi crops					
Wheat	60.60	62.96	71.94	78.53	68.51
Gram	79.42	82.10	82.48	86.00	82.50
Lentil	66.67	86.96	73.53	83.33	77.62

Table 9: Value of output and marketed surplus (aggregate of all crops)

	Value of output (main + byproduct)		Value of marketed surplus		% of output marketed
	Rs Per household	Rs Per acre	Rs Per household	Rs Per acre	
Marginal	70875.38	14869.63	49436.65	10406.28	69.75
Small	189510.44	15430.10	137317.34	11242.72	72.46
Medium	507905.00	17744.68	384070.70	13554.11	75.62
Large	657811.32	13705.16	604026.21	11307.79	91.82
Overall	356525.53	15437.39	293712.72	11627.73	77.41

B. SOYBEAN GROWERS

Table 10: Demographic profile of the selected farmers (% of households)

Characteristics		Marginal	Small	Medium	Large	Total
No of HH		40.00	40.00	40.00	40.00	160.00
Household size (numbers)		6	8	8	9	8
Average numbers of earners		2	2	2	3	2
Proportion of Male/Female/ Children (%)	Male >15 years	36.34	33.78	35.16	34.24	34.88
	Female >15 years	32.56	29.34	32.39	31.99	31.57
	Children <15 years	31.10	36.88	34.26	31.98	33.56
Identity of Respondent (%)	Head	77.50	92.50	72.50	90.00	83.13
	Others	22.5	7.5	27.5	10	16.88
Average age of the respondent (% households)	Less than 25	7.50	0.00	5.00	7.50	5.00
	Between 25 to 40	30.00	35.00	35.00	55.00	38.75
	Above 40	62.50	65.00	60.00	37.50	56.25
Highest Education status of a family member (% households)	Illiterate	15.00	27.50	12.50	20.00	18.75
	Up to primary	32.50	27.50	40.00	22.50	30.63
	Up to secondary	27.50	30.00	27.50	27.50	28.13
	Higher secondary	7.50	2.50	10.00	10.00	7.50
	Graduate and above	17.50	12.50	10.00	20.00	15.00
Caste (% households)	SC	40.00	22.50	5.00	10.00	19.38
	ST	5.00	5.00	2.50	2.50	3.75
	OBC	32.50	47.50	72.50	47.50	50.00
	General	22.50	25.00	20.00	40.00	26.88
Distance from the main market (km)		14.74	15.99	16.68	16.05	15.86
Annual family income (Rs)		0.30	0.47	0.95	2.53	1.06

Table 11: Characteristics of operational holdings (acres per household)

Farm size	Owned land	Un cultivated land	Leased-in	Leased -out	NOA	Irrigated area	GCA	Cropping intensity
Marginal	1.62	0.00	0.09	0.00	1.71	1.50 (87.72)	3.37	197.16
Small	4.30	0.00	0.34	0.00	4.62	4.48 (96.97)	8.58	185.46
Medium	11.58	0.00	0.39	0.00	11.83	10.79 (91.21)	22.18	186.08
Large	30.64	0.00	1.03	0.00	31.66	28.14 (88.88)	60.11	189.82
Overall	12.03	0.00	0.46	0.00	12.46	11.23 (90.13)	23.56	189.63

Figures in parenthesis show percentage to total net operated area

Table12: Nature of tenancy in leasing-in land (% households)

Farm size	Crop sharing	Crop and cost sharing	Fixed rent in cash	Others	Total	% share of tenancy in NOA	Rent amount Rs. Per acre
Marginal	0.00	0.00	5.00	0.00	5.00	5.12	5000.00
Small	0.00	0.00	7.50	0.00	7.50	7.25	5307.69
Medium	0.00	0.00	7.50	0.00	7.50	3.28	5161.29
Large	0.00	0.00	10.00	0.00	10.00	3.24	4878.05
Overall	0.00	0.00	**7.50**	**0.00**	**7.50**	**4.72**	**5086.76**

Table13: Source of irrigation of net irrigated area (%)

Farm size	Only canal	Canal + tube-well	Only electric tube-well	Only diesel tube-well	Tanks	Open well	Others
Marginal	10.53	5.26	76.32	0.00	7.89	0.00	0.00
Small	5.26	15.79	78.95	0.00	0.00	0.00	0.00
Medium	0.00	20.00	80.00	0.00	0.00	0.00	0.00
Large	10.00	7.50	82.50	0.00	0.00	0.00	0.00
Overall	**6.45**	**12.14**	**79.44**	**0.00**	**1.97**	0.00	0.00

Table14: Cropping pattern of selected farmers (% of GCA for the whole year)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Soybean	49.03	45.59	50.27	49.50	48.60
Rice	0.00	6.84	3.30	3.47	3.40
Tur	3.77	2.74	0.96	0.78	2.06
Maize	0	0	0.16	0.09	0.06
Rabi crops					
Wheat	34.79	37.05	39.98	36.87	37.18
Gram	14.29	12.57	8.31	10.10	11.32
Potato	0	0	2.72	1.96	1.17
Summer crops					
Berseem	0	0	0.16	0.76	0.23
Gross cropped area	100	100	100	100	100

Table15: Percentage of area under HYV seeds

Name of the crop	**Marginal**	**Small**	**Medium**	**Large**	**Total**
Kharif crops					
Soybean	100.00	100.00	100.00	100.00	**100.00**
Rice	0.00	100.00	100.00	100.00	**100.00**
Rabi crops					
Wheat	**100.00**	100.00	100.00	100.00	100.00
Gram	86.05	82.41	84.81	81.41	83.67
Potato	**0.00**	0.00	**100.00**	**100.00**	100.00
Summer crops					
Berseem	0.00	0.00	100.00	0.00	100.00

