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**Gokhale Institute
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Economics**

(Deemed to be University)
Pune - 411 004

AERC Report



**Agro-Economic
Research Centre
(AERC)**

Assessment of Pre and Post Harvest Losses in Tur and Soyabean Crops in Maharashtra

Deepak Shah



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July 2013

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FOREWORD

Despite various policy measures initiated in more recent times, sustainability of foodgrain production system still remains an issue that needs to be taken cognizance of because pre-and post harvest losses account for substantial share in crop production. The post harvest losses may occur on account of several reasons. The leakages between production and consumption include loss of grains before harvesting of crop as well as during various post harvest operations viz. threshing, cleaning, winnowing, drying, storage, transportation, packaging, etc.. The losses of grain may also occur due to destruction by pests, losses on account of damage caused by mechanical agents such as birds, animals, hailstorms, rains, over drying, shattering in the fields during harvesting, rodents, mites and insects, changes in moisture content, dust and broken grains, reduction in germination power, loss of palatability, heating and caking, etc.. These sources of leakage between production and consumption of foodgrains and other crops not only include wastage of grains during various post-harvest operations but also at the stage of harvesting. This coupled with substantial loss of grain before harvesting operation leads to reduction in net availability of grain for human consumption.

The state of Maharashtra, which cultivates a significant production volume of pulses and oilseeds of the country, is seen to have witnessed crop loss owing to increasing infestation of pests and diseases, aside from loss of crop occurring during various operations viz. harvesting, threshing, cleaning, winnowing, drying, storage, transportation, packaging, etc. The present study, therefore, attempts to evaluate the extent of pre- and post harvest losses for important pulse and oilseed crops in the state of Maharashtra. The pre- and post harvest losses have been assessed for tur among pulses and soyabean among oilseed crops. The present study estimates reveal around 14-18 per cent of the total production of tur and soyabean crops as lost during various pre- and post-harvest stages with pre-harvesting losses accounting for the major share, followed by harvesting, storage, threshing and winnowing, and transportation operations. Efforts, therefore, need to be initiated to curb such losses by adopting appropriate measures. It is expected that measures and programme initiatives such as adoption of improved pre- and post-harvest technology and water and pest control practices will not only increase the productivity of individual crops and their quality but these are also likely to substantially minimize the post-harvest losses, increase the total crop area cover and generate adequate quality surplus for their conversion into value-added food products.

I hope the findings of the report would assume increasing significance, especially with growing concern for pulses and oilseeds production and food security in our country.

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Rajas Parchure
Professor and Offg. Director

PREFACE

India at present is passing through a complex type of situation due to shift in consumption pattern in favour of high value crops and consequent crop diversification drive. The crop diversification drive has raised concern about food security in the country. Very slow growth in agriculture sector of India has further raised doubts about bridging demand supply gap in foodgrain production. Although production in agriculture is seasonal and exposed to natural environment, the post-production operations play an important role in providing stability in the food supply chain. However, both pre-and post harvest operations involve significant losses of crops, resulting in much lower availability of grains for human consumption. While the pre-harvest losses occur before the process of harvesting begins, and may be due to insects, weeds and rusts, the post-harvest losses are seen during the period between harvesting of crop and its final consumption. There is potential for loss throughout the grain harvesting and marketing chains. Generally, most of the crops are cultivated in a particular season but made available throughout the year, which is possible through storage. Storage therefore plays a vital role in grain supply chains. Losses in stored grain are determined by the interaction between the grain, the storage environment and a variety of organisms. Further, transportation at the time of marketing also causes losses of grains due to poor handling of the crop.

The state of Maharashtra, which cultivates a significant production volume of pulses and oilseeds of the country, is seen to have witnessed crop loss owing to increasing infestation of pests and diseases, aside from loss of crop occurring during various operations viz. harvesting, threshing, cleaning, winnowing, drying, storage, transportation, packaging, etc. The present study, therefore, attempts to evaluate the extent of pre- and post harvest losses for important pulse and oilseed crops in the state of Maharashtra. The pre- and post harvest losses have been assessed for tur among pulses and soyabean among oilseed crops.

The present study estimates reveal around 14-18 per cent of the total production of tur and soyabean crops as lost during various pre- and post-harvest stages with pre-harvesting losses accounting for the major share followed by harvesting, storage, threshing and winnowing, and transportation operations. Efforts, therefore, need to be initiated to curb such losses by adopting appropriate measures. It is expected that measures and programme initiatives such as adoption of improved pre- and post-harvest

technology and water and pest control practices will not only increase the productivity of individual crops and their quality but these are also likely to substantially minimize the post-harvest losses, increase the total crop area cover and generate adequate quality surplus for their conversion into value-added food products.

At the initial stage of this study, I had fruitful discussions with Mr. Prabhakar Deshmukh, Agriculture Commissioner, Commissionerate of Agriculture, Government of Maharashtra, Pune and other senior officers of the Department. I am extremely grateful to them for providing inputs for this study. I am equally grateful to Sr. Jayant Deshmukh, Director (Extension and Training), Commissionerate of Agriculture, GOM, Pune, Mr. Lokhande Ashok, Joint Director (E & T), and Mr. D.B. Deshmukh, Dy. Director (Project) for not only supplying the requisite information but also extending all possible help during the conduct of this study. I also extend special thanks to Mr. Anil Madhukar Ingle, Sub-divisional Agriculture Officer, Yavatmal, Mr. Bhise Mohan Shri Rangrao, Sub-divisional Agri. Officer (SDAO), Latur, Mr. Malegaonkar P.H S.D.A.O. SDAO, Nanded and Mr. S.M. Mundare, SDAO, Nagpur for their support in this study.

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CHAPTER – I

INTRODUCTION

The agricultural sector has always been an important component of the Indian economy with period after mid-sixties being marked with significant expansion in foodgrain output of the country due to introduction of new technology, popularly known as seed-fertilizer-water technology. Though before the mid-sixties increase in foodgrain output in the country came mostly from the growth of the cultivated area and extension of irrigation, ever since mid-sixties the new farm technology symbolized by HYV seeds and use of chemical fertilizer has been relied upon to get the desired increase in production. Though the new farm technology had a powerful impact on the food sector of the country, this technology revolution could gain momentum only in some select regions of the country and that too with respect to some cereal crops like rice and wheat. The impact of new technology was tardy and dismal in the case of pulses. In fact, in the race of output growth, pulses have lagged so far behind that these can be categorized as 'also ran' (Shah, 2003). A number of earlier studies have also shown a sluggish and erratic growth in pulses and coarse cereal production, though most of the studies are area specific (Moorti et. al. 1991; Bhatia, 1991, Shah, 1997). In the late 1970's and early 1980's, several studies raised concerns about a possible deceleration in the growth of foodgrain production, indicating a decline in the momentum of the green revolution and possible exhaustion of the potential of available technology (Alagh and Sharma, 1980; Desai and Namboodiri, 1983). Further, the nineties period not only witnessed a declining trend in area and productivity of various foodgrain crops but also shift in cropping pattern in favour of high value horticulture and oilseed crops. This has put a threat to food security of the nation. The Government of India, therefore, is now giving top priority for boosting the production of pulses in the country with the objective of meeting their domestic requirement and also to reduce their import bill.

At present, Indian agriculture is facing several constraints as well as challenges due to less than 2 per cent annual growth of the sector in more recent times. Though the National Policy on Agriculture (NAP) document released in July 2000 envisages agricultural growth rate in excess of 4 per cent per year over the next two decades, the achievement of this growth to a greater extent depends on market and irrigation infrastructure development and the adoption of biotechnology, especially genetic modification. With a view to raise the productivity and production of food crops to meet

their increased demand due to ever increasing population pressures, the NAP categorically emphasizes upon adoption of differentiated strategy for different regions, taking into account the agronomic, climatic and environmental conditions to achieve the full growth potential of every region. It also pins attention on development of new crop varieties of food crops to achieve higher nutritional value through biotechnology measures. Another important element of NAP is the promotion of availability of hybrid seeds and disease-free planting materials of improved varieties. The NAP also accords high priority towards development, production and distribution of improved varieties of seeds and planting materials, and also strengthening and expansion of seed and plant certification system with private sector participation. As for the seed sector, the NAP emphasizes upon restructure of the National Seeds Corporation (NSC) and State Farms Corporation of India (SFCEI) and establishment of National Seed Grid to ensure supply of seeds to those areas affected by natural calamities.

In general, government policies envisage to focus on quality aspects at all stages of farm operations, including sowing to processing activity, with the extension to focusing on other aspects encompassing improving the quality of inputs and other support services to farmers, creating quality consciousness amongst farmers and agro-processors, promotion of grading and standardization of agricultural products to enhance exports, promotion of application of science and technology in agriculture through a regular system of interface between S&T institutions and potential users to make the agricultural sector globally more competitive (NAP, 2000).

It is disquieting to note that while many sectors of India show remarkable growth in the post-reform period, there are still several difficulties to cope with or tackle more than 300 million people living below the poverty line, which stands at one-fourth of the world's poor and represents the highest concentration of poverty of any country in the world. Sustained rural poverty reduction heavily depends on the growth of agriculture sector, which employs 75 per cent of the rural working population and accounts for 65-70 per cent of rural income. Interestingly, while other sectors of India showed rapid growth in the 1990s, the rural growth at the same time was marked with loss of momentum and became less effective in alleviating poverty. Of late, the major constraints faced by the Government of India are relating to investments towards creating rural and social infrastructure, subsidies and dissemination of technology that have become serious cause of concern, especially with respect to the future of India's rural economy and prospects for further alleviation of rural poverty in India (Bhalla, et. al., 1999).

India at present is passing through a complex type of situation due to crop diversification witnessed during 1980s and 1990s and change in the nature of demand for agricultural commodities during 2000s, both the domestic and foreign markets. The consumption pattern has shifted worldwide from cereals to high value commodities. Obviously, importance is given to the production of those commodities that have export demand in the world market. The changes witnessed during the last three decades have led to specialized system of commodity production, which, in turn, has resulted in loss of area under traditional crops. The developments witnessed in recent past have also caused widespread prevalence of pests and diseases and consequent use of higher amount of pesticides to raise the productivity of crops. The increased use of pesticides has also resulted in developing insects and disease resistance, which further led to reduction in crop yield. Almost all the foodgrain and oilseed crops cultivated across states in the country are seen to have been affected by such measures. The state of Maharashtra, which cultivates a significant production volume of pulses and oilseeds of the country, is seen to have witnessed crop loss owing to increasing use of pesticides and insecticides. Pre-harvest loss is one end of the spectrum, the other end being post harvest losses during various operations viz. harvesting, threshing, cleaning, winnowing, drying, storage, transportation, packaging, etc. The present study, therefore, attempts to evaluate the extent of pre- and post harvest losses for important pulse and oilseed crops in the State.

1.1 Status of Agricultural Economy in Maharashtra

Maharashtra, the commercial state of India, is located in the western part of the country. Maharashtra is also the industrially leading state in the country with Bombay as the country's commercial capital. It is one of the largest states with an area of 3.08 lakh hectares, accounting for 9.4 per cent of India's geographical area. The state occupies the second position, both in terms of population and geographical area, next only to Uttar Pradesh and Rajasthan, respectively. The population of the state as per 2011 census is 11.24 crores, which turns out to be 9.3 per cent of India's total human population. About 55 per cent of human population of Maharashtra belongs to rural area and 45 per cent to urban area. This is an indicator of growing urbanization in the State.

The economy and infrastructure of the state has flourished considerably since the initiation of economic policies in 1970s. Though largely an industrial state, agriculture sector remains as the mainstay of the state. The black basaltic soil prevents the cultivation of food crops and, therefore, the principal crops include jowar, bajra, wheat and pulses, and several oilseeds, including groundnut, sunflower and soybean. The cash crops

cultivated in the state include groundnut, cotton, sugarcane, turmeric, and tobacco. The horticulture sector has made rapid progress in the state, and the major horticultural crops cultivated in the state are, grapes, banana, mango, oranges, onion and a host of other aromatic and medicinal plants. As per Economic Survey of Maharashtra (2011-12), the state of Maharashtra accounts for 12.3 per cent of India's net sown area, 11.5 per cent of gross cropped area, 4.5 per cent of gross irrigated area, 3.5 per cent of area under rice, 4.2 per cent of area under wheat, 54 per cent of area under jowar, 12.9 per cent of area under bajra, 9.0 per cent of area under all cereals, 10.3 per cent of area under foodgrains, 33.8 per cent of area under cotton, and 6.6 per cent of area under groundnut. The state also accounts for 6.8 per cent of livestock and 9.9 per cent of poultry population of the country. The state accounts for 15.5 per cent income of India at current prices and 14.9 per cent of gross state domestic product at factor cost.

The net sown area of 17.43 million hectares in Maharashtra is distributed among nearly 13.72 million farm holdings with an average size of holding of 1.46 hectares. Although agricultural sector in the state has been making progress, its performance is not very satisfactory as compared to non-agricultural sector. The major reason for weak performance being that the agriculture in the state is mainly rainfed, and the major part of its territory falls on the plateau where the rainfall is low and highly unstable (Dange and Pawar, 2003). Obviously, the growth prospect of agriculture in the state is largely linked to the level and distribution of rainfall. The improvement in agricultural productivity and higher intensity of cropping is restricted due to low and unstable irrigation base.

Maharashtra is one of the most industrialized and urbanized states in the country, However, it also enjoys the dubious distinction of a state having highest rural-urban disparity in standard of living of its population (Sawant et. al., 1999). The gross state domestic product (GSDP) at current prices for 2010-11 was estimated at Rs.10,68,327 crores and contributed about 14.7 per cent of the GDP (Table 1.1). The GSDP has been growing at a rapid pace over the last few years. The State boasts to have a very vibrant industrial sector and a rapidly growing services sector. Both these sectors presently account for 87.22 per cent of the State's domestic product. The agriculture and allied activities sector accounts for 12.78 per cent share in State's gross domestic product. Interestingly, at current prices, while share of agriculture and allied activities in gross domestic product of India has declined from 19 per cent in 2004-05 to 18 per cent in 2010-11, this share for Maharashtra has increased from 11 per cent to 13 per cent during the same time. Within agriculture and allied activities, the share of agriculture in GSDP

has increased from 8 per cent in 2004-05 to 11 per cent in 2010-11. On the other hand, the share of industrial sector in GSDP at current prices remained by and large constant at around 30 per cent during the period between 2004-05 and 2010-11. Contrary to the rise in share of agriculture sector in GSDP of the state, the share of service sector in GSDP of the at current prices declined from 60 per cent 2004-05 to 57 per cent 2010-11. However, the service and industrial sector still accounted for the bulk of the GSDP of Maharashtra.

Table 1.1: Percent Share of Industry by Origin in Gross State Domestic Product at Factor Cost at Current Prices: Maharashtra

Sr. No.	Industry	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10*	2010-11#
1	Agriculture	8.29	8.20	8.72	9.45	7.85	8.48	10.78
2	Forestry	2.20	2.33	2.50	2.07	1.98	1.87	1.78
3	Fishing	0.33	0.32	0.28	0.26	0.23	0.22	0.22
4	Agriculture & Allied Activities	10.81	10.84	11.50	11.78	10.06	10.58	12.78
5	Mining and quarrying	0.84	0.79	0.56	0.57	0.69	0.50	0.44
6	Primary Sector	11.65	11.63	12.06	12.35	10.74	11.08	13.22
7	Registered manufacturing	14.09	16.83	17.67	17.26	16.01	14.98	14.23
8	Un-registered manufacturing	6.48	6.39	6.29	6.44	6.16	5.90	5.56
9	Construction	6.29	6.21	5.88	6.53	6.96	7.91	8.45
10	Electricity, Gas and Water supply	1.90	1.56	1.57	1.55	1.49	1.54	1.59
11	Secondary Sector	28.77	30.99	31.42	31.79	30.63	30.33	29.83
12	Industry	29.61	31.78	31.98	32.35	31.31	30.84	30.26
13	Railways	0.69	0.60	0.59	0.57	0.60	0.70	0.57
14	Transport by other means & storage	5.26	5.02	5.04	4.90	5.17	5.07	4.75
15	Communication	1.98	1.88	1.68	1.62	1.72	2.31	2.22
16	Trade, Hotels & restaurants	16.16	15.64	15.94	15.45	14.95	15.15	14.77
17	Banking and Insurance	11.41	10.50	10.20	10.15	11.05	10.29	10.25
18	Real estate, Ownership of dwelling	12.82	12.86	12.75	13.02	14.10	13.62	13.16
19	Public Administration	4.70	4.40	4.04	4.15	4.77	4.90	4.83
20	Other services	6.55	6.47	6.29	6.00	6.27	6.56	6.41
21	Tertiary Sector/ Services	59.58	57.38	56.52	55.87	58.63	58.59	56.96
22	Gross Domestic Product (Rs Crores)	415480 (100.00)	486766 (100.00)	584498 (100.00)	684817 (100.00)	753969 (100.00)	867866 (100.00)	1068327 (100.00)

Source: Computations are based on figures obtained from 'Economic Survey of Maharashtra, 2011-12

Note: * - Provisional; # - Preliminary

As against the current price estimates, the constant price estimates present altogether a different scenario. At constant (2004-05) prices, the GSDP of Maharashtra was found increase from Rs.4,15,480 crores in 2004-05 to Rs.5,94,831 crores in 2007-08 and further to Rs.7,41,694 in 2010-11 (Table 1.2). However, the share of agriculture and allied activities in GSDP at constant (2004-05) prices declined steadily from 11 per cent in 2004-05 to nearly 8 per cent in 2010-11. Within agriculture and allied activities, the share of agriculture in GSDP of Maharashtra declined from 8 per cent in 2004-05 to 7 per cent in 2010-11. Like agriculture sector, the industrial sector also showed a marginal decline in its share in GSDP at constant prices, which declined from 32 per cent in 2006-07 to 31 per cent in 2010-11. On the other hand, the service sector showed a rising trend

in its share in GSDP at constant prices, which increased from 58 per cent in 2006-07 to 61 per cent 2010-11. Within industrial sector, the sub-sectors like trade, hotel and restaurants, banking and insurance, real estate, etc. were found to account for major share in GSDP of Maharashtra, both at current and constant (2004-05) prices.

Table 1.2: Percent Share of Industry by Origin in Gross State Domestic Product at Factor Cost at Constant (2004-05) Prices: Maharashtra

Sr. No.	Industry	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10*	2010-11#
1	Agriculture	8.29	8.15	8.34	8.72	6.81	6.48	6.91
2	Forestry	2.20	1.94	1.84	1.71	1.77	1.45	1.34
3	Fishing	0.33	0.33	0.29	0.27	0.24	0.22	0.20
4	Agriculture & Allied Activities	10.81	10.42	10.47	10.70	8.82	8.14	8.45
5	Mining and quarrying	0.84	0.76	0.69	0.62	0.59	0.57	0.52
6	Primary Sector	11.65	11.18	11.15	11.32	9.40	8.72	8.98
7	Registered manufacturing	14.09	16.30	17.48	16.71	15.35	15.11	14.71
8	Un-registered manufacturing	6.48	6.37	6.25	6.47	6.26	6.11	5.94
9	Construction	6.29	5.92	5.67	6.41	6.86	7.46	7.96
10	Electricity, Gas and Water supply	1.90	1.72	1.61	1.62	1.64	1.67	1.65
11	Secondary Sector	28.77	30.31	31.01	31.21	30.11	30.35	30.26
12	Industry	29.61	31.07	31.69	31.83	30.70	30.92	30.78
13	Railways	0.69	0.63	0.60	0.57	0.64	0.70	0.67
14	Transport by other means & storage	5.26	4.98	4.78	4.42	4.37	4.36	4.00
15	Communication	1.98	2.13	2.17	2.29	2.62	4.23	5.01
16	Trade, Hotels & restaurants	16.16	15.44	15.66	15.23	14.71	15.24	15.17
17	Banking and Insurance	11.41	11.69	12.27	12.98	14.53	14.31	14.52
18	Real estate, Ownership of dwelling	12.82	12.76	12.40	12.28	13.19	12.08	11.63
19	Public Administration	4.70	4.42	3.94	4.02	4.59	4.36	4.29
20	Other services	6.55	6.47	6.03	5.67	5.83	5.66	5.48
21	Tertiary Sector/ Services	59.58	58.51	57.84	57.47	60.48	60.93	60.77
22	Gross Domestic Product (Rs Crores)	415480 (100.00)	470929 (100.00)	534654 (100.00)	594831 (100.00)	610191 (100.00)	666123 (100.00)	741694 (100.00)

Source: Computations are based on figures obtained from 'Economic Survey of Maharashtra, 2011-12

Note: * - Provisional; # - Preliminary

The Net State Domestic Product (NSDP) and Per Capita Income (PCI) put Maharashtra as the economically leading state of India. The NSDP of the State for 2010-11 was found to be Rs.9, 82, 452 crores at current prices, which turns out to be higher than India's NSDP. In addition to this, PCI of Maharashtra has been steadily growing over the past several years. The per capita income is noticed to be higher than the national average during the period between 2004-05 and 2010-11, both at current and constant (2004-05) prices (Table 1.3). The per capita income in Maharashtra has increased from Rs.36,077 in 2004-05 to Rs.87,686 in 2010-11 at current prices and from 36,077 in 2004-05 to Rs.59,735 in 2010-11 at constant (2004-05) prices. The national average per capita income is found to be Rs.24,143 in 2004-05 and Rs.53,331 in 2010-11 at current prices, and Rs.24,143 in 2004-05 and Rs.35,993 in 2010-11 at constant (2004-05) prices. These estimates clearly underscore the fact that Maharashtra had much higher

per capita income as against the national average of the same during the entire period between 2004-05 and 2010-11, both at current and constant (2004-05) prices.

Table 1.3: Per Capita National Income in Maharashtra and India

(Rs/ Annum)

Income	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Maharashtra							
At Current Prices	36,077	41,965	49,831	57,760	62,234	71,309	87,686
At Constant (2004-05) Prices	36,077	40,671	45,582	50,138	50,183	54,166	59,735
India							
At Current Prices	24,143	27,131	31,206	35,825	40,775	46,117	53,331
At Constant (2004-05) Prices	24,143	26,015	28,067	30,332	31,754	33,843	35,993

Source: Economic Survey of Maharashtra, 2011-12

In the state of Maharashtra, the districts which have higher per capita income than the national average of the same are Thane, Pune, Satara, Sangli, Kolhapur, Solapur, Raigad, Sindhudurg, Ratnagiri, Nashik, Dhule, Ahmednagar, Aurangabad, Jalgaon, Amravati, Akola, Yavatmal, Nagpur, Wardha, Bhandara, Latur, and Chandrapur. It is only in the case of districts like Beed, Jalna, Hingoli, Parbhani, Nanded, Washim, Gadchiroli, Gondia and Buldhana that the per capita district income is lower as compared to the national average of the same.

Although the state of Maharashtra has shown significantly high GSDP and per capita income, this state is also marked with considerable regional disparity in terms of growth and development. Strong irrigation infrastructure prevailing in Western region in the face of weak irrigation infrastructure prevailing in Vidarbha and Marathwada regions coupled with significant climatic changes and soil type across the regional are the major reasons for the disparity in agricultural growth across regions of Maharashtra. The past studies showed regional disparities ever since the formation of the state of Maharashtra (Prabhu and Sarker, 1992). The regional disparities were shown in terms of economic growth as well as agricultural, industrial and human resource development. Most of the districts belonging to Vidarbha and Marathwada regions have remained underdeveloped due to poor attention being given to them. The regional disparity over time has been growing in Maharashtra.

1.2 Importance of Selected Crops in Maharashtra

Though India has become self sufficient in foodgrains production in spite of tremendous increase in population, mere self sufficiency in agriculture is not the chief objective of Maharashtra, which accords higher priority to assuring more remunerative net income to the farmers through efficient and sustainable use of available resources. The state has been implementing various schemes from time to time not only to increase

agricultural production and exports but also to encourage agro-processing industries with a view to reap the benefits of liberalized economy and global trade. Agricultural department in the state is firmly heading towards economic progress along with self-sufficiency through agriculture with the ultimate goal of achieving important position in the global agriculture produce market. The innovative horticulture plantation scheme under employment guarantee scheme implemented by the state is a part of this policy. However, in spite of Maharashtra's higher level of economic growth and despite being one of the higher-income States with growth rates exceeding several other States, Maharashtra was ranked fifth among 17 states in 2011 in terms of Human Development Index (HDI) with a HDI value of 0.572 (Table 1.4). Further, the lower proportion of area under irrigation renders Maharashtra's agriculture vulnerable to draughts, resulting in periodic fluctuation in farm output, which in a normal year is only 90 per cent of the State's total foodgrain requirement. The cropping intensity of Maharashtra is relatively higher than irrigation intensity.

Table 1.4: Comparison of Selected Indicators of Maharashtra with India

Sr. No.	Indicators	Maharashtra	India
1.	Geographical area (lakh sq. km) – 2011	3.08	32.87
2.	Density of Population (per sq. km) – 2011	365	382
3.	Percentage of urban to total population – 2011	45.23	31.6
4.	Percentage of agricultural workers to total workers – 2011	54.96	58.20
5.	Per capita income at current prices (Rs.)	87,686	53,331
6.	Human Development Index (HDI) - 1981	0.363	0.302
	- 1991	0.452	0.381
	- 2001	0.501	0.387
	- 2011	0.572	0.467
7.	Rank in HDI - 1981	3	-
	- 1991	4	-
	- 2001	5	-
	- 2011	5	-
6.	Yield per hectare (kg.) – Triennium Average (2006-07 to 2008-09)		
	- All cereals	1192	2118
	- All pulses	628	632
	- All foodgrains	1030	1842
	- All oilseeds	1031	1012
	- Cotton (lint)	293	430
	- Sugarcane	78	81
7.	Per capita foodgrain production (kg) – 2008-09	104.9	202.3
8.	Consumption of fertilizer per hectare cropped area (kg.) – 2008-09	116.1	127.7
9.	Percentage gross irrigated area to gross cropped area – 2008-09	17.7	45.3
10.	Net area sown per cultivator (hectare) – 2008-09	1.5	1.1
11.	Percentage of net area sown to geographical area – 2008-09	56.6	43.0
12.	Cropping intensity (%)	126.9	138.0
13.	Labour force participation rate – Rural	49.1	41.4
	- Urban	39.2	36.2
14.	Percentage of employed persons – Rural	49	41
	- Urban	38	35

Source: Economic Survey of Maharashtra, 2011-12

It is to be noted that the yield level of most of the foodgrain and cash crops are lower in Maharashtra as against the national average. Though Maharashtra is one of the major pulse growing states of India, most of the pulses have shown lower yield in Maharashtra. However, Maharashtra enjoys marginally higher yield levels for oilseed crops. Besides, the net sown area per cultivator and proportion of net sown area to geographical area are higher in Maharashtra as compared to national average.

Although the major crops cultivated in Maharashtra are jowar, bajra, pulses, oilseeds and cotton, other cereal crops also find place in the cropping pattern of the state. Almost all the cereal crops are cultivated in Maharashtra, though most of them having very low yield level. Majority of cereal crops are cultivated in Maharashtra for farmers' subsistence needs. However, in course of time, the farmers have become increasingly price conscious and commercial oriented. This has resulted in significant change in the cropping pattern in Maharashtra in favour of oilseed and horticulture crops. The cropping pattern changes in Maharashtra encompassing the period between 1980-81 and 2009-10 are shown in Table 1.5.

Table 1.5: Cropping Pattern Changes in Maharashtra: 1980/81 – 2009-10

Area	(Percent Share in GCA)						
	1980-81	1990-91	2000-01	2005-06	2007-08	2008-09	2009-10
Rice	7.43	7.31	6.99	6.71	6.96	6.78	6.51
Wheat	5.41	3.97	3.49	4.14	5.53	4.55	4.78
Jowar	32.93	28.82	23.56	21.01	18.31	18.13	18.47
Bajra	7.81	8.88	8.33	6.36	5.66	3.85	4.57
Other Cereals	2.30	1.98	3.07	3.03	3.82	3.76	4.31
All Cereals	55.88	50.94	45.44	41.24	40.28	37.08	38.63
Tur	3.28	4.59	5.07	4.88	5.12	4.49	4.83
Gram	2.09	3.06	3.13	4.56	5.97	5.09	5.71
Moong	0.00	0.00	3.30	2.37	2.92	1.90	1.89
Udid	0.00	0.00	2.66	2.07	2.49	1.44	1.57
Other Pulses	8.46	7.25	2.30	1.37	1.41	0.84	0.92
All Pulses	13.82	14.90	16.45	15.21	17.91	13.77	14.93
Total Foodgrains	69.70	65.84	61.90	56.46	58.19	50.85	53.55
Groundnut	2.30	4.48	2.17	1.95	2.23	1.57	1.61
Soyabean	0.00	0.92	5.28	10.41	11.76	13.64	13.35
Safflower	2.44	2.90	1.37	1.17	1.02	0.83	0.83
Other Oilseeds	3.08	5.16	2.92	2.66	2.25	1.84	1.47
All Oilseeds	9.06	12.93	11.84	16.23	16.88	17.72	17.17
Sugarcane	1.31	2.02	2.75	2.22	4.82	3.42	3.34
Cotton	12.98	12.45	14.23	12.75	14.10	14.01	15.00
GCA (in '000' Hectares)	19642 (100.00)	21859 (100.00)	21619 (100.00)	22556 (100.00)	22655 (100.00)	22454 (100.00)	22612 (100.00)

Source: Computations are based on figures obtained from 'Economic Survey of Maharashtra, 2011-12'

The gross cropped area (GCA) in Maharashtra was estimated at 19,642 thousand hectares in 1980-81, which encompassed 7.43 per cent area under rice, 5.41 per cent

under wheat, 32.93 per cent under jowar, 7.81 per cent under bajra, 2.30 per cent under other cereals, 55.88 per cent under all cereals, 3.28 per cent under tur, 2.09 per cent under gram, 8.46 per cent under other pulses, 13.82 per cent under all pulses, 69.70 per cent under total foodgrains, 2.30 per cent under groundnut, 2.44 per cent under safflower, 3.08 per cent under other oilseeds, 9.06 per cent under all oilseeds, 1.31 per cent under sugarcane and 12.98 per cent under cotton. The scenario obtaining in Maharashtra in terms of cropping pattern underwent significant changes during the nineties period and thereafter when significant area was allocated to oilseeds crops and, in particular to soyabean. During the early eighties period, soyabean crop did not find place in the cropping pattern of farmers in Maharashtra and it was only during the mid-eighties that farmers started cultivating this high value oilseed crop mainly due to high element of profit involved in its cultivation. The cultivation of soyabean was initially confined to Vidarbha region of Maharashtra. However, in due course of time, the farmers belonging to all the regions of Maharashtra started cultivating soyabean crop with the sole exception of Konkan region where land is grossly unsuitable for soyabean crop cultivation.

There has been steady increase in GCA of Maharashtra over the last three decades so much so that in 2009-10 it was estimated at 22,612 thousand hectares, which turned out to be 15.12 per cent higher as compared to GCA noticed in 1980-81. The distribution of GCA across various crops revealed significant shift in cropping pattern over the last three decades in Maharashtra. This concomitant from the fact that the area under foodgrains as proportion of GCA declined continuously from 69.70 per cent in 1980-81 to 61.90 per cent in 2000-01 and further to 53.55 per cent in 2009-10. Within foodgrain, the area under cereals as proportion of GCA declined from 55.88 per cent in 1980-81 to 38.63 per cent in 2009-10. The decline in area under cereals was mainly due to sharp decline in area under jowar as proportion of GCA, which declined from 32.93 per cent in 1980-81 to as low as 18.47 per cent in 2009-10. However, the area under tur and gram as proportion of GCA increased during the period between 1980-81 and 200-10. The increase in area under tur as proportion of GCA was from 3.28 per cent in 1980-81 to 4.83 per cent in 2009-10. Similarly, the increase in area under gram as proportion of GCA was from 2.09 per cent in 1980-81 to 5.71 per cent in 2009-10. Consequently, the area under all the pulses put together as proportion of GCA increased from 13.82 per cent in 1980-81 to 17.91 per cent in 2007-08 with a decline in the same to 14.93 per cent in 2009-10. Unlike decline in area under foodgrains, the area under oilseeds as proportion of GCA has grown significantly. The area under all the oilseeds put together as proportion

of GCA increased from 9.06 per cent in 1980-81 to as much as 17.17 per cent in 2009-10. The major reason for the rise in area under oilseeds in Maharashtra has been significant allocation of area under soyabean crop. The area under soyabean crop as proportion of GCA increased from as low as 0.92 per cent in 1990-91 to 13.35 per cent in 2009-10. This is also a reflection to the fact that at present more than 70 per cent of area under oilseeds in Maharashtra is accounted for by soyabean crop alone.

There has been growing demand of soyabean not only in domestic but also in international market due to perceptible change in consumption habits of urban population. Soybean possesses a very high nutritional value. It contains about 20 per cent oil and 40 per cent high quality protein (as against 7.0 per cent in rice, 12 per cent in wheat, 10 per cent in maize and 20-25 per cent in other pulses). Soybean protein is rich in valuable amino acid lysine (5 per cent) in which most of the cereals are deficient. In addition, it contains a good amount of minerals, salts and vitamins and its sprouting grains contain a considerable amount of Vitamin C. The soybean crop generally does not require any irrigation during *Kharif* season. However, if there were a long spell of drought at the time of pod filling, one irrigation would be desirable. During excessive rains proper drainage is also equally important. Spring crop would require about five to six irrigation. During the last one and a half decades, the domestic price of soyabean has gone up significantly, resulting in reasonable amount of profit in its cultivation. Another reason for higher allocation of area under soyabean has been mixed cropping. Mixed cropping of soybean with maize and sesamum has been found feasible and more remunerative. In mixed stand of maize and soybean, the yield of maize is not affected at the same time 10-12 quintals of soybean per hectare can be obtained.

Another crop among pulses that has shown significant expansion in area under its cultivation in Maharashtra is tur. Tur or Pigeon Pea is known for its rich nutritional value. Tur believed to be a native of India spread to other regions in Asia and is currently cultivated in nearly 25 countries. It is also known as red gram. The crop is cultivated on marginal land by resource-poor farmers, who commonly grow traditional medium- and long-duration (5-11 months) landraces. Short-duration pigeon peas (3-4 months) suitable for multiple cropping have recently been developed. Since traditionally the use of inputs like fertilizers, weeding, irrigation, and pesticides, etc. is minimal in tur crop cultivation, the yield levels are low. Greater attention is now being given to managing the crop because it is in high demand at remunerative prices. Pigeon peas are very drought resistant, so can be grown in areas with less than 650 mm annual rainfall.

1.3 Background of Pre and Post Harvest Losses

There are several stages when grains may be lost, and these include the pre-harvest, harvest and post-harvest stages. The pre-harvest losses occur before the process of harvesting begins, and may be due to insects, weeds and rusts. The harvest losses occur between the beginning and completion of harvesting, and are primarily caused by losses due to shattering of grains. The post-harvest losses occur during the period between harvesting of crop and its final consumption. The post harvest losses encompass on-farm losses, such as when grain is threshed, winnowed and dried, as well as losses along the chain during transportation, storage and processing. There is potential for loss throughout the grain harvesting and marketing chains. Generally, threshing losses occur as a result of spillage, incomplete removal of the grain or by damage caused to grain during the threshing. They can also occur after threshing due to poor separation of grain from the chaff during cleaning or winnowing.

It is to be noted that most of the crops are cultivated in a particular season but made available throughout the year, which is possible through storage. Storage therefore plays a vital role in grain supply chains. Losses in stored grain are determined by the interaction between the grain, the storage environment and a variety of organisms. Further, transportation at the time of marketing also causes losses of grains due to poor handling of the crop. Pre – and post harvest losses of the crops lead to much lower availability of the crop for consumption than expected volumes.

1.3.1 Pre-Harvest Losses

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

Generally, crop loss is estimated as the difference between potential (attainable yield) and the actual yield. The potential yield is the yield that would have been obtained in the absence of pest under consideration. By multiplying the area with the estimated yield loss, total loss is obtained. To estimate the crop loss, most of the existing studies have adopted experimental treatment approach (with or without pest attack through artificial infestation) or fields with natural infestation wherein half of the field is protected against the pest while the other half is not. But, the results obtained from artificial infestation or natural infestation in the selected plots/fields will not be appropriate for extrapolation over a geographical area (Groote, 2002). It is for the reason that the estimated crop losses under these conditions may not represent the actual field conditions of farmers. Alternatively, the estimates collected directly from the farmers through sample survey may be reliable and could be used for extrapolation in similar geographical settings. However, the farmers' estimates are likely to be subjective and these should be validated with expert estimates of the state department of agriculture.

1.3.2 Post-Harvest Losses

Production in agriculture is seasonal and exposed to natural environment, but post-production operations play an important role in providing stability in the food supply chain. According to a World Bank (1999) study, post harvest losses of foodgrains in India are 7-10 percent of the total production from farm to market level and 4-5 percent at market and distribution level. Given the total production of foodgrains at around 240 million tonnes at present, the total losses work out at around 15-25 million tonnes. With the given per capita cereal consumption requirement in India, the above grains lost would be sufficient to feed more than 100 million 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. Foodgrain stocks suffer qualitative and quantitative losses during 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 operation, it is important to know the optimum environment conditions for storage of the product, as well as the conditions under which insects/pests damage the produce.

According to FAO study, about 70 percent of the farm produce is stored by farmers for their own consumption, seed, feed and other purposes. In India, farmers store grain in bulk using different types of storage structures made from locally available materials. For the better storage, it is necessary to clean and dry the grain to increase its life during storage. In addition, storage structure, design and its construction also play a vital role in reducing or increasing the losses during storage. With the scientifically constructed storage, it is also essential that the grain being stored is also of good quality. At the village, generally harvesting is done at high moisture content and, therefore, before storing the same, it is necessary to obtain the desired moisture to obtain safe post storage grain. While there are small storage structures at the farmers' level, the bulk storage of foodgrains is done by the government in FCI, State and Central Warehousing Corporations, etc. 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 an average, out of total 6 percent loss of foodgrains in such storage structures, about half is due to rodents and rest half is due to insects and fungi. The storage at the farmer level includes: coal tar drum bin, domestic Hapur bin, Chittore stone bin, double walled polyethylene lined bamboo bin, Pusa bin and so on. The bulk storage of foodgrains is done mainly by traders, cooperatives and government agencies like FCI, CWC, SWC and grain marketing cooperatives. There are many kinds of storage systems followed depending on the length of storage and the product to be stored. Some examples are cover and plinth storage, community storage structures, rural godowns and scientific warehouses.

1.4 Need for the Present Study

Although, as per the available data, the crop losses caused by pests and diseases are huge, the knowledge on the crop loss at the farm level has been very much limited. In addition to losses occurring during the growth period of the crop, there is a huge quantity

of grains lost during the process of harvesting, threshing, transportation and storage operations. Therefore, the present study makes a comprehensive attempt to estimate the dimension of losses occurring during the pre- and post harvest stages of tur and soybean crops among pulses and oilseeds cultivated in Maharashtra. The study estimates yield losses due to pest and diseases in the crops namely tur (pigeon pea) 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 would be made to estimate such losses based on the visual observations and according to farmers' estimates.

1.5 Objectives of the Study

Keeping in view about this important subject, the present investigation is carried out with following specific objectives:

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

1.6 Database and Methodology

The study is based on farm level data collected from tur and soybean cultivating farmers belonging to the state of Maharashtra since the focus of the study has been assessing the extent of pre-and post harvest losses at farm level, especially for tur and

soyabean crops. The crop production constraints, particularly infestation by pests and diseases, and losses caused by them are worked based on the information/estimates furnished by the farmers. It is not only pests and diseases that cause crop damage when their population reach beyond a threshold level but there have been other bio-economic factors viz. soil fertility, water scarcity, poor seed quality, high input costs and low output prices which lead to considerable financial loss to the farmers. Thus, data on these bio-economic variables have been collected from the farmers. The post harvest losses occurring during the process of harvesting, collection and threshing , transportation and storage operations have also been quantified based on the estimates/ information extended by the farmers. Generally, the farmers do not use any scientific method of storage and normally use material like mud, bamboo, stone, plant material, thatched structure, etc. to store their produce. It is, therefore, essential to identify the structure of storage available at the farmers' level and enumerate the losses occurring in the process of storage at the farmers' level.

In order to collect the primary data, a sample survey was conducted in four districts of Maharashtra, which encompassed two districts for the reference crop 'tur' and another two districts for the reference crop 'soyabean'. The reference agricultural year 2011-12 (July to June) was considered as the reference period for data collection on relevant parameters, particularly for tur and soyabean cultivation during kharif season. The selected four sampled districts belonged to different agro-climatic regions of Maharashtra. Based on higher allocation of area under tur crop, the districts of Yavatmal and Latur were selected for primary data collection for tur crop. The district of Latur falls under assured rainfall zone and belongs to Marathwada region of Maharashtra. It is one of the major tur producing districts of Maharashtra. The district of Yavatmal falls under moderate rainfall zone and belongs to Vidarbha region of Maharashtra. It is also one of the major tur producing districts of Maharashtra. As for soyabean, based on higher allocation of area under soyabean crop, the districts of Nanded and Nagpur were selected for primary data collection for the soyabean crop. The district of Nanded falls under assured rainfall zone and belongs to Marathwada region of Maharashtra. It is one of the major soyabean producing districts of Maharashtra. The district of Nagpur falls under moderate rainfall zone and belongs to Vidarbha region of Maharashtra. It is also one of the major soyabean producing districts of Maharashtra. From each of the selected sampled districts for tur and soyabean crop, one Taluka was selected based on higher area allocation under the reference crops tur and soyabean. A further stratification included

selection of two villages from each Taluka/ district for canvassing the questionnaire with one nearby the market/ mandi centre and one far off from the market centre.

It was decided to select a sample of 30 farmers from each of the selected eight sampled villages belonging to four districts of Maharashtra. Therefore, a complete enumeration of the eight selected villages drawn the districts of Yavatmal, Latur, Nanded and Nagpur was done with view to further categorization of farmers into marginal (less than 1 hectare), small (1 to 2 hectares), medium (2-4 hectares) and large (above 4 hectares). The probability proportion to sample size technique was used for further selection of farmers under each of the land holding size category from the selected sampled villages. The number of sampled farmers for tur crop selected from four villages of Yavatmal and Latur districts encompassed 27 in marginal category, 54 in small, 29 in medium and 10 in large category with a sum of 120 farmers drawn from the districts of Yavatmal and Latur. Similarly, the number of sampled farmers for soyabean crop selected from four villages of Nanded and Nagpur districts encompassed 24 in marginal category, 54 in small, 30 in medium and 12 in large category with a sum of 120 farmers drawn from the districts of Nanded and Nagpur. The distribution sampled farmers for the selected crops across selected districts, Talukas, villages and land holding size categories is provided in Table 1.6.

Table 1.6: Sampled Farmers Selected Districts for Tur and Soyabean Crops in Maharashtra

District	Selected Crop	Selected Taluka	Name of the Selected Villages	Sampled Farmers				
				Marginal	Small	Medium	Large	Total
Yavatmal	Tur	Ner	Kolora (Near)	1	16	9	4	30
			Chikhli (K) (Far)	2	17	8	3	30
Latur	Tur	Ausa	Nagarsoga (Near)	9	11	8	2	30
			Manglur (Far)	15	10	4	1	30
			Total	27	54	29	10	120
Nanded	Soyabean	Hadgaon	Lyahri (Near)	9	11	8	2	30
			Ghogari (Far)	5	22	2	1	30
Nagpur	Soyabean	Umred	Dhurkheda (Near)	7	9	10	4	30
			Pipra (Far)	3	12	10	5	30
			Total	24	54	30	12	120
			Grand Total	51	108	59	22	240

Thus, altogether 120 sampled farmers from Yavatmal and Latur districts and 120 sampled farmers from Nanded and Nagpur districts with a sum of 240 sampled farmers from the state of Maharashtra were selected for the present investigation for assessing pre- and post harvest losses on farmers' field with respect to tur and soyabean crops.

In addition to the collection of primary data from the sampled households/farmers, secondary data related to various performance indicators viz. area,

production and productivity of selected crops cultivated in the state of Maharashtra encompassing the period between 1990-91 and 2009-10 were collected from 'Statistical Division, Commissionerate of Agriculture, Government of Maharashtra, Pune'. In addition to this, secondary data with respect to broad quantitative parameters of agricultural and other sectors of the State viz. Gross Cropped Area (GCA), Gross State Domestic Product (GSDP) at current and constant prices, Per Capita National Income (PCI), yield levels of various crops, per capita foodgrain production, fertilizer consumption in the State, etc., were also collected from various secondary sources such as "Economic Survey of Maharashtra", Directorate of Economics & Statistics, Planning Department, Government of Maharashtra, Mumbai, "Season and Crop Report", Commissionerate of Agriculture, Government of Maharashtra, Pune'. Various reports of Commission for Agricultural Costs and Prices (CACP), Ministry of Agriculture, Government of India were also used to ascertain cost of cultivation and profitability involved in the cultivation of selected crops in Maharashtra.

1.7 Organization of the Report

The study is organized in VI chapters. After this introductory Chapter I focusing on significance and importance of agricultural as well as status of agricultural sector in the state, importance of selected crops, background of pre-and post harvest losses, need of the present study, objectives and methodology of the study, etc., the analysis with respect to secondary data is presented in Chapter II, which not only provides information relating to trend estimates with respect to area, production and productivity of selected crops cultivated in the state of Maharashtra but also trends with respect to cost of cultivation and profitability involved in the cultivation of selected crops based on various CACP reports. Since the socio-economic characteristics of farmers have a profound influence on the decision making process and profitability of crop enterprise, the Chapter III deals with the socio-economic profile of sampled farmers with focus on their family size and composition, education status, caste composition, land use pattern, cropping pattern, irrigated area, sources of irrigation, crop productivity, marketed surplus, value of output, etc. The Chapter IV evaluates the pre harvest losses of selected crops with focus on constraints faced in cultivation of reference crops, assessment of incidences of pests and disease attacks and crop losses. methods of pests and diseases control adopted by the selected sample households, sources of information for pests and disease control by the selected households, household suggestions on how to minimize pre harvest losses, etc. The major focus of Chapter V is on assessing post harvest losses of selected crops, which

includes production loss during harvest, threshing, winnowing, transportation and handling, storage, capacity utilization of storage by the households, quantitative aspects of storage and their pests control measures adopted by the selected households, suggestions of selected households to minimize post harvest losses, etc. The Chapter VI summarizes the key findings of the study with a synthesis of policy implications and conclusions arising out of the present investigation.

CHAPTER – II

AREA, PRODUCTION, PRODUCTIVITY OF TUR AND SOYABEAN IN MAHARASHTRA

This chapter provides an insight into the estimates relating to area, production and productivity of selected tur and soyabean crops cultivated in the state of Maharashtra encompassing the period between 1990-91 and 2009-10. The primary focus is on evaluating structural changes and growth estimates with respect to area, production and productivity for tur and soyabean crops across all the districts and regions/divisions of the State during the period from 1990-91 and 2009-10, aside from evaluating share of different districts in tur and soyabean crops acreage and production in the State during the given period of time. This chapter also evaluates trends with respect to cost of cultivation and profitability involved in the cultivation of tur and soyabean crops in the state of Maharashtra based on the reports of Commission for Agricultural Costs and Prices (CACP). The other important aspect evaluated in this chapter relates to review of studies conducted on the extent of losses caused by various pests and diseases with respect to tur and soyabean crops in particular and other crops in general. The major thrust of this chapter is, therefore, on providing information relating to trend estimates for tur and soyabean crops cultivated in the state of Maharashtra, especially with respect to their area, production, productivity, cost of cultivation, profitability and extent of losses caused by various pests and diseases.