Table16: Average yield of major crops grown by the selected households (q per acre)

Name of the crop	**Marginal**	**Small**	**Medium**	**Large**	**Total**
Kharif crops					
Soybean	4.31	4.40	5.54	4.85	**4.77**
Rice	0.00	8.64	9.74	10.07	**9.48**
Tur	4.60	4.40	4.18	6.20	**4.85**
Maize	0.00	0.00	0.00	3.00	**3.00**
Rabi crops					
Wheat	15.50	13.47	13.80	13.03	**13.95**
Gram	5.51	4.83	4.43	4.15	**4.73**
Potato	0.00	0.00	10.64	12.73	**11.68**
Summer crops					
Berseem	0.00	0.00	6.00	0.00	**1.50**

Table 17: Percentage of output marketed by the selected households

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Soybean	87.18	81.37	87.09	87.84	85.87
Rice	0.00	79.22	70.27	89.29	79.59
Tur	88.94	89.30	87.00	80.65	86.47
Rabi crops					
Wheat	72.22	72.77	70.58	68.83	71.10
Gram	70.39	83.05	80.18	77.17	77.70
Potato	0.00	0.00	88.50	96.44	92.47

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Table 18: Value of output and marketed surplus (aggregate of all crops)

	Value of output (main + byproduct)		Value of marketed surplus		% of output marketed
	Rs Per household	Rs Per acre	Rs Per household	Rs Per acre	
Marginal	56587.375	16777.33	42910.84	12723.73	75.83
Small	132903.375	15671.32	104361.47	12329.63	78.52
Medium	336710.25	16263.07	268657.67	12934.68	79.79
Large	936115.75	15836.15	732192.04	12404.60	78.22
Total	365579.19	16136.97	287030.51	12598.16	78.09

ANNEXURE 2

Action Taken Report on Comments on the report **"Assessment of Pre and Post Harvest Losses of Wheat and Soybean in Madhya Pradesh"** submitted by AERC, JNKVV, Jabalpur.

1. **Title of the draft report examined:**
   Assessment of Pre and Post Harvest Losses of Wheat and Soybean in Madhya Pradesh
2. **Date of receipt of the Draft report:** 16 April 2013
3. **Date of dispatch of the comments:** 3 July 2013
4. **Comments on the Objectives of the study:**
   All the objectives of the study have been addressed
5. **Comments on the methodology**
   Common methodology proposed for the collection of field data and tabulation of results has been followed. It is appreciable that authors have made efforts to generate some useful additional information on post harvest losses at different agro-climatic regional level. Similar information on pre harvest losses may also be useful, but they need to be generated and presented in a table. However, estimates in some tables should be changed for uniformity and comparisons across the states.
   Action: Done as per suggestion
6. **Comments on analysis, organization, presentation etc.**
   (i) In Chapter I, Table 1.6 provides information on land use classification of MP. It is not clear to which year these data pertain to. Further, this information may be presented in percentages at different points of time (rather than for a single year) for better understanding of the changes in land use in MP.
   Action: Done as per suggestion
   (ii) Figures 1.2 to 1.4 provide some information on per cent share of different of crops. Reference year is again missing for these figures also. It would be useful to provide a table containing cropping pattern in MP (% share of different crops in GCA) at different points of time, perhaps in Triennium Ending (TE). In that case, please remove the figures.
   Action: Done as per suggestion
   (iii) In table 1.8, percentage change over 2004-05 gives misleading information that agricultural sector grew at 9.01 per cent and total economy at 20.42 per cent in 2007-08. But, the fact is that agricultural sector in MP had registered a negative growth in 2007-08. This will be evident only when year-over-year growth rates are calculated rather than working out the percentage change over a constant year (2004-05).
   Action: Done as per suggestion
   (iv) Since the composition of GSDP, both in absolute and percentage terms, has been presented in constant prices, there is no need to provide the same in current prices. Therefore, please remove the Table 1.10 and Table 1.11.
   Action: Done as per suggestion

(v) In Chapter III, Table 3.4, the per cent sources of irrigation by farm size groups does not add to 100. Authors should recalculate and present the values.

Action: Done as per suggestion

(vi) In Chapter III, authors have made appreciable efforts to present the information by wheat and soybean sample farmers. However, authors are requested to compute similar tables for entire sample (wheat and soybean farmers) taken together as per the table format provided by the coordinating centre. This will facilitate the coordinating centre to prepare the consolidation report at all India level on a uniform basis. Authors may retain details of crop specific sample farmers.

Action: Done as per suggestion

(vii) In Chapter IV, Table 4.1 should be modified. From the current results given in these tables, it is not possible to state the proportion of the famers out of the total sample farmers who have faced a particular constraint in the study region and how each of the constraints has been ranked by these farmers. Therefore to obtain appropriate results, estimate the percentage of households out of total sample households (i.e., 160 households for each crop) rather than the sum of households falling within each constraint.

Action: Done as per suggestion

(viii) Table 4.3 and Table 4.4 should also be modified in the light of the comment (vii). That is, estimate the percentage of households by each rank out of total sample households (i.e., 160 households) rather than the sum of households falling within each pest/disease/weed category. Likewise, in Table 4.9, page 54, work out the per cent households out of the total sample households.

Action: Done as per suggestion

(ix) In chapter V, Table 5.4 and Table 5.5, please check % quantity lost during transport and handling as these estimates are quite varied from average physical loss.

Action: Done as per suggestion

(x) Farmer households' suggestions to minimize the pre harvest and post harvest losses are missing in the respective chapters of the report.

Action: Done as per suggestion

(xi) Authors should provide economic explanation of data presented in all the chapters. It is suggested to copy edit the report before it is finalized.

Action: Done as per suggestion

7. Overall view on acceptability of report

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