2.1 Trend and Growth in Area, Production and Yield of Tur and Soyabean Crops

Tur and soyabean are the major pulse and oilseed crops cultivated in the state of Maharashtra. Although tur crop is cultivated in a number of states like of U.P, M.P, Maharashtra, Bihar and Andhra Pradesh, Punjab, Haryana, West Bengal, Assam, Orissa, Rajasthan, H.P., Gujarat, Jammu and Kashmir, Karnataka, Tamil Nadu, Kerala, etc, Maharashtra accounts for the major share in tur crop production of India. Similarly, though Madhya Pradesh is the leading producer of Soyabean, Maharashtra has a substantial share in India's total soyabean production. While there is not much increase in area under tur crop in Maharashtra during the last two decades, the area under soyabean crop has rapidly grown in the state during this period. However, the production of both these crops has grown significantly during this period. The subsequent sections provide an insight into the changes in area, production and productivity of tur and soyabean crop cultivated in the state of Maharashtra during the last two decades.

2.1.1 Area, Production and Yield of Tur Crop in Maharashtra

The estimates relating to structural changes in area, production and yield of tur crop cultivated across different districts and regions/divisions of Maharashtra during the period between TE 1992-93 and TE 2009-10 are brought out in Table 2.1.

The estimates presented in Table 2.1 reveal that the area under tur crop in Maharashtra has remained constant and hovered at around 10 lakh hectares during the past two decades. Various regions/divisions belonging to Maharashtra have also not shown much difference in area under tur crop during the last two decades. However, variations are noticed in terms of share of different divisions in total area under tur crop in Maharashtra (Table 2.2).

It is to be noted that Amravati, Latur, Nagpur and Aurangabad divisions account for almost 90 per cent share in total area under tur crop of Maharashtra with Amravati division alone accounting for 34 per cent share in total area under tur crop of Maharashtra. The share of Amravati division in total area under tur crop of Maharashtra has increased from 30 per cent in TE 1992-93 to 34 per cent in TE 2009-10. Similarly, the share of Latur division in total area under tur crop of Maharashtra has increased from 26 per cent in TE 1992-93 to 28 per cent in TE 2009-10. The division of Nagpur has also shown a marginal increase in its share of tur crop area of Maharashtra, which increased from 14 per cent in TE 1992-93 to 15 per cent in TE 2009-10. However, the division of Aurangabad showed a steady decline in its share of tur crop area of Maharashtra, which declined from 15 per cent in TE 1992-93 to 13 per cent in TE 2001-02, and further to 12 per cent in TE 2009-10. Pune division has also shown a sharp decline in its share of tur crop area of Maharashtra with a decline in the same from 7 per cent in TE 1992-93 to 3 per cent in TE 2009-10. Thus, the divisions of Amravati, Latur, and Nagpur have shown rise in area under tur crop in the face of fall in area under tur crop in Aurangabad and Pune divisions. On the other hand, the division of Nashik neither shows any decline in area under tur crop in absolute terms nor in terms of share in total tur crop area of Maharashtra during the last two decades. Thus, despite the fact that the area under tur crop in Maharashtra has stagnated during the last two decades, there are variations in area under tur crop across various regions/ divisions of the state during this period.

Unlike stagnant area under tur crop, the production of tur crop in Maharashtra has increased from 4.56 lakh MT in TE 1992-93 to 7.68 lakh MT in TE 2001-02, and further to 8.67 MT in TE 2009-10, showing thereby 90 per cent rise in tur crop production during the last two decades with the decade of 1990s showing the major increase in this respect.

The regions/divisions that have contributed significantly towards rise in tur crop production of Maharashtra are Amravati, Latur, Nagpur and Aurangabad. During the period between TE 1992-93 and TE 2009-10, the tur crop production is noticed to have increased from 1.88 lakh MT to 3.21 lakh MT in Amravati division, 0.72 lakh MT to 2.68 lakh MT in Latur division, 0.81 lakh MT to 1.20 lakh MT in Nagpur division, and 0.39 lakh MT to 0.91 lakh MT in Aurangabad division.

Table 2.1: Structural Changes in Area, Production and Yield of Tur Crop in Maharashtra: 1990-91 to 2009-10
(Area in '00' Hectares; Production in '00' MT Tonnes; Yield in Kg/Ha)

Districts/Divisions	Area			Production			Yield		
	TE 1992-93	TE 2001-02	TE 2009-10	TE 1992-93	TE 2001-02	TE 2009-10	TE 1992-93	TE 2001-02	TE 2009-10
Thane	42.33	28.67	32.00	25.67	12.67	23.13	608.68	442.78	723.71
Raigad	17.33	9.67	10.67	11.33	4.33	7.47	633.33	451.85	713.26
Ratnagiri	5.33	5.33	6.00	3.33	2.67	4.35	611.11	500.00	748.61
Kokan Division	65.33	43.67	48.67	40.67	19.67	34.94	618.16	451.51	717.13
Nashik	83.67	87.00	91.67	61.00	37.33	53.16	726.77	429.14	577.06
Dhule	211.33	70.33	82.67	141.33	20.67	52.48	661.46	295.02	623.14
Nandurbar	-	231.67	224.00	-	94.00	143.47	-	407.10	620.86
Jalgaon	220.33	263.33	195.00	172.00	134.67	141.48	785.35	507.59	705.91
Nashik Division	515.33	652.33	593.33	374.33	286.67	390.59	726.49	439.72	637.08
Ahmednagar	210.67	183.67	98.00	82.33	105.00	51.34	376.33	561.47	511.60
Pune	48.00	41.33	26.33	20.67	22.67	14.02	422.26	548.97	561.81
Solapur	426.67	239.67	186.00	78.33	79.00	69.10	185.63	297.86	374.24
Pune Division	685.33	464.67	310.33	181.33	206.67	134.45	261.71	423.84	433.35
Satara	94.00	68.67	40.33	52.67	27.00	26.14	549.33	391.33	638.28
Sangli	143.67	133.00	89.00	76.33	52.67	56.27	534.86	386.54	640.76
Kolhapur	47.00	22.33	26.33	25.67	8.00	17.09	542.10	358.21	639.20
Kolhapur Division	284.67	224.00	155.67	154.67	87.67	99.50	540.13	385.85	640.30
Aurangabad	519.00	425.00	391.33	112.67	133.67	280.48	216.96	316.53	704.22
Jalna	422.33	450.67	438.67	133.00	213.67	362.64	316.03	476.20	811.48
Beed	537.33	485.33	516.67	148.67	162.00	266.57	277.43	330.74	517.24
Aurangabad Division	1478.67	1361.00	1346.67	394.33	509.33	909.69	267.00	375.16	667.87
Latur	654.67	727.67	836.00	153.00	502.33	920.76	236.12	702.81	1122.07
Osmanabad	821.00	773.00	772.00	155.33	518.67	680.30	188.06	662.75	826.33
Nanded	443.67	530.33	598.00	181.67	423.33	394.10	405.21	797.16	656.17
Parbhani	714.00	485.00	603.33	232.33	252.00	402.98	330.15	522.32	667.60
Hingoli	-	259.00	282.00	-	150.33	282.78	-	585.18	1005.49
Latur Division	2633.33	2775.00	3091.33	722.33	1846.67	2680.92	275.59	669.47	863.45
Buldhana	531.33	570.33	626.67	304.00	346.33	559.79	556.09	612.19	886.06
Akola	761.33	465.67	528.67	406.00	444.33	463.55	536.07	954.16	863.00
Washim	-	397.00	499.00	-	372.67	444.23	-	946.98	888.69
Amaravati	834.33	959.00	937.67	542.00	826.00	901.96	650.31	865.98	965.02
Yavatmal	929.00	1194.00	1059.00	632.67	1455.00	843.67	676.01	1218.15	790.91
Amaravati Division	3056.00	3586.00	3651.00	1884.67	3444.33	3213.20	613.01	963.32	876.96
Wardha	515.33	519.33	644.67	356.33	555.00	434.87	690.45	1062.50	667.32
Nagpur	537.00	502.00	544.67	264.67	444.00	393.43	490.02	881.03	730.18
Bhandara	89.67	57.67	81.67	52.00	52.33	58.24	578.77	907.12	711.22
Gondia	-	40.00	53.67	-	37.33	38.23	-	933.33	710.72
Chandrapur	224.00	269.00	306.33	130.33	178.33	250.10	578.35	663.25	810.67
Gadchiroli	15.33	18.00	41.33	9.00	16.67	28.96	575.78	924.40	712.01
Nagpur Division	1381.33	1406.00	1672.33	812.33	1283.67	1203.83	586.14	910.30	718.02
Total Maharashtra	10100.00	10512.67	10869.33	4564.67	7684.67	8667.12	450.99	733.41	789.67

Source: Computation are based on the figures/data obtained from 'Statistical Division, Commissionerate of Agriculture, Government of Maharashtra, Pune'

Table 2.2: Share of Districts in Total Area and Production of Tur Crop in Maharashtra: 1990-91 to 2009-10
(in per cent)

Districts/Divisions	Area			Production		
	TE 1992-93	TE 2001-02	TE 2009-10	TE 1992-93	TE 2001-02	TE 2009-10
Thane	0.42	0.27	0.29	0.56	0.16	0.27
Raigad	0.17	0.09	0.10	0.25	0.06	0.09
Ratnagiri	0.05	0.05	0.06	0.07	0.03	0.05
Kokan Division	0.65	0.42	0.45	0.89	0.26	0.40
Nashik	0.83	0.83	0.84	1.34	0.49	0.61
Dhule	2.09	0.67	0.76	3.10	0.27	0.61
Nandurbar	-	2.20	2.06	-	1.22	1.66
Jalgaon	2.18	2.50	1.79	3.77	1.75	1.63
Nashik Division	5.10	6.21	5.46	8.20	3.73	4.51
Ahmednagar	2.09	1.75	0.90	1.80	1.37	0.59
Pune	0.48	0.39	0.24	0.45	0.30	0.16
Solapur	4.22	2.28	1.71	1.72	1.03	0.80
Pune Division	6.79	4.42	2.86	3.97	2.69	1.55
Satara	0.93	0.65	0.37	1.15	0.35	0.30
Sangli	1.42	1.27	0.82	1.67	0.69	0.65
Kolhapur	0.47	0.21	0.24	0.56	0.10	0.20
Kolhapur Division	2.82	2.13	1.43	3.39	1.14	1.15
Aurangabad	5.14	4.04	3.60	2.47	1.74	3.24
Jalna	4.18	4.29	4.04	2.91	2.78	4.18
Beed	5.32	4.62	4.75	3.26	2.11	3.08
Aurangabad Division	14.64	12.95	12.39	8.64	6.63	10.50
Latur	6.48	6.92	7.69	3.35	6.54	10.62
Osmanabad	8.13	7.35	7.10	3.40	6.75	7.85
Nanded	4.39	5.04	5.50	3.98	5.51	4.55
Parbhani	7.07	4.61	5.55	5.09	3.28	4.65
Hingoli	-	2.46	2.59	-	1.96	3.26
Latur Division	26.07	26.40	28.44	15.82	24.03	30.93
Buldhana	5.26	5.43	5.77	6.66	4.51	6.46
Akola	7.54	4.43	4.86	8.89	5.78	5.35
Washim	-	3.78	4.59	-	4.85	5.13
Amaravati	8.26	9.12	8.63	11.87	10.75	10.41
Yavatmal	9.20	11.36	9.74	13.86	18.93	9.73
Amaravati Division	30.26	34.11	33.59	41.29	44.82	37.07
Wardha	5.10	4.94	5.93	7.81	7.22	5.02
Nagpur	5.32	4.78	5.01	5.80	5.78	4.54
Bhandara	0.89	0.55	0.75	1.14	0.68	0.67
Gondia	-	0.38	0.49	-	0.49	0.44
Chandrapur	2.22	2.56	2.82	2.86	2.32	2.89
Gadchiroli	0.15	0.17	0.38	0.20	0.22	0.33
Nagpur Division	13.68	13.37	15.39	17.80	16.70	13.89
Total Maharashtra	100.00	100.00	100.00	100.00	100.00	100.00

Source: Computation are based on the figures/data obtained from 'Statistical Division, Commissionerate of Agriculture, Government of Maharashtra, Pune'

Although the division of Amravati accounts for the major share in tur crop production of Maharashtra, the division of Latur has shown sharper increase in its share in tur crop production of the state. This is concomitant from the fact that while the share of Amravati division in tur crop production of Maharashtra declined 41.29 per cent in TE 1992-93 to 37.07 per cent in TE 2009-10, the share of Latur division in this respect

increased by leaps and bounds from 15.82 per cent to 30.93 per cent during the same period (Table 2.2). The share of Nagpur division in tur crop production of Maharashtra is noticed to have declined from 17.80 per cent in TE 1992-93 to 13.89 per cent in TE 2009-10. Nashik division has also shown a decline in its share in total tur crop production of Maharashtra, which declined from 8.20 per cent in TE 1992-93 to 4.51 per cent in TE 2009-10. On the other hand, the share of Aurangabad division in tur crop production of Maharashtra has marginally increased from 8.64 per cent in TE 1992-93 to 10.50 per cent in TE 2009-10. The other divisions/regions like Pune, Kolhapur, and Konkan have marginal presence in terms of their contribution towards total tur crop production of the State. In the state of Maharashtra, the districts that have significant contribution towards total tur crop production of Maharashtra are Yavatmal, Amravati, Washim, Akola, Buldhana, Nanded, Osmanabad, Latur, Jalna, Aurangabad, Wardha and Nagpur.

It is to be noted that there has not been any significant rise in area under tur crop in Maharashtra during the last two decades. The substantial increase in tur crop production in Maharashtra during the last two decades is, therefore, due to perceptible increase in yield level of tur crop during this period, which has increased from 450.99 kg/ha in Te 1992-93 to as much as 733.41 kg/ha in Te 2001-02, and further to 789.69 kg/ha in TE 2009-10. The districts belonging to Latur division of Maharashtra have shown tremendous increase in their yield levels of tur crop. For instance, during the period between TE 1992-93 and TE 2009-10, the yield level of tur crop has increased from 236 kg/ha to 1122 kg/ha in Latur district, 188 kg/ha to 826 kg/ha in Osmanabad district, 405 kg/ha to 656 kg/ha in Nanded district, and 330 kg/ha to 668 kg/ha in Parbhani district. Some of the districts belonging to Amravati division have also shown significant rise in their yield level of tur crop, an important among these are Buldhana, Akola, Amravati and Yavatmal districts. During the period between TE 1992-93 and TE 2009-10, the yield level of tur crop has increased from 556 kg/ha to 886 kg/ha in Buldhana district, 536 kg/ha to 863 kg/ha in Akola district, 650 kg/ha to 965 kg/ha in Amravati district, and 676 kg/ha to 791 kg/ha in Yavatmal district. The other districts like Jalna and Aurangabad belonging to Aurangabad division and Nagpur, Gadchiroli, and Chandrapur belonging to Nagpur division have also shown perceptible increase in their yield levels of tur crop during the period between TE 1992-93 and TE 2009-10.

The annual average growth rate estimates with respect to area, production and yield of tur crop for different districts as well as divisions of Maharashtra for there time periods viz. from 1990-91 to 1999-2000, 2000-01 to 2009-10, and 1990-91 to 2009-10

are shown in Table 2.3. These represent growth in area, production and yield of tur crop across divisions and districts of Maharashtra for the 1990s, 2000s and the overall period.

There has been marginal increase in area under tur crop in Maharashtra, which increased at an annual compound growth rate of 0.45 per cent during the period between 1990-91 and 2009-10. The increase in area under tur crop during the period between 1990-91, and 2009-10 has been mainly due to rise in area under tur crop in districts belonging to Amravati, Latur and Nagpur divisions of Maharashtra. The districts belonging to Konkan, Pune, Nashik, Kolhapur and Aurangabad have shown decline in their area under tur crop between 1990-91 and 2009-10. All the districts belonging to Konkan, Nashik and Pune divisions have shown negative growth in area under tur crop not only during 1990s period but also 2000s period. Although the area under most of the districts of Maharashtra declined, some of the districts like Jalna, Latur, Nanded, Wardha, Chandrapur and Gadchiroli have shown more than 1 per cent annual growth in their area under tur crop during the period between 1990-91 and 2009-10. The decline in area under tur crop in districts belonging to Konkan, Nashik, Pune and Aurangabad divisions is, therefore, more than compensated by rise in area under tur crop in districts belonging to Latur, Amravati and Nagpur divisions during given period.

In dismal contrast to slow or declining growth in area, the production of tur crop has grown substantially in majority of the districts of Maharashtra, especially in districts belonging to Latur, Amravati, Nagpur and Aurangabad divisions. The districts belonging to Latur division have shown 5-10 per cent annual growth in tur crop production during the period between 1990-91 and 2009-10 with an overall average annual growth in tur crop production for Latur division being 7.41 per cent during this period. Although tur crop production in Aurangabad division has grown at an annual compound growth rate of 5.70 per cent between 1990-91 and 2009-10, the districts belonging to this division showed their tur crop production to grow at 4-8 per cent per annum during this period. The districts belonging to Nagpur division have shown 2-5 per cent annual growth in tur crop production with the district of Gadchiroli showing the highest growth in this respect. Interestingly, the districts belonging to Amravati division showed impressive annual growth in tur crop production during the 1990s period with a slowing down in the same during the 2000s period. As a result, the overall annual growth in tur crop production in Amravati division turned out to be 2.27 per cent during the period between 1990-91 and 2009-10. Further, majority of the districts belonging to Konkan, Nashik, Pune and Kolhapur divisions have shown negative growth in tur crop production during the period

between 1990-91 and 2009-10, which may not be considered as a matter of concern since the contribution of these districts to the total tur crop production of Maharashtra is very small. Between 1990-91 and 2009-10, the annual decline in tur crop production is noticed to be 1.44 per cent in Konkan division, 0.15 per cent in Nashik division, 3.92 per cent in Pune division and 2.55 per cent in Kolhapur division.

Table 2.3: Compound Annual Growth Rates (CAGR) of Area, Production and Yield of Tur Crop in Maharashtra: 1990-91 to 2009-10

Districts/Divisions	Area			Production			Yield		
	1990/91 – 1999-00	2000/01 – 2009-10	1990/91 – 2009/10	1990/91 – 1999-00	2000/01 – 2009-10	1990/91 – 2009/10	1990/91 – 1999-00	2000/01 – 2009-10	1990/91 – 2009/10
Thane	-4.52*	2.03**	-1.44*	-5.58	9.62*	-1.12	-1.11	7.52*	0.35
Raigad	-6.27*	0.7	-2.86*	-7.72**	7.91*	-2.87	-1.55	7.39*	0.05
Ratnagiri	-2.43	0.67	0.61	-3.1	6.99*	0.64	-0.69	6.9*	0.2
Konkan Division	-4.86*	1.56*	-1.62*	-6.08	8.9*	-1.44	-1.28	7.23*	0.19
Nashik	0.74	0.54	0.78**	-3.9	3.99	-0.2	-4.61	3.46	-0.96
Dhule	-9.92	0.53	-7.2*	-14.79	12.19*	-8.13*	-5.41	11.63*	-1
Nandurbar	-	-	-	-	-	-	-	-	-
Jalgaon	1.09	-4.98	-0.33	-5.59	-0.63	-0.72	-6.61	4.57	-0.4
Nashik Division	2.33*	-1.98	0.89	-2.37	3.41	-0.15	-4.59	5.50*	-1.04
Ahmednagar	-0.67	-9.16	-5.84*	3.58	-8.57	-5.42**	4.28	0.64	0.45
Pune	-1.58	-6.46	-3.71*	2.4	-5.38	-2.22	4.04	1.32	1.6
Solapur	-3.19	2.81	-6.52*	0.52	8.06	-3.45	3.83	5.11	3.29
Pune Division	-2.23	-3.29	-5.9*	2.04	-2.4	-3.92	4.37	0.92	2.10**
Satara	-2.92	-6.5**	-4.4*	-7.06	0.62	-4.00**	-4.26	7.61**	0.42
Sangli	-1.04	-4.76	-2.52	-4.98	2.56	-2	-3.98	7.77**	0.55
Kolhapur	-7.36*	1.86	-2.66*	-11.18*	11.00*	-2.18	-4.12	8.82*	0.45
Kolhapur Division	-2.57	-4.28	-3.03*	-6.54	3.19	-2.55	-4.08	7.8**	0.5
Aurangabad	-3.00*	-0.91	-1.68*	2.67	13.89*	5.22*	5.84	14.94*	7.02*
Jalna	1.19	-0.12	1.05**	7.7	7.77**	7.87*	6.44	7.9*	6.75*
Beed	-1.38	1.12	-0.05	4.66	10.02	4.34**	6.12	8.82	4.40**
Aurangabad Division	-1.13	0.11	-0.2	4.54	9.98*	5.70*	5.73	9.85*	5.92*
Latur	0.86	1.55	1.11*	14.46	12.12*	10.01*	13.49	10.42*	8.80*
Osmanabad	-0.49	-0.3	0.03	9.27	4.82	7.85*	9.81	5.13	7.82*
Nanded	1.48	1.43*	1.62*	8.85	0.27	5.25**	7.26	-1.15	3.56
Parbhani	-2.84	1.49	-1.63*	-1.14	5.4**	2.06	1.75	3.86	3.75
Hingoli	-	-	-	-	-	-	-	-	-
Latur Division	0.25	2.35	0.78	7.99	6.15*	7.41*	7.72	3.72	6.58*
Buldhana	1.73	0.82	0.48	6.5	6.74	1.66	4.69	5.88	1.18
Akola	-5.25**	1.61	-2.54*	4.2	0.9	-1.4	9.96*	-0.71	1.17
Washim	-	-	-	-	-	-	-	-	-
Amaravati	0.87	-0.24	0.72*	6.49**	1.87	2.1*	5.58**	2.11	1.37
Yavatmal	3.13*	-2.13*	0.86	8.45*	-7.21*	1.23	5.16**	-5.19**	0.37
Amaravati Division	1.68*	-0.02	1.09*	8.02*	-0.45	2.27**	6.24*	-0.43	1.16
Wardha	-0.89	2.55*	1.12*	0.28	-8.77**	1.73	1.18	-11.04*	0.61
Nagpur	-0.74**	1.14*	0.08	2.2	1.24	2.65	2.96	0.11	2.58
Bhandara	-1.4	4.08*	-1.26	0.45	-0.02	0.42	1.87	-3.9	1.72
Gondia	-	-	-	-	-	-	-	-	-
Chandrapur	2.64*	1.23	1.07*	3.78	7.31	1.99	1.11	6.01	0.92
Gadchiroli	7.57*	3.10*	3.53*	9.99*	8.8**	5.29*	2.26	-3.73	1.73
Nagpur Division	0.07	2.13*	0.88*	1.76	-1.73	2.58**	1.69	-3.78	1.69
Total Maharashtra	0.35	0.36	0.45*	6.2	2.14	3.28*	5.82	1.77	2.82*

Source: Computation are based on the figures/data obtained from 'Statistical Division, Commissionerate of Agriculture, Government of Maharashtra, Pune'

Note: 1) * and ** represent significance of growth rates at 1 and 5 per cent level of probability

2) Some of the districts of Maharashtra were carved after 1996-07, and, therefore, growth rates for these districts are not estimated

In general, the production of tur crop in Maharashtra is seen to have grown at the rate of 6.2 per cent per annum during 1990s and 2.14 per cent per annum during 2000s with an overall average growth rate in this respect at 3.28 per cent per annum during the period between 1990-91 and 2009-10. Thus, the major growth in tur crop production is noticed during 1990s period as against the 2000s period.

The major reason for increase in tur crop production has been significant yield gains of tur crop during the last two decades, especially in districts belonging to Latur, Amravati, Nagpur and Aurangabad divisions of Maharashtra. During the period between 1990-91 and 2009-10, the annual increase in yield level of tur crop is noticed to be 4-9 per cent for districts belonging to Latur division, 4-7 per cent for districts belonging to Aurangabad division, and 1-2 per cent for districts belonging to Amravati and Nagpur divisions of Maharashtra. However, the major increase in yield level of tur crop is noticed during the 1990s period as against the 2000s period. On an average, between 1990-91 and 2009-10, the yield level of tur crop has grown at 6.58 per cent per annum in Latur division, 5.92 per cent per annum in Aurangabad division, 1.16 per cent per annum in Amravati division and 1.69 per cent in Nagpur division. The Kolhapur and Pune divisions of Maharashtra have shown 0.50 per cent and 2.10 per cent annual increase in yield level of tur crop, respectively, during the period between 1990-91 and 2009-10. On the contrary, the Nashik division of Maharashtra has shown 1.04 per cent annual decline in yield level of tur crop during the period between 1990-91 and 2009-10, which was mainly due to 4.59 per cent annual decline in yield level of tur crop during the 1990s in the face of 5.5 per cent annual increase in the same during 2000s period.

In general, the state of Maharashtra has shown 5.82 per cent annual increase in yield level of tur crop during the 1990s period and 1.77 per cent annual rise in the same during the 2000s period. The overall average increase in yield level of tur crop for the state of Maharashtra is estimated at 2.82 per cent during the period between 1990-91 and 2009-10. Thus, the yield level of tur crop in the state of Maharashtra has grown significantly with the decade of 1990s showing higher growth in yield level of tur crop as against the decade of 2000s.

2.1.2 Area, Production and Yield of Soyabean Crop in Maharashtra

The soybean crop is cultivated in all the districts of Maharashtra with the exception of Konkan region. The estimates relating to structural changes in area, production and yield of soybean crop cultivated across different districts of Maharashtra during the period between TE 1992-93 and TE 2009-10 are shown in Table 2.4.

Unlike tur crop, there has been significant expansion in area under soybean crop in the state of Maharashtra during the last two decades. This is concomitant from the fact that the area under soyabean crop in Maharashtra has increased from mere 2.73 lakh in TE 1992-93 to 10.97 lakh hectares in TE 2001-02, and further to 29.15 lakh hectares in TE 2009-10, showing thereby almost ten folds rise in area under soyabean crop in the State during the last two decades (Table 2.4).

Table 2.4: Structural Changes in Area, Production and Yield of Soybean Crop in Maharashtra: 1990-91 to 009-10
(Area in '00' Hectares; Production in '00' MT Tonnes; Yield in Kg/Ha)

Districts/Divisions	Area			Production			Yield		
	TE 1992-93	TE 2001-02	TE 2009-10	TE 1992-93	TE 2001-02	TE 2009-10	TE 1992-93	TE 2001-02	TE 2009-10
Thane	-	-	-	-	-	-	-	-	-
Raigad	-	-	-	-	-	-	-	-	-
Ratnagiri	-	-	-	-	-	-	-	-	-
Kokan Division	-	-	-	-	-	-	-	-	-
Nashik	9.00	66.00	436.67	8.33	99.00	572.33	895.83	1531.49	1332.95
Dhule	5.00	22.33	133.00	4.67	27.67	124.00	916.67	1229.25	1046.16
Nandurbar	-	22.00	244.33	-	24.33	322.33	-	1094.92	1326.91
Jalgaon	9.67	28.33	206.67	7.67	35.67	403.67	888.89	1262.37	1964.23
Nashik Division	23.67	138.67	1020.67	20.67	186.67	1422.00	885.29	1356.01	1409.39
Ahmednagar	3.00	64.67	563.00	2.33	72.00	592.67	666.67	1145.54	1055.42
Pune	4.67	5.33	29.00	4.00	5.67	45.33	866.67	1102.38	1567.11
Solapur	4.00	6.33	28.33	3.00	9.00	30.00	954.55	1416.67	1060.62
Pune Division	11.00	76.33	620.33	9.33	86.67	668.00	878.79	1158.26	1077.80
Satara	30.33	134.67	296.33	28.00	283.67	586.33	887.65	2105.08	1973.90
Sangli	241.67	576.33	570.67	373.67	1427.67	1109.00	1464.43	2478.85	1939.53
Kolhapur	204.33	620.67	583.67	326.33	1255.33	1229.33	1488.03	2025.02	2107.65
Kolhapur Division	476.33	1331.67	1450.67	728.00	2966.67	2924.67	1439.70	2230.33	2017.84
Aurangabad	6.33	31.67	66.33	5.67	36.33	82.00	777.78	1174.70	1179.22
Jalna	13.00	45.00	371.33	17.00	36.67	379.33	1307.69	848.54	1026.20
Beed	18.00	39.67	622.33	13.33	48.67	236.33	898.55	1350.95	389.54
Aurangabad Division	37.33	116.33	1060.00	36.00	121.67	697.67	897.96	1095.69	675.62
Latur	9.00	90.67	2039.33	9.00	90.00	1490.33	1000.00	1097.05	750.89
Osmanabad	40.00	28.33	361.67	29.00	15.67	256.00	1000.00	608.47	686.80
Nanded	3.00	122.00	1702.00	2.33	172.67	1294.24	777.78	1375.57	778.60
Parbhani	7.00	109.00	857.00	6.67	149.33	860.33	833.33	1582.84	1021.92
Hingoli	-	167.67	1271.00	-	220.67	1343.67	-	1332.70	1089.61
Latur Division	59.00	517.67	6231.00	40.00	648.33	5244.58	866.67	1313.66	859.06
Buldhana	133.00	590.67	2144.33	178.00	696.33	2025.30	888.89	1213.13	1009.43
Akola	33.67	242.67	1238.67	31.00	265.00	1133.73	875.83	1153.99	1057.47
Washim	-	739.00	2186.33	-	893.00	1632.40	-	1185.79	768.90
Amaravati	368.67	1677.00	3254.67	265.33	1934.33	2889.39	725.66	1156.15	947.17
Yavatmal	46.33	729.67	2967.33	41.67	922.67	1879.39	876.88	1265.98	663.33
Amaravati Division	550.00	3979.00	11791.33	516.00	4711.33	9560.21	751.49	1207.06	862.78
Wardha	319.67	1340.00	2193.33	246.33	1736.67	1851.33	810.45	1295.33	832.67
Nagpur	1076.67	2184.33	2886.00	757.33	1979.67	2854.00	710.18	909.28	995.16
Bhandara	105.00	93.00	84.33	83.67	102.67	89.00	840.50	1095.75	1048.48
Gondia	-	1.00	-	-	1.00	-	-	1000.00	-
Chandrapur	230.33	1174.33	1746.00	202.67	1587.67	1354.00	864.26	1348.82	796.11
Gadchiroli	1.33	18.67	69.33	1.33	20.33	44.67	1000.00	1081.44	726.31
Nagpur Division	1732.67	4810.67	6979.00	1291.00	5427.33	6193.00	754.51	1127.73	890.18
Total Maharashtra	2729.00	10970.33	29153.00	2419.00	14148.67	26710.63	878.29	1294.39	940.60

Source: Computation are based on the figures/data obtained from 'Statistical Division, Commissionerate of Agriculture, Government of Maharashtra, Pune'

The districts that account for substantial share in total soyabean crop area of Maharashtra belong to the divisions of Amravati, Latur, Nagpur, and Kolhapur (Table 2.5). The division of Amravati has not only shown significant and substantial increase in area under soyabean crop in absolute terms but also in terms of its share in total soyabean crop area of Maharashtra during the last two decades. The area under soyabean crop in the division of Amravati has increased from as low as 0.55 lakh hectares in TE 1992-93 to as much as 11.79 lakh hectares in TE 2009-10, showing thereby about 20 folds rise in area under soyabean crop during the last two decades. The division of Amravati accounted for 20 per cent share in total soyabean crop area of Maharashtra in TE 1992-93, which increased to 36 per cent in TE 2001-02, and further to 40 per cent in TE 2009-10. Among various districts belonging to Amravati division, the district of Yavatmal showed its area under soyabean crop to increase by leaps and bounds, which increased from 0.05 lakh hectares in TE 1992-93 to as much as 2.97 lakh hectares in TE 2009-10. Even the share of Yavatmal district in total soyabean crop area of Maharashtra increased from as low as 1.70 per cent in TE 1992-93 to as much as 10.18 per cent in TE 2009-10. However, the district of Amravati belonging to Amravati division showed a declining share in total soyabean crop area of Maharashtra, which declined from 13.51 per cent TE 1992-93 to 11.16 per cent in TE 2009-10.

Although Nagpur division accounted for about 63 per cent share in soyabean crop area of Maharashtra in TE 1992-93, this share kept declining in the subsequent periods so much so that it declined to about 24 per cent in TE 2009-10. However, in absolute terms, the area under soybean crop in Nagpur division increased from 1.73 lakh hectares in TE 1992-93 to 6.98 lakh hectares in TE 2009-10. The district of Nagpur belonging to Nagpur division showed a steep fall in its share in total soyabean crop area of Maharashtra, which declined from 39 per cent in TE 1992-93 to as low as 10 per cent in TE 2009-10. Latur is found to be another division, accounting for significant share in total soyabean crop area of Maharashtra, especially in TE 2009-10. The share of Latur division in total soyabean crop area of Maharashtra is noticed to be 21 per cent in TE 2009-10. The Kolhapur division also accounts for significant share in total soyabean crop area of Maharashtra. However, its share in soyabean crop area of Maharashtra has declined sharply from 17 per cent in TE 1992-93 to 5 per cent in TE 2009-10. The decline in share of Kolhapur division is mainly due to sharp decline in shares of Sangli and Kolhapur districts in total soyabean crop area of Maharashtra during the last two decades, which have fallen from 8-9 per cent in TE 1992-93 to nearly 2 per cent in TE 2009-10.

Table 2.5: Share of Districts in Total Area and Production of Soybean Crop in Maharashtra: 1990-91 to 2009-10
(in per cent)

Districts/Divisions	Area			Production		
	TE 1992-93	TE 2001-02	TE 2009-10	TE 1992-93	TE 2001-02	TE 2009-10
Thane	-	-	-	-	-	-
Raigad	-	-	-	-	-	-
Ratnagiri	-	-	-	-	-	-
Kokan Division	-	-	-	-	-	-
Nashik	0.33	0.60	1.50	0.34	0.70	2.14
Dhule	0.18	0.20	0.46	0.19	0.20	0.46
Nandurbar	-	0.20	0.84	-	0.17	1.21
Jalgaon	0.35	0.26	0.71	0.32	0.25	1.51
Nashik Division	0.87	1.26	3.50	0.85	1.32	5.32
Ahmednagar	0.11	0.59	1.93	0.10	0.51	2.22
Pune	0.17	0.05	0.10	0.17	0.04	0.17
Solapur	0.15	0.06	0.10	0.12	0.06	0.11
Pune Division	0.40	0.70	2.13	0.39	0.61	2.50
Satara	1.11	1.23	1.02	1.16	2.00	2.20
Sangli	8.86	5.25	1.96	15.45	10.09	4.15
Kolhapur	7.49	5.66	2.00	13.49	8.87	4.60
Kolhapur Division	17.45	12.14	4.98	30.10	20.97	10.95
Aurangabad	0.23	0.29	0.23	0.23	0.26	0.31
Jalna	0.48	0.41	1.27	0.70	0.26	1.42
Beed	0.66	0.36	2.13	0.55	0.34	0.88
Aurangabad Division	1.37	1.06	3.64	1.49	0.86	2.61
Latur	0.33	0.83	7.00	0.37	0.64	5.58
Osmanabad	1.47	0.26	1.24	1.20	0.11	0.96
Nanded	0.11	1.11	5.84	0.10	1.22	4.85
Parbhani	0.26	0.99	2.94	0.28	1.06	3.22
Hingoli	-	1.53	4.36	-	1.56	5.03
Latur Division	2.16	4.72	21.37	1.65	4.58	19.63
Buldhana	4.87	5.38	7.36	7.36	4.92	7.58
Akola	1.23	2.21	4.25	1.28	1.87	4.24
Washim	-	6.74	7.50	-	6.31	6.11
Amaravati	13.51	15.29	11.16	10.97	13.67	10.82
Yavatmal	1.70	6.65	10.18	1.72	6.52	7.04
Amaravati Division	20.15	36.27	40.45	21.33	33.30	35.79
Wardha	11.71	12.21	7.52	10.18	12.27	6.93
Nagpur	39.45	19.91	9.90	31.31	13.99	10.68
Bhandara	3.85	0.85	0.29	3.46	0.73	0.33
Gondia	-	0.01	-	-	0.01	-
Chandrapur	8.44	10.70	5.99	8.38	11.22	5.07
Gadchiroli	0.05	0.17	0.24	0.05	0.14	0.17
Nagpur Division	63.49	43.85	23.94	53.37	38.36	23.19
Total Maharashtra	100.00	100.00	100.00	100.00	100.00	100.00

Source: Computation are based on the figures/data obtained from 'Statistical Division, Commissionerate of Agriculture, Government of Maharashtra, Pune'

The production of soyabean crop in Maharashtra has also grown substantially during the last two decades with major production expansion witnessed during the 1900s period as against the 2000s period. The production of soyabean crop in Maharashtra increased from 1.29 lakh MT in TE 1992-93 to 14.15 lakh MT in TE 2001-02, and further to 26.71 lakh MT in TE 2009-10. The divisions of Nagpur, Amravati, Latur and

Kolhapur are noticed to account for about 90 per cent share in total soyabean crop production of Maharashtra. The share of Amravati division in total soyabean crop production of Maharashtra has increased substantially from 21 per cent in TE 1992-93 to 36 per cent in TE 2009-10. Similarly, the share of Latur division in total soyabean crop production of Maharashtra has increased from 1.65 per cent in TE 1992-93 to as much as 20 per cent in TE 2009-10. Contrary to this, the share of Nagpur division in total soyabean crop production of Maharashtra has declined sharply and steadily from 53 per cent in TE 1992-93 to 38 per cent in TE 2001-02, and further to 23 per cent in TE 2009-10. The division of Kolhapur also showed a sharp decline in its share in total soyabean crop production of Maharashtra, which decline from 30 per cent in TE 1992-93 to 21 per cent in TE 2001-02, and further to 11 per cent in TE 2009-10. The districts belonging to Nashik, Pune and Aurangabad divisions put together have shown about 10 per cent share in total soyabean crop production of Maharashtra, especially during TE 2009-10.

The increase in soyabean crop production of Maharashtra over the last two decades is noticed due to area expansion under this crop since the yield level of soyabean crop has not grown much during this period. The yield level of soyabean crop in Maharashtra increased from 878 kg/ha in TE 1992-93 to 1294 kg/ha in TE 2001-02 with a decline in the same to 940 kg/ha in TE 2009-10, showing hardly any significant expansion in the same during the last two decades. The districts belonging to Nagpur, Amravati, and Latur divisions have shown a similar trend of rise in yield level of soyabean crop from TE 1992-93 to TE 2001-02 and subsequent fall in TE 2009-10. The districts belonging to Kolhapur division invariable showed very high level of yield of soyabean crop during the entire period between 1990-91 and 2009-10. The yield level of soyabean crop in Kolhapur division was estimated at 1440 kg/ha in TE 1992-93, which increased to as much as 2230 kg/ha in TE 2001-02 with a marginal fall in the same to 2018 kg/ha in TE 2009-10. In fact, the yield level of soyabean crop across all the districts of Kolhapur division was found to be twice the average yield level of soyabean crop for the state of Maharashtra, especially during TE 2009-10. Even districts of Nashik and Pune divisions showed higher yield level of soyabean crop than the State average during TE 2009-10. However, the districts belonging to Nashik and Pune divisions do not account for significant share in total soyabean crop production of Maharashtra.

The annual compound growth rate estimates with respect to area, production and yield of soyabean crop for different districts as well as divisions of Maharashtra for there time periods viz. from 1990-91 to 1999-2000, 2000-01 to 2009-10, and 1990-91 to 2009-

10 are brought out in Table 2.6, which represent growth trend estimates in area production and yield of soyabean crop for the 1990s, 2000s and the overall period.

The estimates shown in Table 2.6 reveal substantial annual growth in area under soyabean crop in the state of Maharashtra during the last two decades. The area under soyabean crop is seen to have grown at the rate of 19.31 per cent per annum during the 1990s period and 13.67 per cent per annum during the 2000s period with an overall growth in the same at 14.49 per cent per annum during the period between 1990-91 and 2009-10. During the period between 1990-91 and 2009-10, the annual growth in area under soyabean crop is noticed to be at the rate of 19.16 per cent in Amravati division, 8.06 per cent in Nagpur division, 33.85 per cent in Latur division, 21.24 per cent in Aurangabad division, 6.28 per cent in Kolhapur division, 27.67 per cent in Pune division, and 22.43 per cent in Nashik division. The major growth in area under soyabean crop is noticed during the 1990s period as against the 2000s period, especially in Nagpur, Amravati and Kolhapur divisions. On the other hand, the divisions of Latur, Aurangabad, Pune and Nashik have shown major growth in area under soyabean crop only during the 2000s period as against the 1990s period.

It is not the area alone but the production of tur crop in Maharashtra has also grown substantially with an annual growth of 26.31 per cent during the 1990s, 7.71 per cent during the 2000s with an overall average growth in the same at 14.25 per cent between 1990-91 and 2009-10. This is an indication of the fact that major growth in production of soyabean crop has taken place during 1990s period as against the 2000s period. The districts belonging to Amravati division have shown 12-23 annual growth in soyabean crop production during the period between 1990-91 and 2009-10. During the same, period, the districts belonging to Nagpur division have shown 8-21 annual growth in soyabean crop production. The districts belonging to Latur division have shown as much as 14-45 per cent annual growth in soyabean crop production during the last two decades. The districts belonging to Kolhapur division have shown relatively lower growth in production of soyabean crop during the last two decades. In general, during the period between 1990-91 and 2009-10, the annual rate of growth in production of soyabean crop is estimated at 17.31 per cent in Amravati division, 8.70 per cent in Nagpur division, 34.31 per cent in Latur division, 18.91 per cent in Aurangabad division, 7.54 per cent in Kolhapur division, 29.64 per cent in Pune division, and 24.23 per cent in Nashik division. The divisions of Nagpur, Amravati, Latur, Kolhapur and Pune have shown major growth in production of soyabean crop mainly during the 1990s period as

against the 2000s period. On the contrary, the division of Aurangabad has shown major growth in production of soyabean crop during the 2000s period as against the 1990s period. Interestingly, the division of Nashik has shown same growth in production of soyabean crop during both 1990s and 2000s period.

Table 2.6: Compound Annual Growth Rates (CAGR) of Area, Production and Yield of Soybean Crop in Maharashtra: 1990-91 to 2009-10

Districts/Divisions	(in per cent)								
	Area			Production			Yield		
	1990/91 – 1999-00	2000/01 – 2009-10	1990/91 – 2009/10	1990/91 – 1999-00	2000/01 – 2009-10	1990/91 – 2009/10	1990/91 – 1999-00	2000/01 – 2009-10	1990/91 – 2009/10
Thane	-	-	-	-	-	-	-	-	-
Raigad	-	-	-	-	-	-	-	-	-
Ratnagiri	-	-	-	-	-	-	-	-	-
Kokan Division	-	-	-	-	-	-	-	-	-
Nashik	26.16*	30.23*	25.56*	33.88*	29.24*	29.02*	6.13*	-0.76	2.75*
Dhule	26.54*	28.54*	14.06*	32.72*	25.26*	13.76*	4.88	-2.57	-0.27
Nandurbar	-	-	-	-	-	-	-	-	-
Jalgaon	16.07*	32.03*	18.25*	25.85*	37.42*	24.23*	6.06**	4.09	4.45*
Nashik Division	25.18*	33.15*	22.43*	33.64*	33.39*	25.89*	6.16*	0.19	2.67*
Ahmednagar	47.47*	29.20*	38.26*	60.38*	28.03*	41.52*	8.76**	-0.89	2.36
Pune	2.15	27.77*	9.54*	6.06	30.86*	15.23*	3.82	2.41	5.19*
Solapur	9.66	25.85*	9.96*	15.9	22.21*	12.66*	3.79	-2.92	1.76
Pune Division	25.48*	28.83*	27.67*	30.55*	27.59*	29.64*	3.75	-0.97	1.49
Satara	22.26*	11.43*	14.25*	33.98*	9.25*	18.73*	9.59*	-1.95	3.92*
Sangli	12.74*	-0.05	4.80*	17.04*	-3.29	5.74*	3.81	-3.24	0.9
Kolhapur	16.3*	-1.13	5.76*	21.57*	-0.68	7.10*	4.53	0.46	1.27
Kolhapur Division	15.01*	1.09	6.28*	19.88*	-0.53	7.54*	4.24	-1.6	1.18
Aurangabad	29.57*	11.76**	12.02*	37.23*	13.73	13.87*	5.92	1.73	1.64
Jalna	17.54*	31.51*	20.94*	10.1	35.37*	20.44*	-6.34	2.94	-0.42
Beed	4.79	35.92*	29.13*	5.67	15.99**	25.00*	0.84	-14.68*	-3.21
Aurangabad Division	13.75**	30.2*	21.24*	14.58**	22.86*	18.91*	2.61	-5.64	-1.38
Latur	39.41*	45.31*	39.57*	41.58*	34.92*	35.77*	1.56	-7.15	-2.72
Osmanabad	-0.71	37.96*	15.26*	-4.18	37.41*	14.25*	-7.91**	-0.44	-2.41
Nanded	48.47*	35.88*	46.07*	59.52*	24.79*	44.46*	7.44*	-8.16*	-1.11
Parbhani	52.26*	26.04*	34.33*	64.42*	21.16*	34.68*	7.99	-3.87	0.27
Hingoli	-	-	-	-	-	-	-	-	-
Latur Division	23.84*	32.75*	33.85*	32.00*	23.79*	34.31*	3.85	-6.75**	-0.57
Buldhana	15.81*	16.66*	18.52*	13.05*	9.33	15.41*	3.06	-6.29	-1.02
Akola	26.44*	22.06*	19.51*	33.74*	15.3**	18.41*	5.77*	-5.53	-0.92
Washim	-	-	-	-	-	-	-	-	-
Amaravati	21.72*	9.80*	12.19*	32.72*	8.52	12.31*	9.03*	-1.17	0.11
Yavatmal	45.81*	21.7*	25.98*	57.69*	7.99	22.67*	8.15*	-11.26**	-2.63
Amaravati Division	27.87*	15.43*	19.16*	34.05*	8.04	17.31*	8.42*	-6.4	-0.59
Wardha	22.21*	6.18*	12.07*	27.32*	-0.87	11.99*	4.18	-6.64**	-0.06
Nagpur	12.46*	4.64*	4.84*	15.29*	4.86	6.45*	2.52	0.21	1.54
Bhandara	3.64	-0.54	-1.70	10.70*	-1.26	-0.57	6.8**	-0.7	1.15
Gondia	-	-	-	-	-	-	-	-	-
Chandrapur	18.41*	5.79*	13.04*	31.54*	-3.45	11.74*	6.68*	-8.72**	-0.93
Gadchiroli	41.63*	16.88*	23.74*	43.74*	8.44**	21.09*	0.84	-7.19	-2.06
Nagpur Division	14.77*	5.42*	8.06*	21.73*	1.08	8.70*	6.07**	-4.11	0.59
Total Maharashtra	19.31*	13.67*	14.49*	26.31*	7.71**	14.25*	5.87*	-5.25	-0.21

Source: Computation are based on the figures/data obtained from 'Statistical Division, Commissionerate of Agriculture, Government of Maharashtra, Pune'

Note: 1) * and ** represent significance of growth rates at 1 and 5 per cent level of probability

2) Some of the districts of Maharashtra were carved after 1996-07, and, therefore, growth rates for these districts are not estimated

The production of soyabean crop in Maharashtra has expanded mainly due to area expansion during the last two decades since there is negative growth in yield level of soyabean crop during this period. Almost all the major soyabean growing districts have shown negative growth in yield during the overall period between 1990-91 and 2009-10, which is mainly due to declining yield level of soyabean crop during 2000s period as against the 1990s period. The yield level of soyabean crop in Maharashtra has been declining at the rate of 0.21 per cent per annum during the period between 1990-91 and 2009-10, which is mainly due to 5.25 per cent annual decline yield level of soyabean crop during the 2000s period in the face of 5.87 per cent annual increase in yield level of soyabean crop during 1990s period. During the period between 1990-91 and 2009-10, the yield level of soyabean crop is estimated to have declined at the rate of 0.59 per cent per annum in Amravati division, 0.57 per cent per annum in Latur division, and 1.38 per cent per annum in Aurangabad division. On the other hand, during the same period, the yield level of soyabean crop is estimated to have increased at the rate of 0.59 per cent per annum in Nagpur division, 1.18 per cent per annum in Kolhapur division, 1.49 per cent per annum in Pune division and 2.67 per cent per annum in Nashik division. However, the declining trend of yield level of soyabean crop in major producing districts during the 2000s period has ultimately led the overall yield level of soyabean crop to decline for the state of Maharashtra during the last two decades.

2.2 Changes in Costs and Profitability of Tur and Soyabean Crops

The Commission for Agricultural Costs and Prices (CACP) in its report provides cost and return estimates for different crops cultivated across various states of India. The cost estimates for various foodgrain, oilseeds and other crops for both kharif and rabi seasons are based on cost concepts, which include estimation of cost A_1 , A_2 , $A_2 + FL$, B_1 , B_2 , C_1 , C_2 , and C_2^* . These costs represent a break-up of total cost of cultivation of various crops at different stages. The CACP report also provides estimates relating to yield, prices, and value of main and by product, etc. for various crops cultivated across different states of India. These cost and return estimates help in ascertaining the extent of profit involved in the cultivation of various crops in different states of India. In this section, therefore, an attempt is made to provide cost and return estimates for tur and soyabean crops cultivated in the state of Maharashtra based on CACP reports.

2.2.1 Changes in Costs and Profitability of Tur Crop

The estimates relating to various cost concepts for tur crop cultivated in the state of Maharashtra encompassing the period between 1997-98 and 2007-08 are brought out

in Table 2.7. A break-up of cost of cultivation of tur crop, which includes cost incurred in labour, seed, fertilizer and manure, insecticides, irrigation, interest on working capital, etc. encompassing the period between 1997-98 and 2007-08 is shown in Table 2.8.

The total cost of cultivation (C_2) of tur crop in the state of Maharashtra has grown significantly from Rs.6,568 per hectare in 1997-98 to Rs.22,103 per hectare in 2007-08, showing thereby 237 per cent rise in the same during the last one decade. The cost C_2 for tur crop estimated at Rs.6,568 per hectare in 1997-98 encompassed 48 per cent share on account of cost A_2 , which represented actual expenses in cash and kind incurred in production and rent paid on leased in land. The cost $A_2 + FL$ accounted for 62 per cent share in cost C_2 for tur crop in 1997-98, where FL represented imputed value of family labour involved in production. In course of time, a substantial increase in share of cost A_2 and cost $A_2 + FL$ was noticed in cost C_2 , so much so that in 2007-08 the cost C_2 estimated at Rs.22,103 per hectare encompassed 60 per cent share on account of cost A_2 and 74 per cent share with respect to cost $A_2 + FL$.

Table 2.7: Cost of Cultivation of Tur Based on Various Cost Concepts: Maharashtra

							(Rs./ha)	
Year	A_1	A_2	$A_2 + FL$	B_1	B_2	C_1	C_2	
1997-98	3160.78	3160.78	4062.43	4301.05	5666.22	5202.70	6567.87	
1998-99	3270.65	3270.65	4306.43	4131.14	6590.23	5166.92	7626.00	
1999-00	3933.47	3933.47	4905.99	5168.77	7559.15	6141.29	8351.66	
2000-01	4382.53	4382.53	5770.17	5485.83	7396.70	6873.48	8784.34	
2001-02	5851.84	5851.84	7263.02	7303.62	9853.79	8714.80	11264.97	
2002-03	7097.39	7097.39	8290.31	8689.81	11298.71	9882.73	12491.63	
2003-04	8451.48	8451.48	9841.58	10119.09	13091.28	11509.19	14486.38	
2006-07	12266.98	12269.32	14365.29	13888.69	17289.71	15984.66	19385.68	
2007-08	13359.05	13361.29	16419.82	14988.12	19043.96	18046.86	22102.50	
Share (%)								
1997-98	48.12	48.12	61.85	65.49	86.27	79.21	100.00	
1998-99	42.89	42.89	56.47	54.17	86.42	67.75	100.00	
1999-00	47.10	47.10	58.74	61.89	90.51	73.53	100.00	
2000-01	49.89	49.89	65.69	62.45	84.20	78.25	100.00	
2001-02	51.95	51.95	64.47	64.83	87.47	77.36	100.00	
2002-03	56.82	56.82	66.37	69.57	90.45	79.11	100.00	
2003-04	58.34	58.34	67.94	69.85	90.37	79.45	100.00	
2006-07	63.28	63.29	74.10	71.64	89.19	82.46	100.00	
2007-08	60.44	60.45	74.29	67.81	86.16	81.65	100.00	

Source: Computations are based on figures obtained from various CACP Reports, Ministry of Agriculture, Government of India

Note: (i) Cost estimates for Maharashtra are not reported in CACP reports for Tur crop prior to 1997-98 and for 2004-05 and 2005-06

(ii) Cost A_1 = All actual expenses in cash and kind incurred in production by owner

Cost A_2 = Cost A_1 + rent paid for leased in land

Cost $A_2 + FL$ = Cost A_2 + imputed value of family labour

Cost B_1 = Cost A_1 + interest on value of owned capital assets (excluding land)

Cost B_2 = Cost B_1 + rental value of owned land (net of land revenue) and rent paid for leased in land

Cost C_1 = Cost B_1 + imputed value of family labour

Cost C_2 = Cost B_2 + imputed value of family labour

The rise in share of cost A_2 and cost $A_2 + FL$ in cost C_2 for tur crop is an indication of the fact that the actual expenses in cash and kind incurred in production and imputed value of family labour expenses have gone up in course of time. However, the share of cost B_2 in cost C_2 for tur crop remained by and large same and hovered at around 86 per cent during the period between 1997-98 and 2007-08. Here, cost B_2 included actual expenses in cash and kind incurred in production, interest on value of owned capital assets, rental value of owned land and rent paid for leased in land.

A further analysis drawn from Table 2.8 revealed that the total cost of cultivation (C_2) of tur crop estimated in 1997-98 encompassed a share of 32.17 per cent share on account of expenses towards human labour, 11.33 per cent for bullock labour, 0.40 per cent for machine labour, 4.87 per cent for seed, 4.04 per cent for fertilizer and manure, 0.44 per cent for insecticides, 0.51 per cent for irrigation, 1.25 per cent towards interest on working capital and 0.03 per cent miscellaneous expenses with a sum of 55.04 per cent share towards variable cost and remaining 44.96 per cent share towards fixed cost.

Table 2.8: Break up of Cost of Cultivation (C_2) for Tur Crop

Year	Labour			Seed	Fert. & Manure	Insecticide	Irrigation	Int. on Working Capital	Misc.	(Rs./Ha)		Total Cost (C_2)
	Human	Bullock	Machine							Variable Cost	Fixed Cost	
Tur												
997-98	2113.10	744.36	26.45	319.60	265.34	28.94	33.24	82.22	1.72	3614.97	2952.90	6567.87
998-99	2406.10	627.17	131.93	389.93	247.61	32.29	5.33	87.82	5.66	3933.94	3692.06	7626.00
999-00	2484.02	659.03	273.99	326.86	395.09	164.92	4.67	104.32	2.07	4414.97	4116.69	8531.66
000-01	2920.93	979.04	242.42	401.30	479.39	14.68	51.75	115.73	1.33	5206.57	3577.77	8784.34
001-02	3115.13	2057.81	170.55	343.91	435.73	7.52	155.09	152.66	0.54	6448.95	4816.02	11264.97
002-03	3015.03	2701.26	471.75	485.17	648.72	149.10	38.70	199.58	69.64	7778.95	4712.68	12491.63
003-04	3421.52	3750.14	637.77	525.37	536.54	65.00	85.18	238.50		9260.11	5226.27	14486.38
006-07	5257.32	5126.80	699.30	615.21	1186.57	440.52	112.10	354.43		13792.25	5593.43	19385.68
007-08	6975.36	4621.79	919.11	600.15	1730.50	475.55	48.37	384.77		15755.60	6346.90	22102.50
Share in Cost C_2 (%)												
997-98	32.17	11.33	0.40	4.87	4.04	0.44	0.51	1.25	0.03	55.04	44.96	100.00
998-99	31.55	8.22	1.73	5.11	3.25	0.42	0.07	1.15	0.07	51.59	48.41	100.00
999-00	29.12	7.72	3.21	3.83	4.63	1.93	0.05	1.22	0.02	51.75	48.25	100.00
000-01	33.25	11.15	2.76	4.57	5.46	0.17	0.59	1.32	0.02	59.27	40.73	100.00
001-02	27.65	18.27	1.51	3.05	3.87	0.07	1.38	1.36	0.00	57.25	42.75	100.00
002-03	24.14	21.62	3.78	3.88	5.19	1.19	0.31	1.60	0.56	62.27	37.73	100.00
003-04	23.62	25.89	4.40	3.63	3.70	0.45	0.59	1.65	0.00	63.92	36.08	100.00
006-07	27.12	26.45	3.61	3.17	6.12	2.27	0.58	1.83	0.00	71.15	28.85	100.00
007-08	31.56	20.91	4.16	2.72	7.83	2.15	0.22	1.74	0.00	71.28	28.72	100.00

Source: Computations are based on various CACP Reports, Ministry of Agriculture, Government of India

Note: Cost estimates for Maharashtra are not reported in CACP reports for Tur crop prior to 1997-98 and for 2004-05 and 2005-06

The composition of expenses towards various items of total cost changed with the passage of time and during 2007-08 the total cost of cultivation (C_2) of tur crop included 31.56 per cent share on account of expenses towards human labour, 20.91 per cent for

bullock labour, 4.16 per cent for machine labour, 2.72 per cent for seed, 7.83 per cent for fertilizer and manure, 2.15 per cent for insecticides, 0.22 per cent for irrigation, and 1.74 per cent towards interest on working capital with a sum of 71.28 per cent share towards variable cost and remaining 28.72 per cent share towards fixed cost.

A critical evaluation of Table 2.8 clearly underscore the fact that the share of expenses towards bullock labour, machine labour, fertilizer and manure, and insecticides in total cost of cultivation (C_2) of tur crop has increased steadily during the period between 1997-98 and 2007-08. On the other hand, during the same period, the share of expenses for seed in total cost of cultivation (C_2) of tur crop has declined. The share of expenses towards irrigation and interest on working capital in total cost of cultivation (C_2) of tur crop did not vary much during the given period of time. In general, during the period between 1997-98 and 2007-08, the share of expenses towards variable cost in total cost of cultivation (C_2) of tur crop increased from 55.04 per cent to 71.28 per cent in the face of decline in fixed expenses in this respect from 44.96 per cent to 28.72 per cent.

The estimates relating to yield level of tur crop, prices, value of main and by product, variable and total cost, and gross and net returns for tur crop in Maharashtra for the period between 1997-98 and 2007-08 are brought out in Table 2.9.

Table 2.9: Profitability Indicators of Tur Crop in Maharashtra

Year	Yield (Q/Ha)	Implicit Price (Rs/Q)	Price (Rs/Q) MSP	Value Main Product	Value By Product	Gross Returns	Variable Cost	Total Cost	(Rs./Ha)	
									Returns over Variable Cost	Net Returns
1997-98	4.74	1570.57	900	7444.48	744.88	8189.36	3614.97	6567.87	4574.39	1621.49
1998-99	8.54	1580.79	960	13499.95	1251.63	14751.58	3933.94	7626.00	10817.64	7125.58
1999-00	9.01	1464.51	1105	13195.28	1144.08	14339.36	4414.97	8351.66	9924.39	5807.7
2000-01	7.26	1449.19	1200	10521.10	941.81	11462.91	5206.57	8784.34	6256.34	2678.57
2001-02	9.29	1470.16	1320	13657.78	1640.14	15297.92	6448.95	11264.97	8848.97	4032.95
2002-03	9.94	1454.10	1320	14453.80	1195.49	15649.29	7778.95	12491.63	7870.34	3120.47
2003-04	9.88	1708.72	1360	16882.12	977.41	17859.53	9260.11	14486.38	8599.42	3301.84
2006-07	9.28	2055.26	1410	19072.83	1344.48	20417.31	13792.25	19385.68	6625.06	1051.63
2007-08	10.76	2172.65	1550	23377.75	956.79	24334.54	15755.60	22102.50	8578.94	2160.8

Source: Computations are based on figures obtained from various CACP Reports, Ministry of Agriculture, Government of India

The estimates presented in Table 2.9 show an increase in yield level of tur crop in Maharashtra from 4.74 qt/ha in 1997-98 to 10.76 qt/ha in 2007-08. Although the total cost of cultivation of tur crop in Maharashtra has grown from Rs.6,568 in 1997-98 to Rs.22,103 in 2007-08, the gross returns from this crop is also seen to have increased from Rs.8,189 to Rs.24,335 during this period, mainly due to rise in yield level of the crop. The rise in cost of cultivation of tur crop has led its MSP to increase from Rs.900 per

quintal in 1997-98 to Rs.1,550 per quintal in 2007-08. Further, the estimates brought out in Table 2.9 show significant fluctuation in per hectare net returns from tur crop in Maharashtra during the period between 1997-98 and 2007-08, which increased from Rs.1,621 in 1997-98 to Rs.7,126 in 1998-99 with a decline in the same to Rs.2,161 in 2007-08. The per hectare net returns from tur crop cultivation do not appear to be very encouraging in the state of Maharashtra. Nevertheless, since per hectare returns over variable cost for tur crop cultivation in the state of Maharashtra is estimated to have increased steadily from Rs.4,574 in 1997-98 to Rs.8,579 in 2007-08, its cultivation may be considered as a profitable proposition. The returns from tur crop cultivation over variable cost are quite reasonable in the state of Maharashtra.

2.2.2 Changes in Costs and Profitability of Soybean Crop

The estimates relating to various cost concepts furnished in the CACP reports for soybean crop cultivated in the state of Maharashtra encompassing the period between 1996-97 and 2007-08 are provided in Table 2.10. A break-up with respect to cost of cultivation of soybean crop showing estimates relating expenses incurred towards labour, seed, fertilizer and manure, insecticides, irrigation, interest on working capital, etc. for the period between 1996-97 and 2007-08 is brought out in Table 2.11.

The estimates presented in Table 2.10 reveal that the total cost of cultivation (C_2) of soybean crop in the state of Maharashtra has increased substantially from Rs.7,887 per hectare in 1996-97 to as much as Rs.19,519 per hectare in 2007-08, showing thereby 147 per cent rise in the same during the last one decade. The cost A_2 shows by and large fluctuating share in cost C_2 for soybean crop, which is seen to have increased from 67 per cent in 1996-97 to 72 per cent in 2005-06 with a decline in the same to 65 per cent in 2007-08. Similarly, the share of cost $A_2 + FL$ in cost C_2 for soybean crop is seen to have increased from 75 per cent in 1997-98 to 78 per cent in 2005-06 with a fall in the same to 72 per cent in 2007-08. The fluctuation in share of cost A_2 and cost $A_2 + FL$ in cost C_2 for soybean crop is an indication that there has been variations in actual expenses in cash and kind incurred in production and expenses towards imputed value of family labour for soybean crop during the last one decade.

Interestingly, the share of cost B_1 in cost C_2 has increased from 76 per cent in 1996-97 to 80 per cent in 2004-05 with a steep decline in the same to 70 per cent in 2007-08. This is an indication of the fact that the actual expenses in cash and kind incurred and expenses incurred towards interest on value of owned capital assets for soybean crop have remained unstable during the period between 1996-97 and 2007-08. Even the cost

B₂ has shown by and large fluctuating share in cost C₂, which is seen to have grown from 91 per cent in 1998-99 to 96 per cent in 2003-04 with a fall in the same to again 91 per cent in 2006-07, and again a rise in the same to 94 per cent in 2007-08.

Table 2.10: Cost of Cultivation of Soybean Based on Various Cost Concepts: Maharashtra

(Rs./ha)							
Year	A ₁	A ₂	A ₂ + FL	B ₁	B ₂	C ₁	C ₂
1996-97	5250.00	5250.00	-	5960.47	7397.90	6449.80	7887.23
1997-98	5644.34	5644.34	6227.52	6079.23	7698.39	6662.41	8281.57
1998-99	6194.72	6194.72	7038.45	6656.17	8714.01	7499.90	9557.74
1999-00	7976.33	7976.33	9017.77	8649.18	10850.51	9690.62	11891.95
2000-01	8757.53	8757.53	9910.22	9394.24	11503.80	10546.93	12656.49
2001-02	9614.79	9614.79	10584.29	10258.16	12894.71	11227.66	13864.22
2002-03	9124.76	9124.76	9938.15	10382.06	12775.43	11195.44	13588.82
2003-04	9888.62	9888.62	10528.43	11020.86	13992.13	11660.68	14631.94
2004-05	11877.32	11877.32	12583.02	13183.82	15742.09	13889.53	16447.79
2005-06	10652.03	10652.03	11547.32	11621.53	13895.86	12516.83	14791.15
2006-07	12290.51	12290.51	13448.27	13316.92	16321.08	14474.68	17878.85
2007-08	12758.33	12766.11	13968.58	13713.91	18316.93	14916.38	19519.40
Share (%)							
1996-97	66.56	66.56	-	75.57	93.80	81.78	100.00
1997-98	68.16	68.16	75.20	73.41	92.96	80.45	100.00
1998-99	64.81	64.81	73.64	69.64	91.17	78.47	100.00
1999-00	67.07	67.07	75.83	72.73	91.24	81.49	100.00
2000-01	69.19	69.19	78.30	74.22	90.89	83.33	100.00
2001-02	69.35	69.35	76.34	73.99	93.01	80.98	100.00
2002-03	67.15	67.15	73.13	76.40	94.01	82.39	100.00
2003-04	67.58	67.58	71.96	75.32	95.63	79.69	100.00
2004-05	72.21	72.21	76.50	80.16	95.71	84.45	100.00
2005-06	72.02	72.02	78.07	78.57	93.95	84.62	100.00
2006-07	68.74	68.74	75.22	74.48	91.29	80.96	100.00
2007-08	65.36	65.40	71.56	70.26	93.84	76.42	100.00

Source: Computations are based on figures obtained from various CACP Reports, Ministry of Agriculture, Government of India

Note: (i) Cost estimates for Maharashtra are not reported in CACP reports for Soybean crop prior to 1996-97

(ii) Cost A₁ = All actual expenses in cash and kind incurred in production by owner

Cost A₂ = Cost A₁ + rent paid for leased in land

Cost A₂ + FL = Cost A₂ + imputed value of family labour

Cost B₁ = Cost A₁ + interest on value of owned capital assets (excluding land)

Cost B₂ = Cost B₁ + rental value of owned land (net of land revenue) and rent paid for leased in land

Cost C₁ = Cost B₁ + imputed value of family labour

Cost C₂ = Cost B₂ + imputed value of family labour

Although the estimates presented in Table 2.10 have shown considerable rise in cost of cultivation of soyabean crop in the state of Maharashtra during the period between 1996-97 and 2007-08, they do not reveal much regarding as to which cost component actually led to rise in cost of cultivation as various items of cost show mixed trends in terms of their in Cost C₂ during this period. However, an analysis presented in Table 2.11 show that the total cost of cultivation (C₂) of Rs.7,887 estimated for soyabean crop in 1996-97 included 27.31 per cent share on account of expenses towards human labour, 11.00 per cent for bullock labour, 2.36 per cent for machine labour, 18.15 per cent for

seed, and 1.91 per cent towards interest on working capital with a sum of 69.34 per cent share towards variable cost and 30.66 per cent share towards fixed cost.

Table 2.11: Break up of Cost of Cultivation (C₂) for Soybean Crop

Year	Labour			Seed	Fert. & Manure	Insecticide	Irrigation	Int. on Working Capital	Misc.	Variable Cost	Fixed Cost	Total Cost (C ₂)
	Human	Bullock	Machine									
Soybean												
1996-97	2153.77	867.33	186.31	1431.73	679.00	-	-	150.90		5469.05	2418.18	7887.23
1997-98	2136.96	1208.06	375.56	1337.59	852.85	6.33	3.66	166.81		6087.83	2193.74	8281.57
1998-99	2390.18	1431.57	465.15	1391.08	835.47	96.13	-	180.18		6789.77	2767.97	9557.74
1999-00	3509.21	1440.54	1036.42	1196.73	1176.68	50.99	72.69	232.56		8715.82	3176.13	11891.95
2000-01	3815.04	1488.58	1122.22	1249.32	1494.91	43.07	128.24	255.90		9597.28	3059.21	12656.49
2001-02	2816.43	3056.48	1133.52	1378.21	1391.80	48.76	121.52	280.54		10227.26	3636.96	13864.22
2002-03	2695.28	2542.70	1237.44	1422.21	1213.69	111.60	53.66	264.48		9541.06	4047.76	13588.82
2003-04	2684.35	2658.81	1516.33	1595.63	1264.73	141.77	21.90	288.87		10172.39	4459.55	14631.94
2004-05	2884.84	4209.43	1568.88	1846.38	1166.87	125.33	72.70	349.02		12223.45	4224.34	16447.79
2005-06	3012.80	3382.69	1496.95	1612.91	1175.10	195.17	15.34	312.36		11203.27	3587.88	14791.15
2006-07	3421.31	4290.67	1773.25	1509.36	1512.58	206.90	7.14	361.36		13482.57	4396.28	17878.85
2007-08	3978.68	3917.71	1882.90	1641.48	1543.34	210.60	41.52	375.43		13591.66	5927.74	19519.40
Share in Cost C₂ (%)												
1996-97	27.31	11.00	2.36	18.15	8.61	0.00	0.00	1.91	0.00	69.34	30.66	100.00
1997-98	25.80	14.59	4.53	16.15	10.30	0.08	0.04	2.01	0.00	73.51	26.49	100.00
1998-99	25.01	14.98	4.87	14.55	8.74	1.01	0.00	1.89	0.00	71.04	28.96	100.00
1999-00	29.51	12.11	8.72	10.06	9.89	0.43	0.61	1.96	0.00	73.29	26.71	100.00
2000-01	30.14	11.76	8.87	9.87	11.81	0.34	1.01	2.02	0.00	75.83	24.17	100.00
2001-02	20.31	22.05	8.18	9.94	10.04	0.35	0.88	2.02	0.00	73.77	26.23	100.00
2002-03	19.83	18.71	9.11	10.47	8.93	0.82	0.39	1.95	0.00	70.21	29.79	100.00
2003-04	18.35	18.17	10.36	10.91	8.64	0.97	0.15	1.97	0.00	69.52	30.48	100.00
2004-05	17.54	25.59	9.54	11.23	7.09	0.76	0.44	2.12	0.00	74.32	25.68	100.00
2005-06	20.37	22.87	10.12	10.90	7.94	1.32	0.10	2.11	0.00	75.74	24.26	100.00
2006-07	19.14	24.00	9.92	8.44	8.46	1.16	0.04	2.02	0.00	75.41	24.59	100.00
2007-08	20.38	20.07	9.65	8.41	7.91	1.08	0.21	1.92	0.00	69.63	30.37	100.00

Source: Computations are based on various CACP Reports, Ministry of Agriculture, Government of India

Note: The cost estimates for Maharashtra are not reported in CACP reports for Soybean crop prior to 1996-97

After a span of a decade or so, the composition of expenses with respect to various items of cost changed significantly and in 2007-08 the total cost of cultivation (C₂) of soyabean crop estimated at Rs.19,519 in 2007-08 encompassed a share of 20.38 per cent share on account of expenses towards human labour, 20.07 per cent for bullock labour, 9.65 per cent for machine labour, 8.41 per cent for seed, 7.91 per cent for fertilizer and manure, 1.08 per cent for insecticides, 0.22 per cent for irrigation, and 1.92 per cent towards interest on working capital with a sum of 69.63 per cent share towards variable cost and remaining 30.37 per cent share towards fixed cost.

The trend discernible from Table 2.11 clearly show a steady increase in share of bullock and machine labour expenses in total cost of cultivation (C₂) of soyabean crop during the period between 1996-97 and 2007-08. In dismal contrast, during the same period, the share of expenses towards human labour, seed and to some extent fertilizer

and manure in total cost of cultivation (C_2) of soyabean crop has declined. The shares with respect to expenses towards irrigation and interest on working capital in total cost of cultivation (C_2) of soyabean crop have not changed much during the given last one decade. Further, the share of variable and fixed cost in total cost of cultivation (C_2) of soyabean crop fluctuated considerably during the period between 1996-97 and 2007-08. The share of variable cost in total cost of cultivation (C_2) of soyabean crop increased from 69 per cent in 1996-97 to 76 per cent in 2000-01 with a subsequent decline in the same to 70 per cent in 2007-08. Similarly, the share of fixed cost in total cost of cultivation (C_2) of soyabean crop decreased from 31 per cent in 1996-97 to 24 per cent in 2000-01 with a rise in the same to 30 per cent in 2007-08. In general, variable cost accounted for 70-75 per cent share in total cost of cultivation (C_2) of soyabean crop during the period between 1996-97 and 2007-08.

The estimates relating to yield level of tur crop, prices, value of main and by product, variable and total cost, and gross and net returns for soybean crop in Maharashtra for the period between 1996-97 and 2007-08 are presented in Table 2.12.

Table 2.12: Profitability Indicators of Soybean Crop in Maharashtra

Year	Yield (Q/Ha)	Implicit Price (Rs/Q)	Price (Rs/Q) MSP	Value Main Product	Value By Product	Gross Returns	Variable Cost	Total Cost	(Rs./Ha)	
									Returns over Variable Cost	Net Returns
1996-97	9.24	856.23	700	8303.36	919.48	9222.84	5469.05	7887.23	3753.79	1335.61
1997-98	10.25	906.99	750	9296.63	416.37	9713	6087.83	8281.57	3625.17	1431.43
1998-99	13.62	876.53	795	11938.31	406.24	12344.55	6789.77	9557.74	5554.78	2786.81
1999-00	14.44	868.59	845	12542.51	662.82	13205.33	8715.82	11891.95	4489.51	1313.38
2000-01	15.78	792.22	865	12501.23	153.61	12654.84	9597.28	12656.49	3057.56	-1.65
2001-02	15.98	945.47	885	15108.64	707.55	15816.19	10227.26	13864.22	5588.93	1951.97
2002-03	12.99	1078.68	885	14012.00	345.38	14357.38	9541.06	13588.82	4816.32	768.56
2003-04	14.68	1185.58	930	17404.32	419.72	17824.04	10172.39	14631.94	7651.65	3192.1
2004-05	12.49	1199.54	1000	14982.24	364.28	15346.52	12223.45	16447.79	3123.07	-1101.27
2005-06	11.70	1133.89	1010	13266.46	376.79	13643.25	11203.27	14791.15	2439.98	-1147.9
2006-07	13.96	1254.16	1020	17508.04	513.39	18021.43	13482.57	17878.85	4538.86	142.58
2007-08	16.64	1617.26	1050	26911.25	696.61	27607.86	13591.66	19519.40	14016.2	8088.46

Source: Computations are based on figures obtained from various CACP Reports, Ministry of Agriculture, Government of India

As can be discerned from Table 2.12, the yield level of soyabean crop in the state of Maharashtra has increased from 9.24 qt/ha in 1996-97 to 16.64 qt/ha in 2007-08. In view of rise in cost of cultivation over time, the MSP for soyabean crop has grown from Rs.700 per quintal in 1996-97 to Rs.1,050 in 2007-08. Further, though the estimates show that the total cost of cultivation for soyabean crop in the state of Maharashtra has grown significantly from Rs.7,887 per hectare in 1996-97 to Rs.19,519 per hectare in 2007-08,

the per hectare net returns for soyabean crop are also seen to have increased substantially from Rs.1,336 in 1996-97 to Rs.8,088 in 2007-08. However, the period between 1996-97 and 2007-08 also show several instances when there have been negative net returns from soyabean crop in the state of Maharashtra. The case in point are the years 2000-01, 2004-05 and 2005-06 when the cost of cultivation of soyabean crop in Maharashtra exceeded the gross returns, resulting in negative returns from this crop during these years. The negative returns from soyabean crop during years 2000-01, 2004-05 and 2005-06 could be considered as a cause of concern and may discourage farmers to cultivate this important oilseed crop in the state of Maharashtra. In fact, during the entire period between 1996-97 and 2007-08, it is only in 2007-08 when the net return from soyabean crop cultivation in Maharashtra turned out to be reasonable. The cost and return estimates clearly show that it is only per hectare returns over variable cost that soyabean crop cultivation can be considered as a profitable proposition in the state of Maharashtra. There is, therefore, a need to reduce costs and increase yield level of soyabean crop in the state of Maharashtra. This coupled with rise in MSP will induce the farmers to cultivate this important oilseed crop in the state of Maharashtra.

2.3 Secondary Estimates of Losses Caused by Pests and Diseases of Selected Crops: Review

The studies relating to losses caused by pests and diseases for various foodgrains, oilseeds and other crops are not very many. At all-India level and across various states, there are quite a few studies that pin their attention to the post-harvest losses of foodgrains and other crops. For instance, Birewar (1977) estimated post-harvest losses of foodgrains at 10 per cent in India. Singh and Khosla (1978), while estimating losses at various post-harvest stages of foodgrains, found losses on account of transit to storage operation to be between 1.03 per cent and 1.09 per cent of the value of sales during 1969-73, and with respect to rice the total range of loss at various post-harvest operations was estimated at 10-37 per cent.

A study conducted by Chakravarti (1970) examined the areal variations in foodgrain sufficiency, developed a method for measuring and mapping foodgrain sufficiency levels and analyzed the areal patterns of surplus and deficiency. A direct method developed by the researcher for measuring foodgrain surplus and deficit areas was based on the computation of actual foodgrain production, minus the consumption by the (weighted) population, with allowances for wastage between farm and kitchen. The approach used by the researcher at the district level had two essential advantages: (a) the direct estimate of production and consumption was the only reliable way to ascertain the

deficiency or surplus in a unit area, and (b) it appeared to be the only dependable way to compare one area with another. The study found many sources of leakage between production and consumption, i.e., destruction by pests, losses in transportation or storage, kitchen waste, and use for seed. However, the formulas developed in the study were neither perfect nor final due to several handicaps existed owing to lack of precise information, particularly at the district level.

The range of losses during various storage operations is reported to vary from 5 to 50 per cent (Swaminathan, 1977). The study conducted by Boxall et. al. (1979) on farm-level storage of paddy in coastal Andhra Pradesh attempted to assess losses occurring at farm-and home-level storage operations. The authors found information on storage losses - both quantitative and qualitative terms - of foodgrains other than wheat and rice, such as sorghum, millet, and legumes, extremely limited as it was based more on laboratory experiments than on field survey. Reduction of weight losses in bulk storage of grain was found to be directly sum-able in financial terms, and the cost-benefit ratio turned out to be highly convincing factor for research and development in improved storage structures. The authors argued that as against the problems of commercial storage, those of farm and home storage received low priority because the damage was insidious and often difficult to quantify. The study conducted by Pushpamma and Uma Reddy (1979) on the changes in the quality of rice and jowar stored for up to one year in three different agro-climatic regions of Andhra Pradesh, found progressive increase in insect infestation in both grains during storage. The range of weight loss varied between 3.9 and 5.10 per cent at the end of 12 months of storage. The insect infestation was higher for the samples drawn from coastal region of Andhra Pradesh. Except for rice samples stored for one year in the coastal region, all the jowar and rice samples had uric acid contents below the safe level.

In order to identify location, causes, and magnitude, and to evolve appropriate strategies for conservation of foodgrains, several efforts were made in the past based on the available information on post-harvest losses. The reports of Shulten (1982) and Tyler (1982) clearly indicated that qualitative changes in storage of foodgrains, especially at farm and home levels, were the main grey patches in our knowledge of post-harvest damages occurring in foodgrains. While assessing damage, emphasis was frequently on weight loss followed by kernel damage. Other forms of damage, such as reduction in quality and nutritive value, viability of seeds, microbial spoilage, and contamination with substances harmful to health or unacceptable for edible purposes, which could be of greater importance than weight loss. were often ignored or given low priority. Even when

these factors were given importance, lack of approved and standardized methodology for assessing qualitative changes turned out to be the main constraint.

The study conducted by Ojha (1984) on 'Improved Post-harvest Technology to Maximize Yield and Minimize Quantitative and Qualitative Losses' found 10 per cent of the total grain yield lost on account of post-harvest operations. The author's systematic study carried out on paddy crop found several important factors contributing to post-harvest losses viz. (i) harvesting, 1 to 5 per cent, (ii) transportation, 2 to 7 per cent, (iii) threshing, 2 to 6 per cent, (iv) storage, 2 to 6 per cent, (v) drying, 1 to 6 per cent, and (vi) milling, 2 to 10 per cent. These losses cumulatively accounted for 40 per cent of the total weight of paddy crop, which also deteriorated the quality of the produce. The quality loss was mainly found at the stage of drying, storage, and milling. The quantitative losses were caused on account of mechanical agents such as birds, animals, rains, over drying, and shattered in the fields during harvesting. Ojha (1984) mentioned that the losses occurring due to other factors such as (a) changes in moisture content, (b) dust and broken grains, (c) reduction in germination power, (d) loss of palatability, (e) heating and caking, etc. could render the grains unacceptable for use as human food or as animal feed.

An important study conducted by Gupta and Mohan (1985) estimated economic returns in storage of foodgrains at farm level and covered state like Maharashtra, Rajasthan and Punjab for this estimation. The three major foodgrains viz. jowar in Maharashtra, bajra in Rajasthan and Bengal gram in Punjab were selected and the range of returns in storage with respect to jowar, bajra and Bengal gram stood at 13.10-31.53 per cent, 5.14-21.86 per cent and 5.79-14.15 per cent, respectively. The study categorically showed that the farmers would have gained a lot had they shifted to modern scientific structures instead of traditional storage practices followed by them. Further, while conducting a study on fertilizer application to paddy under four different production environments in West Godavari district of Andhra Pradesh, Rao and Sirohi (1986) found significant loss of the crop due to damages caused by floods, rats, brown plant hopper, etc. The study classified the damage due to rats into three levels viz. nil, light (8.57 per cent) and medium (25 per cent).

Another study conducted by Singh et. al. (1992) reported a loss of 1.49-1.55 per cent in wheat crop during harvesting by sickle, whereas such loss with harvest-combine ranged from 1.57-1.60 per cent. The study showed an alarming loss ranging from 6.79-6.84 per cent in the case traditional storage structure. Gill (2000) found the extent of post-harvest loss in the range of 7-10 per cent at the farm to market level and 4-5 per cent

from market to distribution level. The total loss of grains was estimated at 12-16 million metric tonnes per year that included 3-4 million metric tonnes of wheat and 5-7 million metric tonnes of rice.

A very recent study conducted by Ramasamy and Selvaraj (2002) found harvesting of pulses in India by hand as the major cause of wastage, besides wastages occurring owing to insects and storage problems. The study estimated the domestic supply of pulses at 82 per cent with seed accounting for 6 per cent, feed 9 per cent and waste 3 per cent. The study categorically emphasized on the fact that nearly 4-5 lakh tonnes of pulses are wasted in the country, which stands higher than the imports in almost all the decades except during 1990s, and that there would not be any need for imports if waste of pulses could have been minimized through appropriate post-harvest measures. Lack of infrastructure, under-developed markets for pulses and poor integration of markets for pulses, thus, blunt the market competitiveness. Added to this, the value addition procedures such as grading, packaging, storage and processing are not well developed for pulses.

In case of pulses, a number of pests damage the produce during storage. These pests cause both quantitative and qualitative losses. Pests of Red gram also damage seed viability and nutritive value of the produce. The infestation of these pests depends on various factors like moisture content of the grain, relative humidity, temperature, storage structures, storage period, processing, unhygienic condition, fumigation frequency, etc. The major stored grain pests of Red gram and their control measures are Pulse beetle (*Callosobruchus* spp.), Khapra beetle (*Trogoderma granarium*), Dried bean weevil (*Acanthoscelides obtectus*), Rice moth (*Corcyra cephalonica*), Confused flour beetle (*Tribolium confusum* J. du V.), Rodents, etc.

The study conducted by Kumar, et. al. (2011) made an attempt to assess post harvest losses of pulses in Uttarakhand and specifically focused on storage losses, seed germination losses, etc. Improper storage condition was cited as the main reason that reduced the yield of pulses. Further, the main reasons for the declining yield level of pulses were traced in non-availability of HYV seeds, improper storage conditions, lack of knowledge about recently released seeds, and poor technical guidance and other related problems. The study found maximum post-harvest losses of pulses on account of storage operations, which were caused Pulses Beetle, Rodent, Rice moth, etc. According to Deshpande and Singh (2001), among storage losses, pulses are most susceptible to damage due to insects (5 per cent) as compared to wheat (2.5 per cent), paddy (2 per

cent) and maize (3.5 per cent). In case of pulses, processing, threshing and transportations are found to cause 1 per cent, 0.5 per cent and 0.5 per cent losses, respectively (Birewar, 1984). In case of traditional storage, Caswell (1973) recorded 50 to 60 per cent of grain loss of pulses after six months on account of insects. Mukherjee et. al. (1970) had reported that leguminous seeds were more damaged by pulse beetle (32.64 per cent) as compared with those of vegetable and oil seeds (3 per cent).

A study conducted by Rani (2011) in Maharashtra attempted to evaluate the extent of post-harvest losses for pigeon pea at various stages and found 14.425 kg/q of pigeon pea to be lost on account of various post-harvest operations, which encompassed 1.2 kg/q lost during maturity stage, 4 kg/q due to weather impact, 0.5 kg/q during harvesting, 1 kg/q during threshing, 1.5 kg/q due to labour unavailability, 0.025 kg/q during drying, 5 kg/q during storage, 0.2 kg/q on account of storage, and 1 kg/q during processing of grain. The study categorically emphasized on the fact that in comparison to wheat and paddy, pulses are more susceptible to pest damage during storage with approximately 30-40 percent of post harvest loss occurring at this stage.

It is to be noted that during storage, quantitative as well as qualitative losses occur due to insects, rodents, and micro-organisms. A large number of insect pests have been reported to be associated with stored grains. The occurrence and numbers of stored grain insect pests are directly related to geographical and climatic conditions (Lal and Srivastava, 1985). Almost all species have remarkably high rates of multiplication and, within one season, may destroy 10-15 per cent of the grain and contaminate the rest with undesirable odors and flavors. Insect pests also play a pivotal role in transportation of storage fungi (Sinha and Sinha, 1990). Grain storage plays an important role in preventing losses which are caused mainly due to weevils, beetles, moths and rodents (Kartikeyan et al, 2009). It is estimated that 60-70 per cent of foodgrain produced in the country is stored at home level in indigenous storage structures. The percentage of overall food crop production retained at the farm-level and the period of storage is largely a function of farm-size and yield per acre, family-size, consumption pattern, marketing pattern, form of labour payment, credit availability and future crop production expectations (Greeley, 1978).

As for soyabean, the study carried out by Shelar (2008) found seed quality as one of the major constraints in soyabean production. The seed quality problems were reported to be dependent on the manner in which seeds were handled during harvesting, processing and storage. The loss of seed viability during storage and resultant poor stand

have also been cited as the major constraints in soybean production in tropical and subtropical countries mainly owing to prevailing high temperature and high relative humidity (Wien and Kueneman, 1981). Therefore, high quality seed that provides adequate plant stand is the basis for profitable production and expansion of cultivation of the crop. In order to increase the production of soybean, a source of high quality, disease free seed must be established and maintained (Shelar, 2008). Soybean seed deteriorates faster than those of most other crops (Priestley et al., 1985) especially under tropical conditions (Delouche and Baskin, 1973). Further, besides inherent poor storability, mechanical damage is one more factor strongly responsible for seed quality deterioration especially by small farmers in developing countries which has been overshadowed by more important problems such as storage deterioration, insect infestation and diseases (Wilson and McDonald Jr., 1992).

It has been argued that storability of soybean seed is greatly influenced by the degree to which they have deteriorated prior to storage. Soybean seeds are subjected to weathering before harvest, mechanical damage during harvesting, threshing, processing do not store well even though they have fairly good initial germination (Gupta, 1976). During storage, injured or deeply bruised areas may serve as centers for infection and results in deterioration. Injuries close to vital parts of the embryonic axis or near the point of attachment of cotyledons to the axis usually bring about the most rapid losses of viability (Bewley and Black, 1984). Fabrizius *et al.* (1999) reported that high initial levels of mechanical injury or seed infection had little effect on rate of deterioration and storability as compared with sound seed lots.

Soyabean is affected by weather, diseases, pests, weeds and variable soil Quality (Lal, 2009; Strange and Scott, 2005). In soybean, localized variety development is important so that growers use varieties that are well adapted to local conditions such as weather, preferred agronomic practices and photoperiod (Panthee, 2010). However, increases in crop production due to varietal improvements are often offset by constraints caused by broadly categorized abiotic and/or biotic factors. The increased importance and knowledge of soybean pathogens becomes apparent when one compares information contained in the first Soybean Disease Compendium (Sinclair and Shurtleff, 1975), covering 50 diseases, to the latest edition of this book that lists more than 300 diseases (Hartman et al. 1999). Some of the more important diseases have recently been reviewed (Grau et al. 2004; Hartman and Hill, 2010). The increase in number of diseases and their expansion are the result of intense production and increased acreage in new regions of the

world. In production areas where soybean is grown every year or even every other year, propagules of various types produced by pathogens have increased to densities that cause economic yield losses. Parasitic microorganisms, such as bacteria, fungi, nematodes, Oomycetes, and viruses all contribute to economic damage caused to soybeans each year. A similar story occurs for soybean pests as well; many pests such as aphids, beetles, mites, and stinkbugs cause considerable economic damage to the soybean crop (O'Neal and Johnson, 2010).

According to World Bank Report (1999), post-harvest losses in India amount to 12 to 16 million metric tons of foodgrains each year, an amount that the World Bank stipulates could feed one-third of India's poor. The monetary value of these losses amounts to more than Rs.50,000 crores per year (Singh, 2010). The causes of post-harvest losses are manifold, which include harvesting at an incorrect stage of maturity, excessive exposure to rain, drought or extreme temperature, contamination by microorganisms and physical damage that reduces the value of the product. Further, post-harvest losses of food grains in India are 7-10 per cent of the total production from farm to market level and 4-5 per cent at market and distribution levels. For the system as a whole, such losses have been worked out to be 11-15 Mt of food grains annually, which included 3-4 Mt of wheat and 5-7 million tonnes of rice. It has been found that about 75 per cent of the total post-harvest losses occur at the farm level and about 25 per cent at the market level (Basavaraja et. al., 2007).

The estimates furnished by Ali (1998) revealed post-harvest losses to be 5-15 per cent in durables (cereals, pulses and oilseeds), 20-30 per cent in semi-durables (potato, onion, sweet potato, tapioca, etc.), and 30-50 per cent in perishables (fruits, vegetables, milk, meat, fish and eggs) with an average of 17.5 per cent for all agricultural commodities put together. A substantial amount of these losses could have been prevented had appropriate agro-processing centers having backward linkage with farmers to ensure constant supply of quality raw food materials been established and operated.

With a view to curb storage and transit losses at farm and commercial level and in order to modernize the system of handling, storage and transportation of foodgrains in India, a National Policy on 'Handling and Storage of Foodgrains' has been announced recently (India Budget, 2000-01). The major thrust of the policy is on (a) declaration of foodgrain storage as infrastructure, (b) encouragement of mechanical harvesting, cleaning and drying at farm and market level, (c) transportation of grains from farm to silos by specially designed trucks, (d) construction of chain silos at receipt as well as at

distribution points, (e) encouraging private sector for building storage capacities in which grains procured by Government agencies would be stored on payment of storage charges, and (f) encouraging private sector for development of infrastructure for the integrated bulk handling, storage and transportation of foodgrains. Efforts initiated in above directions would certainly help the country to reduce post-harvest and wastage allowances of foodgrains, in particular, during various operations.

2.4 Summary

The last two decades reveal marginal increase in area under tur crop in Maharashtra, which increased from 10.10 lakh hectares in TE 1992-93 to 10.87 lakh hectares in TE 2009-10 with an annual growth rate of 0.45 per cent. However, the increase in tur crop production in Maharashtra during this period has been substantial, which increased from 4.56 lakh MT in TE 1992-93 to 8.67 lakh MT in TE 2009-10 with an annual growth rate of 3.28 per cent. This shows about 90 per cent increase in tur crop production in Maharashtra between TE 1992-93 and TE 2009-10. The major reason for rise in tur crop production in Maharashtra is the perceptible increase in productivity of tur crop during the last two decades. The productivity of tur crop in Maharashtra increased at an annual compound growth rate of 2.82 per cent during the period between 1990-91 and 2009-10. The major regions/divisions that have contributed to rise in tur crop production of Maharashtra are Latur, Amravati, Nagpur and to some extent Aurangabad. The districts belonging to these divisions of Maharashtra account for more than 90 per cent area and production of tur crop of the State, and these districts have shown significant productivity gains for tur crop during the last two decades. As a result, the production of tur crop has grown significantly in the state of Maharashtra.

Unlike tur crop, the area under soyabean crop in Maharashtra has increased by leaps and bounds from 2.73 lakh hectares in TE 1992-93 to 29.15 lakh heaters in TE 2009-10 with an annual compound growth rate of 14.49 per cent during the period between 1990-91 and 2009-10. Even the soyabean crop production has increased substantially in Maharashtra from 2.42 lakh MT in TE 1992-93 to 26.71 lakh MT in TE 2009-10 with an annual compound growth rate of 14.25 per cent during the period between 1990-91 and 2009-10. However, there has been declining trend in yield level of soyabean crop during the 2000s period, which is seen to have caused overall annual decline in yield level of soyabean crop in the state of Maharashtra during the period between 1990-91 and 2009-10. The production expansion in soyabean crop in Maharashtra is, therefore, noticed mainly due to area expansion under this crop during

the last two decades since productivity of soyabean crop has rather declined, especially during the 2000s period. Further, the major districts that have caused substantial increase in area and production of soyabean crop in Maharashtra belong to the divisions of Amravati, Nagpur, Latur, and Kolhapur. These districts are noticed to account for more than 90 per cent share in area and production of soyabean crop in Maharashtra, especially in more recent times. Despite decline in yield levels, the area and subsequent expansion of production of soyabean crop in districts belonging to the divisions of Amravati, Nagpur, Latur, and Kolhapur have ultimately resulted in significant production expansion of soyabean crop in the state of Maharashtra.

An analysis into changes in costs and profitability revealed the cost of cultivation of tur crop in the state of Maharashtra to increase from Rs.6,568 per hectare in 1997-98 to Rs.22,102 per hectare in 2007-08, showing thereby a 237 per cent rise in the same during this period. During the period between 1997-98 and 2007-08, the share of expenses towards variable cost in total cost of cultivation of tur crop increased from 55.04 per cent to 71.28 per cent in the face decline in fixed expenses in this respect from 44.96 per cent to 28.72 per cent. The increase in share of variable expenses in total cost of cultivation of tur crop during the period between 1997-98 and 2007-08 was mainly due to steady increase in share of expenses towards bullock labour, machine labour, fertilizer and manure, and insecticides since share of expenses towards seed in total cost of cultivation of tur crop declined during this period. The shares with respect to irrigation charges and interest on working capital in total cost of cultivation of tur crop did not vary much during the given period of time. Further, the per hectare net returns from tur crop varied significantly during the period between 1997-98 and 2007-08, which increased from Rs.1,621 in 1997-98 to Rs.7,126 in 1998-99 with a decline in the same to Rs.2,161 in 2007-08. However, the per hectare returns over variable cost for tur crop cultivation in Maharashtra increased steadily from Rs.4,574 in 1997-98 to Rs.8,579 in 2007-08. These estimates clearly show reasonable returns from tur crop cultivation in the state of Maharashtra, especially over variable cost.

In the case of soyabean crop, the total cost of cultivation was found to increase from Rs.7,887 in 1996-97 to Rs.19,519 in 2007-08, showing a 147 per cent rise in the same during the period between 1996-97 and 2007-08. About 66 per cent share in cost C_2 was accounted for by cost A_2 and 93 per cent by cost B_2 during the period between 1996-97 and 2007-08, though there were some fluctuations in the same during this period. A break-up with respect to cost of cultivation of soybean crop showed an increasing trend in

terms of share of expenses towards bullock and machine labour in total cost of cultivation of soyabean crop during the period between 1996-97 and 2007-08. During the same period, the shares with respect to expenses towards human labour, seed, fertilizer and manure in total cost of cultivation of soyabean crop declined. The shares with respect to expenses towards insecticides, irrigation and interest on working capital in total cost of cultivation of soyabean crop did not vary much and remained stable during the period between 1996-97 and 2007-08. In general, the variable cost showed fluctuating share in cost of cultivation of soyabean crop in the state of Maharashtra, which increased from 69 per cent in 1996-97 to 76 per cent in 2000-01 with a fall in the same to 70 per cent in 2007-08. Obviously, the share of fixed cost in total cost of cultivation of soyabean crop fell from 31 per cent in 1996-97 to 24 per cent in 2000-01 with an increase in the same to 30 per cent in 2007-08. Although yield level of soyabean crop increased from 9.24 qt/ha in 1996-97 to 16.64 qt/ha in 2007-08 and its MSP grew from Rs.700 per quintal in 1996-97 to Rs.1,050 in 2007-08, this could not result into higher net per hectare returns from soyabean crop during this period. The per hectare net returns from soyabean crop in Maharashtra though increased from Rs.1,336 in 1996-97 to Rs.8,088 in 2007-08, there were several instances when there stood negative net returns from soyabean crop during the period between 1996-97 and 2007-08. The cost and returns estimates clearly showed positive returns from soyabean crop only over variable cost during the period between 1996-97 and 2007-08. In order to boost cultivation of soyabean crop, there is need to reduce cost and increase yield, aside from raising MSP for this important oilseed crop cultivated in the state of Maharashtra. These measures will certainly raise profitability in the cultivation of soyabean crop in Maharashtra.

There are quite a few studies that have shown losses on account of various harvesting and post-harvesting operations. The study conducted by Kumar et. al. (2011) found maximum post-harvest losses of pulses on account of storage operations, which were caused by Pulses Beetle, Rodent, Rice moth, etc. As pointed out by Deshpande and Singh (2001), pulses are the most susceptible to damage due to insects (5 per cent) as compared to wheat (2.5 per cent), paddy (2 per cent) and maize (3.5 per cent). Further, in case of pulses, losses on account of processing, threshing and transportations are 1 per cent, 0.5 per cent and 0.5 per cent losses, respectively, of total production (Birewar, 1984). In case of traditional storage, Caswell (1973) recorded 50 to 60 per cent of grain loss of pulses after six months on account of insects. Mukherjee et. al. (1970) had reported that leguminous seeds were more damaged by pulse beetle (32.64 per cent) as

compared with those of vegetable and oil seeds (3 per cent). It is to be noted that the occurrence and numbers of stored grain insect pests are directly related to geographical and climatic conditions (Lal and Srivastava, 1985).

In case of soyabean, seed quality is one of the major constraints in soyabean production (Shelkar, 2008). The soyabean seed is reported to deteriorate faster than those of most other crops (Priestley et al., 1985), especially under tropical conditions (Delouche et al., 1973). According to Gupta (1976), soyabean seeds are subjected to weathering before harvest, mechanical damage during harvesting, threshing, processing do not store well even though they have fairly good initial germination. Soyabean is affected by weather, diseases, pests, weeds and variable soil Quality (Lal 2009; Strange and Scott 2005). Some of the more important diseases of soyabean have recently been reviewed (Grau et al. 2004; Hartman and Hill 2010). The increase in number of diseases and their expansion are the result of intense production and increased acreage in new regions of the world.

The foregoing review suggest that losses at various stages of pigeon pea among pulses and soyabean among oilseeds occur on account of varied reasons that not only include losses caused by pests and diseases but also during processing, threshing, storage and transportation operations. Therefore, efforts need to be initiated to curb losses of various agricultural commodities during various operations.

CHAPTER – III

HOUSEHOLD CHARACTERISTICS, CROPPING PATTERN AND PRODUCTION STRUCTURE

This chapter mainly deals with the socio-economic profile of sampled tur and soyabean crop cultivating farmers since the socio-economic characteristics of farmers have a profound influence on the decision making process and profitability of crop enterprise. The resource endowments have been compared for different categories of sampled tur and soyabean crop cultivators. The information relating to family size and composition, education status, caste composition, land use pattern, cropping pattern, irrigated area, sources of irrigation, etc. has been analysed and discussed for various categories of sampled farmers. The knowledge of the background of the sampled farmers is essential since the viability of any enterprise heavily depends on the favorable attitudinal changes towards adoption of superior technical inputs, which in turn, depends on technical skills and resource position of the farmers. In general, this chapter focuses on demographic profile of selected farmers, characteristics of their operational holdings, structure of tenancy, sources of irrigation, cropping pattern, area under HYV, crop productivity, marketed surplus and value of output by farm size, etc.

3.1 Socio-economic Characteristics of the Selected Farmers

The socio-economic characteristics of different categories of tur and soyabean crop cultivators have been compared. These characteristics mainly revolve around family size of households, number of earning family members, proportion of family members belonging to various age groups, average age of respondents, education status of households, their caste status, annual family income, etc. The demographic profile of tur and soyabean crop cultivators is provided separately in Table 3.1 and Table 3.2. The demographic profile of tur and soyabean farmers put together is shown in Appendix 1.

The study covered 120 sampled tur crop cultivators, which encompassed 27 marginal farmers, 54 small, 29 medium and 10 large farmers. The average family size was noticed to be 5.67 for marginal farmers, 5.04 for small, 5.62 for medium, 5.50 for large and 5.36 for the average category of tur crop farmers (Table 3.1). The average earning members were 2.33 in marginal category, 2.13 in small, 2.66 in medium and 2.60 in large category. In general, about 44 per cent of family members of tur crop cultivators were earners. The distribution of various members across various age groups revealed that the average family size of tur crop cultivators encompassed 42 per cent male members

above 15 years of age, 34 per cent female members above 15 years of age, and 24 per cent children below 15 years of age. The medium category of tur crop cultivators had higher male members above 15 years of age as compared to other categories of tur crop cultivators. Interestingly, majority of the respondents were head of the households, which held true for all the categories of tur crop cultivators. Further, the distribution of respondents across various age groups revealed that 57.50 per cent of respondents were above 40 years of age, 35 per cent fell between 25 to 40 years of age group, and the remaining 7.5 per cent belonged to less than 25 years of age. In general, majority of the respondents were more than 25 years of age. The education status of sampled tur crop cultivators revealed that about 2 per cent of members of sampled respondents were illiterate, 8 per cent attained education up to primary level, 43 per cent up to secondary level, 18 per cent up to higher secondary level, and 29 per cent of members of respondents were graduates and above. The members of medium and large category of sampled respondents invariably showed higher education status as compared to marginal and small category. The caste profile showed that 51 per cent of sampled tur crop cultivators belonged to OBC category, 43 per cent to general category and 6 per cent to SC category. The annual family income was estimated at Rs.1,08,107 for marginal category, Rs.1,27,833 for small, Rs.1,67,759 for medium and Rs.3,20,500 for large category with an average of Rs.1,49,099 for the average category of tur crop cultivators.

Table 3.1: Demographic Profile of the Selected Tur Crop Farmers (% of households)

Characteristics		Marginal	Small	Medium	Large	Total
No of HH		27	54	29	10	120
Household size (numbers)		5.67	5.04	5.62	5.5	5.36
Average numbers of earners (M&F)		2.33	2.13	2.66	2.6	2.34
Proportion of Male/Female/Children (%)	Male >15	40.56	41.07	45.37	40.00	41.98
	Female >15	31.39	35.12	33.81	41.82	34.33
	Children <15	28.04	23.81	20.82	18.18	23.69
Identity of respondent (%)	Head	85.19	83.33	89.66	80.00	85.00
	Others	14.81	16.67	10.34	20.00	15.00
Average age of the respondent (% households)	Less than 25	7.41	7.41	3.45	20.00	7.50
	Between 25 to 40	48.15	33.33	31.03	20.00	35.00
	Above 40	44.44	59.26	65.52	60.00	57.50
Highest Education status of a family member (% households)	Illiterate	-	3.70	-	-	1.67
	Up to primary	3.70	12.96	6.90	-	8.33
	Up to secondary	55.56	40.74	34.48	50.00	43.33
	Higher secondary	14.81	14.81	20.69	30.00	17.50
	Graduate and above	25.93	27.78	37.93	20.00	29.17
Caste (% households)	SC	-	7.41	10.34	0.00	5.83
	ST	-	-	-	-	-
	OBC	22.22	62.96	48.28	70.00	50.83
	General	77.78	29.63	41.38	30.00	43.33
Distance from the main market (km)		32.07	18.37	15.86	14.2	20.5
Annual family income (Rs)		1,08,107	1,27,833	1,67,759	3,20,500	1,49,099

The study also covered 120 soyabean crop cultivators, which encompassed 24 marginal farmers, 54 small, 30 medium and 12 large farmers. The family size of sampled soyabean crop cultivators varied from 5.20 for medium category to 7.83 for large category with an average of 5.69 for the average category of sampled farmers. About 50 per cent of the family members of soyabean crop cultivators were found to be earners. The distribution of members across various age groups revealed that the average family size of soyabean crop cultivators consisted of 37 per cent male members above 15 years of age, 33 per cent female members above 15 years of age, and 30 per cent children below 15 years of age. The medium category of sampled farmers invariably showed higher male as well as female members in their family as compared to other categories of soyabean crop cultivators. About 81 per cent of the sampled respondents were noticed to be head of the households (Table 3.2). Further, about 37 per cent of sampled respondents showed their age between 25 and 40 years, and 61 per cent had their age above 40 years. The education profile revealed that 23 per cent of sampled respondents attained education up to primary level, 33 per cent up to secondary level, 25 per cent up to higher secondary level, and 14 per cent up to graduation and above. The caste profile revealed that about 51 per cent of sampled soyabean crop cultivators belonged to OBC category, 32 per cent to SC, 4 per cent to ST and the remaining 13 per cent to general category. The annual family income of soyabean crop cultivators varied from Rs.97,079 for marginal category to Rs.2,37,458 for large category with an average of Rs.1,32,599 for average category.

Table 3.2: Demographic Profile of the Selected Soyabean Crop Farmers (% of households)

Characteristics	Marginal	Small	Medium	Large	Total	
No of HH	24	54	30	12	120	
Household size (numbers)	5.63	5.52	5.20	7.83	5.69	
Average numbers of earners (M&F)	2.71	2.8	2.7	3.58	2.83	
Proportion of Male/Female/Children (%)	Male >15	36.30	35.57	39.10	39.36	37.04
	Female >15	31.85	32.89	37.82	29.79	33.38
	Children <15	31.85	31.54	23.08	30.85	29.58
Identity of respondent (%)	Head	79.17	81.48	83.33	75.00	80.83
	Others	20.83	18.52	16.67	25.00	19.17
Average age of the respondent (% households)	Less than 25	-	5.56	-	-	2.50
	Between 25 to 40	45.83	38.89	33.33	16.67	36.67
	Above 40	54.17	55.56	66.67	83.33	60.83
Highest Education status of a family member (% households)	Illiterate	4.17	9.26	0.00	0.00	5.00
	Up to primary	33.33	27.77	13.33	8.33	23.33
	Up to secondary	37.50	38.89	23.33	16.66	32.50
	Higher secondary	16.67	18.52	43.33	25.00	25.00
Caste (% households)	Graduate and above	8.33	5.56	20.00	50.00	14.17
	SC	50.00	24.07	36.67	16.67	31.67
	ST	0.00	5.56	6.67	0.00	4.17
	OBC	45.83	57.41	43.33	50.00	50.83
	General	4.17	12.96	13.33	33.33	13.33
Distance from the main market (km)	13.29	19.46	23.93	28.50	20.25	
Annual family income (Rs)	97,079	1,01,393	1,75,242	2,37,458	1,32,599	

Thus, although soyabean crop cultivators enjoyed larger family size with more earning members, the annual family income was higher for sampled tur crop cultivators. The tur crop cultivators also showed relatively higher level of education as well as more male and female members as against the soyabean crop cultivators. However, the households belonging to general category were less for soyabean crop cultivators as against the tur crop cultivators.

3.2 Characteristics of Operational Holdings

Land is the main resource base of the farmer in the production process. The economic and social progress of farmers largely depends on the size of their operational holdings. Keeping in view the significance of land resources, it was thought essential to show the land use pattern of sampled tur and soyabean crop cultivators. The estimates relating to the magnitude of owned land, uncultivated land, leased in and out land, net operated area, irrigated area, gross cropped area (GCA) and cropping intensity for various categories of sampled tur and soyabean cultivators are shown in Table 3.3 and Table 3.4. These estimates for tur and soyabean farmers put together are shown in Appendix 2.

In the case of tur crop cultivators, the average size of owned land holding was estimated at 2.12 acres for marginal category, 4.24 acres for small, 7.84 acres for medium and 18.05 acres for the large category with an overall average of 5.78 acres for the average category of farmers. Although various categories of sampled tur crop cultivators did not show much leased in or leased out land, the medium and large category, in particular, showed some uncultivated area, which resulted in lower net operated area for these farmers. The net operated area for these farmers was estimated at 2.04 acres for marginal category, 4.06 acres for small, 7.59 acres for medium and 16.10 acres for the large category with an overall average of 5.45 acres for the average category of farmers. In general, about 39 per cent of the net operated area was found to be irrigated.

Table 3.3: Characteristics of Operational Holdings (acres per household) of Tur Crop Farmers

Farm size	Owned land	Un cultivated land	Leased-in	Leased - out	NOA	Irrigated area	GCA	Cropping intensity
Marginal	2.12	0.04	-	0.04	2.04	0.76	2.61	127.94
Small	4.24	0.09	-	0.09	4.06	1.60	4.73	116.50
Medium	7.84	0.47	0.22	-	7.59	3.29	9.47	124.77
Large	18.05	1.95	-	-	16.10	5.00	17.35	107.76
Total	5.78	0.33	0.05	0.05	5.45	2.10	6.45	118.35

The intensity of cropping was worked out at 128 per cent in case of marginal category of tur crop cultivators, 117 per cent for small category, 124 per cent for medium

category and 108 per cent for large category with an average of 118 per cent for the average category of tur crop cultivators (Table 3.3). Thus, large category of tur crop cultivators, in particular, showed very low cropping intensity.

As for the soyabean crop cultivators, the average size of owned land holding was estimated at 2.05 acres for marginal category, 4.09 acres for small, 7.11 acres for medium and 19.63 acres for the large category with an overall average of 5.99 acres for the average category of farmers. The extent of uncultivated area varied from 0.01 acres for marginal category to 2.00 acres for large category with an overall average of 0.34 acres for the average category of soyabean crop cultivators. The large category of sampled soyabean crop cultivators also showed significant leased in and leased out land. The net operated area for these farmers was estimated at 2.04 acres for marginal category, 4.14 acres for small, 7.04 acres for medium and 15.21 acres for the large category with an overall average of 5.55 acres for the average category of farmers. The average category of soyabean crop cultivators showed about 49 per cent of the net operated area under irrigation. The proportion of net operated area under irrigation was higher for medium and large category of soyabean crop cultivators. The intensity of cropping was estimated at 129 per cent for marginal category of soyabean crop cultivators, 128 per cent for small category, 134 per cent for medium category and 132 per cent for large category with an average of 131 per cent for the average category of soyabean crop cultivators (Table 3.4). Thus, by and large, all the categories of sampled soyabean crop cultivators showed similar intensity of cropping.

Table 3.4: Characteristics of Operational Holdings (acres per household) of Soyabean Crop Farmers

Farm size	Owned land	Un cultivated land	Leased-in	Leased - out	NOA	Irrigated area	GCA	Cropping intensity
Marginal	2.05	0.01	-	-	2.04	0.67	2.63	128.92
Small	4.09	0.10	0.19	0.04	4.14	1.62	5.30	128.02
Medium	7.11	0.37	0.30	0.00	7.04	3.43	9.42	133.81
Large	19.63	2.00	0.50	2.92	15.21	9.83	20.08	132.02
Total	5.99	0.34	0.21	0.31	5.55	2.70	7.27	130.99

Thus, while there was hardly any difference in net operated area for tur and soyabean crop cultivators, the intensity of cropping and area under irrigation stood at much higher for soyabean crop cultivators as against the tur crop cultivators. The leased in and leased out land were also quite high for soyabean crop cultivators, which held particularly true for medium and large category of farmers. In general, both tur and soyabean crop cultivators showed rise in proportion of net operated area under irrigation

with the increase in land holding size of farmers with exception of large category of tur crop cultivators, which showed only 31 per cent of net operated area under irrigation as against 37 per cent of net operated area under irrigation for marginal category, 39 per cent for small, and 43 per cent for large category.

3.3 Structure of Tenancy

The information relating to nature of tenancy in leasing-in and leasing-out land for various categories of sampled tur crop cultivators and soyabean crop cultivators is provided separately in Table 3.5 and Table 3.6. The structure of tenancy for tur and soyabean farmers put together is brought out in Appendix 3.

The estimates furnished in Table 3.5 clearly show that none of sampled tur crop cultivators had any crop sharing or cost sharing agreement while leasing-in land. However, in case of leasing-out land, one small category of tur crop cultivator had crop sharing agreement. Similarly, in case of leasing-out land, one marginal category of tur crop cultivator had crop and cost sharing agreement. In general, there were only three medium category of tur crop cultivators who leased-in land at fixed rent of Rs.12,154 per acre. The proportion of net operated area leased-in was worked out at 2.90 per cent for medium category with an average of 0.92 per cent for the average category of tur crop cultivators. Similarly, the proportion of net operated area leased-out was worked out at 1.96 per cent for marginal category and 2.22 per cent for small category with an average of 0.92 per cent for the average category of tur crop cultivators.

Table 3.5: Nature of Tenancy in Leasing-in/ Leasing-out Land (% households) for Tur Crop Farmers

Farm size	Crop sharing	Crop and cost sharing	Fixed rent in cash	Others	Total	% share of tenancy in NOA	Rent amount Rs. Per acre
(Leasing-in)							
Marginal	-	-	-	-	-	-	-
Small	-	-	-	-	-	-	-
Medium	-	-	3 (100.00)	-	3 (100.00)	2.90	12,154
Large	-	-	-	-	-	-	-
Total	-	-	3 (100.00)	-	3 (100.00)	0.92	12,154
(Leasing-out)							
Marginal	-	1(100.00)	-	-	1 (50.00)	1.96	-
Small	1 (100.00)	-	-	-	1 (50.00)	2.22	-
Medium	-	-	-	-	-	-	-
Large	-	-	-	-	-	-	-
Total	1 (100.00)	1 (100.00)	-	-	2 (100.00)	0.92	-

In case of soyabean crop cultivators, none of the farmers had crop sharing or crop and cost sharing agreement while leasing-out land. However, two small category of soyabean crop cultivators had crop sharing agreement while leasing-in land. Most of the sampled soyabean crop cultivators leased-in or leased-out land on fixed rent. There were

five small, two medium and one large with a sum of eight soyabean crop cultivators who had leased-in land on fixed rent (Table 3.6). The fixed rent for leased-in land varied from Rs.8,917 per acre for small category to Rs.10,500 per acre for large category with an average of Rs.9,643 per acre for the average category of soyabean crop cultivator. Similarly, there were two large and one small with a sum of three soyabean crop cultivators who had leased-out land on fixed rent. The fixed rent for leased-out land was worked out at Rs.12,000 per acre for small category and Rs.11,071 per acre for large category with an average of Rs.11,122 per acre for the average category of soyabean crop cultivator. The proportion of net operated area leased-in was worked out at 4.59 per cent for small category, 4.26 per cent for medium category and 3.29 per cent for large category with an average of 3.78 per cent for the average category of soyabean crop cultivators. The proportion of net operated area leased-out was worked out at 0.97 per cent for small category and 19.20 per cent for large category with an average of 5.59 per cent for the average category of soyabean crop cultivators.

Table 3.6: Nature of Tenancy in Leasing-in/ Leasing-out Land (% households) for Soyabean Crop Farmers

Farm size	Crop sharing	Crop and cost sharing	Fixed rent in cash	Others	Total	% share of tenancy in NOA	Rent amount Rs. Per acre
(Leasing-in)							
Marginal	-	-	-	-	-	-	-
Small	2 (100.00)	-	5 (62.50)	-	7 (70.00)	4.59	8,917
Medium	-	-	2 (25.00)	-	2 (20.00)	4.26	9,556
Large	-	-	1 (12.50)	-	1 (10.00)	3.29	10500
Total	2 (100.00)	-	8 (100.00)	-	10 (100.00)	3.78	9,643
(Leasing-out)							
Marginal	-	-	-	-	-	-	-
Small	-	-	1 (33.33)	-	1 (33.33)	0.97	12,000
Medium	-	-	-	-	-	-	-
Large	-	-	2 (66.67)	-	2 (66.67)	19.20	11,071
Total	-	-	3 (100.00)	-	3 (100.00)	5.59	11,122

The practice of leasing-in and leasing-out of land was relatively more widely prevalent among soyabean crop cultivators as against tur crop cultivators. In general, while the average category of tur crop cultivators showed only 0.92 per cent of their net operated area as leased-in as well as leased-out, this proportion for soyabean crop cultivators was as much as 3.78 per cent in case of leased-in land and 5.59 per cent for the leased-out land. The fixed rent per acre was relatively higher for tur crop cultivators as against soyabean crop cultivators. Further, while none of the tur crop cultivators showed any cost sharing or crop sharing agreement during leasing-in land, this held true for soyabean crop cultivators when leasing-out land.

3.4 Sources of Irrigation

Details regarding extent of area under irrigation and sources of irrigation on the farms belonging to sampled tur crop cultivators and soyabean crop cultivators are provided separately in Table 3.7 and Table 3.8. These estimates for tur and soyabean farmers put together are brought out in Appendix 4.

In the case of tur crop cultivators, about 71 per cent of total irrigated area of average category of sampled farmers was under open well irrigation, 18 per cent under electric tube-well irrigation, 6 per cent under diesel tube-well irrigation, 4 per cent under canal plus tubewell irrigation and 1 per cent under canal irrigation (Table 3.7). The proportion of open well irrigated area increased with the increase in land holding size of tur crop cultivators. The proportion of open well irrigated area varied from 40 per cent for marginal category to 92 per cent for large category. On the contrary, the proportion of electric tube-well irrigated area decreased with the increase in land holding size of tur crop cultivators. The proportion of electric tube-well irrigated area varied from 8 per cent for large category to 37 per cent for marginal category. The proportion of diesel tube-well irrigated area varied from 6 per cent for small category to 10 per cent for marginal category of tur crop cultivators. These estimates clearly underscore the fact that the tur crop cultivators were mainly dependent on open well as their major source of irrigation.

Table 3.7: Source of irrigation of net irrigated area (%) for Tur Crop Farmers

Farm size	Irrigated area (acres)	Only canal	Canal + tube-well	Only electric tube-well	Only diesel tube-well	Tanks	Open well	Others
Marginal	20.50	2.75 (13.41)	-	7.50 (36.59)	2.00 (9.76)	-	8.25 (40.24)	-
Small	86.25	-	10.00 (11.59)	24.5 (28.41)	5.00 (5.80)	-	46.75 (54.20)	-
Medium	95.50	-	-	10.5 (10.99)	7.00 (7.33)	-	78.00 (84.68)	-
Large	50.00	-	-	4.00 (8.00)	-	-	46.00 (92.00)	-
Total	252.25	2.75 (1.09)	10.00 (3.97)	46.5 (18.43)	14.00 (5.55)	-	179.00 (70.96)	-

Note: Figures in parentheses are percentages to the total net irrigated area

The open well irrigation system also dominated on the farms belonging to soyabean crop cultivators. The average category of soyabean crop cultivators showed 66 per cent of their total irrigated area under open well irrigation, 17 per cent under canal irrigation, 11 per cent under canal plus tube-well irrigation, 1 per cent under diesel tube-well irrigation, 3 per cent under open well plus river irrigation and 1 per cent under river irrigation (Table 3.8). The proportion of open well irrigated area declined with the increase in land holding size of soyabean crop cultivators. The proportion of open well

irrigated area varied from 59 per cent for large category to 91 per cent for marginal category. The proportion of canal irrigated area varied from 16 per cent for medium category to 21 per cent for small category of soyabean crop cultivators. The third major source of irrigation was canal plus tube-well, which dominated on the farms belonging to large category of soyabean crop cultivators.

Table 3.8: Source of irrigation of net irrigated area (%) for Soyabean Crop Farmers

Farm size	Irrigated area (acres)	Only canal	Canal + tube-well	Only electric tube-well	Only diesel tube-well	Tanks	Open well	Open well+ River	Others (River)
Marginal	16.00	-	1.50 (9.37)	-	-	-	14.50 (90.63)	-	-
Small	87.50	18.50 (21.14)	-	-	3.50 (4.00)	-	65.50 (74.86)	-	-
Medium	103.00	16.50 (16.02)	7.50 (7.28)	-	-	-	65.00 (63.11)	10.00 (9.71)	4.00 (3.88)
Large	118.00	20.00 (16.95)	28.00 (23.73)	-	-	-	70.00 (59.32)	-	-
Total	324.50	55.00 (16.95)	36.99 (11.40)	-	3.51 (1.08)	-	215.01 (66.26)	10.00 (3.08)	3.99 (1.23)

Note: Figures in parentheses are percentages to the total net irrigated area

Thus, open well irrigation system dominated on the farms belonging to tur as well as soyabean crop cultivators. The other major source of irrigation was found to electric tube-well for tur crop cultivators and canal irrigation system for soyabean crop cultivators. The canal plus tube-well irrigation also played a crucial role on the farms belonging to soyabean crop cultivators, particularly for large category of farmers.

3.5 Cropping Pattern

Cropping pattern assumes considerable significance in determining farmer's net annual income through crop husbandry. Though farmers prefer to grow those crops that yield higher net returns, they are constrained to grow several high value field crops due to varied agro-climatic conditions as well as topography and soil type across various regions or within the same region. In general, the cropping pattern of irrigated area differs from the cropping pattern of un-irrigated area. While high value commercial field crops are usually grown under irrigated conditions, low value subsistence crops find place under rainfed conditions. However, there are several important course cereal, pulses and oilseed crops like *jowar*, *mung*, *tur*, *soyabean*, etc. that find place in terms of output and area allocation even under dry or rainfed conditions. The information on proportion of gross cropped area allocation under different crops grown under different seasons by the sampled tur and soyabean crop cultivators is provided in Table 3.9 and Table 3.10. The cropping pattern of tur and soyabean farmers put together is shown in Appendix 5.

In the case of tur crop cultivators, the cropping pattern was seen to be in favour of cultivating tur, soyabean, cotton, jowar, mung, *udid* and sunflower in kharif season and wheat gram and jowar in rabi season. Sugarcane, banana and Lucerne were cultivated as perennial crops by tur crop cultivators. The average category of tur crop cultivators showed 81 per cent of gross cropped area in kharif season, 15 per cent in rabi season and 4 per cent under perennial crops. During kharif season, the average category of tur crop cultivators showed 18 per cent of their gross cropped area under tur, 31 per cent under soyabean, 16 per cent under cotton, 8 per cent under jowar, 2 per cent under mung, 4 per cent under *udid*, 1 per cent under sunflower, and the remaining 2 per cent under other miscellaneous crops like rice, bajra, sesame, groundnut, maize, etc. In rabi season, the average category of tur crop cultivators showed 6 per cent of their gross cropped area under wheat, another 6 per cent under gram and 3 per cent under jowar. Sugarcane accounted for about 3 per cent share in gross cropped area for the average category of tur crop cultivators (Table 3.9). The selected sampled tur crop cultivators did not cultivate summer crops.

Table 3.9: Cropping Pattern of Selected Tur Crop Farmers (% of GCA for the whole year)

(in per cent)					
Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Tur	28.36	19.07	16.38	13.54	17.72
Soybean	24.65	26.01	25.57	48.99	30.88
Cotton	3.38	20.15	17.56	12.10	15.90
Jowar	6.38	6.16	9.10	7.49	7.52
Mung	2.13	1.62	2.55	2.02	2.08
Udid	9.22	4.69	2.18	3.17	3.87
Sunflower	1.77	1.17	0.91	1.44	1.19
Rice	0.71	0.00	0.36	0.00	0.19
Bajra	-	0.78	-	0.58	0.39
Sesame	-	0.39	-	-	0.13
Groundnut	-	0.59	-	-	0.19
Maize	-	-	1.09	-	0.39
Vegetable (Chilly and Coriander)	-	0.78	0.36	-	0.39
Total	76.60	81.42	76.07	89.34	80.86
Rabi crops					
Wheat	0.71	5.09	9.01	3.17	5.65
Gram	9.22	6.06	6.92	4.03	6.20
Jowar	12.06	3.13	2.73	1.15	3.36
Sunflower	-	-	0.36	-	0.13
Total	21.98	14.28	19.02	8.36	15.33
Perennial crops					
Sugarcane	1.42	4.30	3.46	2.31	3.29
Banana	-	-	1.27	-	0.45
Lucerne	-	-	0.18	-	0.06
Total	1.42	4.30	4.91	2.31	3.81
Gross cropped area	100.00	100.00	100.00	100.00	100.00

As for sampled soyabean crop cultivators, the cropping pattern was seen to be in favour of cultivating tur, soyabean, cotton, and jowar in kharif season and wheat and gram in rabi season. Pomegranate was found to be cultivated as perennial crop by small category of soyabean crop cultivators. The average category of soyabean crop cultivators showed 76 per cent of gross cropped area in kharif season and 24 per cent in rabi season. Summer crops were not seen to be cultivated by soyabean crop cultivators. In kharif season, the average category of soyabean crop cultivators showed 8 per cent of their gross cropped area under tur, 42 per cent under soyabean, 22 per cent under cotton, 3 per cent under jowar, and the remaining 1-2 per cent under other miscellaneous crops like mung, udid, rice, etc. In rabi season, the average category of soyabean crop cultivators showed 12 per cent of their gross cropped area under wheat, 11 per cent under gram and the remaining 1 per cent under jowar (Table 3.10). The perennial crop like pomegranate accounted for miniscule share in gross cropped area of soyabean crop cultivators.

Table 3.10: Cropping Pattern of Selected Soyabean Crop Farmers (% of GCA for the whole year)
(in per cent)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Tur	4.37	7.42	6.99	10.17	7.82
Soybean	58.33	38.86	45.04	36.72	41.68
Cotton	13.49	25.50	18.76	23.24	21.83
Jowar	0.79	3.67	2.12	2.49	2.64
Mung	-	0.52	0.18	0.41	0.34
Udid	-	0.61	0.35	0.83	0.54
Rice	0.79	1.40	-	1.45	0.92
Vegetable (Chilly and Turmeric)	-	0.09	1.24	0.41	0.54
Total	77.78	78.08	74.69	75.73	76.31
Rabi crops					
Wheat	12.70	14.76	11.86	10.37	12.46
Gram	9.52	6.64	13.27	12.66	10.66
Jowar	-	0.35	0.18	1.24	0.52
Total	22.22	21.75	25.31	24.27	23.63
Perennial crops					
Pomegranate	-	0.17	-	-	0.06
Total	-	0.17	-	-	0.06
Gross cropped area	100.00	100.00	100.00	100.00	100.00

Thus, both tur and soyabean crop cultivators showed major crops cultivated during kharif season. The crops that dominated the cropping pattern of both tur and soyabean crop cultivators were tur, soyabean, cotton and jowar in kharif season and wheat and gram in rabi season. Sugarcane was found to be one of the major perennial crop cultivated by all the categories of tur crop farmers.

3.6 Percentage of Area under HYV

The introduction of high yielding varieties (HYV) seeds in the aftermath of green revolution has led to significant production expansion of various crops cultivated in India. Majority of the states of India are now dependent on HYV seeds and the state of Maharashtra is not an exception to this phenomenon. The estimates relating to proportion of area under HYV seeds for various crops cultivated by sampled tur and soyabean farmers are provided in Table 3.11 and Table 3.12. These estimates for tur and soyabean crop farmers put together are brought out in Appendix 6.

In the case of tur crop cultivators, the area under HYV seeds for the average category of farmers was found to be 86 per cent for tur, 98 per cent for soyabean, 100 per cent for cotton, 97 per cent for kharif jowar, 67 per cent for mung, 90 per cent for udid, 100 per cent for kharif sunflower, 100 per cent for bajra, 100 per cent for sesame, 100 per cent for groundnut, 33 per cent for vegetables, 93 per cent for wheat, 79 per cent for gram, 38 per cent for rabi jowar, 100 per cent for rabi sunflower, and 100 per cent for sugarcane and banana (Table 3.11). Although the average category of tur crop cultivators showed 86 per cent of their tur crop area under HYV seeds, this proportion varied from 66 per cent for marginal category to 94 per cent for medium category.

Table 3.11: Percentage of area under HYV Seeds for Tur Crop Farmers

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Tur	66.25	84.62	94.44	89.36	85.98
Soybean	94.22	95.49	100.00	100.00	98.33
Cotton	99.79	100.00	100.00	100.00	100.00
Jowar	100.00	90.48	100.00	100.00	97.42
Mung	50.00	63.68	78.57	57.14	67.45
Udid	100.00	95.83	100.00	54.55	90.00
Sunflower	100.00	100.00	100.00	100.00	100.00
Rice	0.00	-	0.00	-	0.00
Bajra	-	100.00	-	100.00	100.00
Sesame	-	100.00	-	-	100.00
Groundnut	-	0.00	-	-	0.00
Maize	-	-	100.00	-	100.00
Vegetable (Chilly and Coriander)	-	50.00	0.00	-	33.33
Rabi crops					
Wheat	100.00	92.31	91.92	100.00	93.14
Gram	96.15	67.74	73.68	100.00	78.65
Jowar	35.29	87.50	0.00	0.00	38.46
Sunflower	-	-	100.00	-	100.00
Perennial crops					
Sugarcane	100.00	100.00	100.00	100.00	100.00
Banana	-	-	100.00	-	100.00
Lucerne	-	-	0.00	-	0.00

As for soyabean crop cultivators, the area under HYV seeds was 100 per cent for soyabean, cotton, kharif jowar, udid, rice, wheat and pomegranate (Table 3.12). However, the crops like tur, mung, vegetables and gram showed about 90 area under HYV seeds. The proportion of tur crop area under HYV seeds varied from 80 per cent for large category to 100 per cent for medium category of soyabean crop cultivators. The proportion of mung crop area under HYV seeds varied from 83 per cent for small category to 100 per cent for medium and large category of soyabean crop cultivators. Similarly, the proportion of gram crop area under HYV seeds varied from 83 per cent for marginal category to 100 per cent for medium category of soyabean crop cultivators.

Table 3.12: Percentage of area under HYV Seeds for Soyabean Crop Farmers

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Tur	81.82	84.71	100.00	79.59	87.18
Soybean	100.00	100.00	100.00	100.00	100.00
Cotton	100.00	100.00	100.00	100.00	100.00
Jowar	100.00	100.00	100.00	100.00	100.00
Mung	-	83.33	100.00	100.00	91.67
Udid	-	100.00	100.00	100.00	100.00
Rice	100.00	100.00	-	100.00	100.00
Vegetable (Chilly and Turmeric)	-	100.00	85.71	100.00	89.47
Rabi crops					
Wheat	100.00	100.00	100.00	100.00	100.00
Gram	83.33	89.47	100.00	83.61	91.40
Jowar	-	0.00	0.00	0.00	0.00
Perennial crops					
Pomegranate	-	100.00	-	-	100.00

Although both tur and soyabean crop farmers showed significantly high area under HYV seeds for various crops cultivated by them, this proportion was relatively high for soyabean crop cultivators as against the tur crop cultivators.

3.7 Crop Productivity, Marketed Surplus and Value of Output by Farm Size

The estimates relating to average productivity of various crops grown on the farms belonging to various categories of sampled tur and soyabean crop farmers are brought out in Table 3.13 and Table 3.14. These estimates for tur and soyabean farmers put together are shown in Appendix 7.

In the case of tur crop cultivators, the average yield of tur varied from 4.47 quintals per acre for marginal category to 4.72 quintals per acre for medium category with an average of 4.65 quintals per acre for the average category of farmers (table 3.13). The average yield of soyabean varied from 4.81 quintals per acre for small category to 5.07 quintals per acre for marginal category with an average of 4.99 quintals per acre for

the average category of farmers. Much wider variation in yield levels across various categories of farmers was noticed in the case of cotton and kharif jowar cultivated by tur crop farmers. In the case of cotton, the average yield varied from 4.21 quintals per acre for marginal category to 5.43 quintals per acre for large category with an average of 5.04 quintals per acre for the average category of farmers. As for kharif jowar, the average yield varied from 4.33 quintals per acre for marginal category to 5.31 quintals per acre for large category with an average of 4.83 quintals per acre for the average category of farmers. There was not much difference in productivity level of other crops cultivated by various categories of tur crop cultivators. In case of other crops, the average yield for average category of tur crop cultivators was estimated at 2.25 quintals per acre for mung, 2.23 quintals per acre for udid, 3.27 quintals per acre for kharif sunflower, 2.17 quintals per acre for rice, 2.08 quintals per acre for bajra, 1.00 quintal per acre for sesame, 5.33 quintals per acre for maize, 26.67 quintals per acre for vegetable, 5.87 quintals per acre for wheat, 4.82 quintals per acre for gram, 4.90 quintals for rabi jowar, 3.00 quintals per acre for rabi sunflower, 266.63 quintals per acre for sugarcane, 121.43 quintals per acre for banana, and 80.00 quintals per acre for Lucerne.

Table 3.13: Average Yield of Major Crops Grown by the Sampled Tur Crop Households
(Quintals per Acre)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Tur	4.47	4.69	4.72	4.60	4.65
Soybean	5.07	4.81	5.06	5.06	4.99
Cotton	4.21	4.85	5.12	5.43	5.04
Jowar	4.33	4.57	4.84	5.31	4.83
Mung	2.43	2.36	2.14	2.29	2.25
Udid	2.23	2.25	2.13	2.32	2.23
Sunflower	3.20	3.25	3.20	3.40	3.27
Rice	2.00	-	2.25	-	2.17
Bajra	-	2.00	-	2.25	2.08
Sesame	-	1.00	-	-	1.00
Groundnut	-	5.33	-	-	5.33
Maize	-	-	4.00	-	4.00
Vegetable (Chilly and Coriander)	-	30.00	20.00	-	26.67
Rabi crops					
Wheat	6.00	5.73	5.88	6.18	5.87
Gram	4.50	4.65	4.90	5.29	4.82
Jowar	4.82	4.69	5.20	5.00	4.90
Sunflower	-	-	3	-	3
Perennial crops					
Sugarcane	300.00	287.27	284.21	300.00	288.63
Banana	-	-	121.43	-	121.43
Lucerne	-	-	80.00	-	80.00

As for soyabean crop cultivators, the average yield of tur varied from 4.18 quintals per acre for marginal category to 5.12 quintals per acre for large category with an average of 4.69 quintals per acre for the average category of farmers (table 3.14). The average yield of soyabean varied from 5.43 quintals per acre for marginal category to 6.06 quintals per acre for large category with an average of 5.81 quintals per acre for the average category of farmers. The average yield of cotton varied from 5.82 quintals per acre to 6.46 quintals per acre for large category with an average of 6.31 quintals per acre for the average category of farmers. The average yield of kharif jowar also varied significantly from 5.00 quintals per acre for marginal category to 6.00 quintals per acre for medium and large category of farmers with an average of 5.94 quintals per acre for the average category of farmers. As for the other crops, the average yield for average category of soyabean crop farmers was estimated at 3.25 quintals per acre for mung, 3.11 quintals per acre for udid, 3.44 quintals per acre for rice, 30.95 per acre for vegetable, 5.46 quintals per acre for wheat, 4.15 quintals per acre for gram, 5.17 quintals for rabi jowar, and 55.00 quintals per acre for pomegranate.

Table 3.14: Average Yield of Major Crops Grown by the Sampled Soyabean Crop Households
(Quintals per Acre)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Tur	4.18	4.21	4.73	5.12	4.69
Soybean	5.43	5.60	5.92	6.06	5.81
Cotton	5.82	6.21	6.35	6.46	6.31
Jowar	5.00	5.91	6.00	6.00	5.94
Mung	-	3.50	3.00	3.00	3.25
Udid	-	3.00	3.00	3.25	3.11
Rice	4.00	3.38	-	3.43	3.44
Vegetable (Chilly and Turmeric)	-	32.00	30.00	34.00	30.95
Rabi crops					
Wheat	5.06	5.48	5.33	5.72	5.46
Gram	3.25	3.79	3.96	4.79	4.15
Jowar	-	5.00	4.50	5.33	5.17
Perennial crops					
Pomegranate	-	55.00	-	-	55.00

The foregoing estimates clearly underscore the fact that the soyabean crop cultivators had much higher average yield for various crops cultivated by them as against the tur crop cultivators. This held especially true for crops like soyabean, cotton, kharif and rabi jowar, mung, udid, rice and vegetables.

The estimates relating to proportion of output of various crops marketed by various categories of sampled tur and soyabean cultivators are provided separately in Table 3.15 and Table 3.16. These estimates for tur and soyabean crop farmers put together are brought out in Appendix 8.

The sampled tur crop cultivators were noticed to cultivate various crops on their farms mainly for the purpose of marketing since the proportion of output marketed for various crops for these farmers stood at very high, especially with respect to tur, soyabean, cotton, udid, sunflower, bajra, sesame, maize, vegetables, gram, sugarcane and banana. The proportion of output marketed by the average category of tur crop farmers was estimated at 81 per cent for tur, 41 per cent for kharif jowar, 67 per cent for mung, 90 per cent for udid, 46 per cent for rice, 80 per cent for bajra, 50 per cent for groundnut, 83 per cent for maize, 95 per cent for vegetables, 64 per cent for wheat, 86 per cent for gram, 62 per cent for rabi jowar, and 100 per cent for soyabean, cotton, kharif sunflower, sesame, rabi sunflower, sugarcane and banana (Table 3.15). In the case of tur crop, the proportion of output marketed varied from 80 per cent for small and medium category to 85 per cent for large category of farmers.

Table 3.15: Percentage of Output Marketed by the Selected Tur Crop Households

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Tur	83.33	80.20	80.24	85.19	81.49
Soybean	100.00	100.00	100.00	100.00	100.00
Cotton	100.00	100.00	100.00	100.00	100.00
Jowar	20.51	26.39	43.80	57.97	41.21
Mung	27.40	92.31	70.23	50.00	67.40
Udid	91.38	87.96	94.12	90.20	90.30
Sunflower	100.00	100.00	100.00	100.00	100.00
Rice	50.00	-	44.44	-	46.15
Bajra	-	100.00	-	44.44	80.00
Sesame	-	100.00	-	-	100.00
Groundnut	-	50.00	-	-	50.00
Maize	-	-	83.33	-	83.33
Vegetable (Chilly and Coriander)	-	96.67	90.00	-	95.00
Rabi crops					
Wheat	33.33	59.06	65.64	70.59	64.01
Gram	82.05	90.28	87.10	81.08	86.49
Jowar	51.22	64.00	69.23	70.00	61.96
Sunflower	-	-	100.00	-	100.00
Perennial crops					
Sugarcane	100.00	100.00	100.00	100.00	100.00
Banana	-	-	100.00	-	100.00
Lucerne	-	-	0.00	-	0.00

The soyabean crop cultivators also grew various crops mainly for the purpose of marketing since the proportion of output market for various crops by these farmers was quite high. The proportion of output marketed by the average category of soyabean crop farmers was estimated at 85 per cent for tur, 99.55 per cent for soyabean, 43 per cent for

kharif jowar, 90 per cent for mung, 51 per cent for rice, 92 per cent for vegetables, 74 per cent for wheat, 94 per cent for gram, 69 per cent for rabi jowar, and 100 per cent for cotton and pomegranate (Table 3.16). In fact, in the case of soyabean, the proportion of output marketed varied from 99 per cent for medium and large category to 100 per cent for marginal and small category of farmers.

Table 3.16: Percentage of Output Marketed by the Selected Soyabean Crop Households

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Tur	52.17	77.65	87.70	91.24	85.00
Soybean	100.00	100.00	99.40	99.07	99.55
Cotton	100.00	100.00	100.00	100.00	100.00
Jowar	-	37.10	50.00	50.00	43.22
Mung	-	90.48	100.00	83.33	89.74
Udid	-	100.00	100.00	100.00	100.00
Rice	-	66.67	-	41.67	50.91
Vegetable (Chilly and Turmeric)	-	87.50	92.38	91.18	91.84
Rabi crops					
Wheat	61.73	77.97	73.67	73.43	74.47
Gram	89.74	93.75	93.60	94.52	93.78
Jowar	-	60.00	133.33	62.50	68.82
Perennial crops					
Pomegranate	-	100.00	-	-	100.00

Thus, as against the tur crop farmers, the sampled soyabean crop cultivators were found to market relatively higher proportion of tur, rabi and kharif jowar, mung, udid, rice, wheat and gram. Further, the lower proportion of output marketed for some of the crops by the sampled tur and soyabean crop cultivators is an indication of the fact that they were mainly cultivating these crops for their own subsistence requirements.

Although various selected sampled farmers cultivated a large number of crops during various seasons of the year, the value of output and marketed surplus was estimated by aggregating all the crops cultivated by them. The estimates with respect to aggregated value of output and marketed surplus on per household and per acre basis for various categories of tur and soyabean cultivators are brought out in Table 3.17 and Table 3.18. These estimates for tur and soyabean farmers put together are shown in Appendix 9.

In the case of tur crop cultivators, the aggregated per household value of output was estimated at Rs.29,896 for marginal category, Rs.62,941 for small, Rs.1,25,076 for medium and Rs.2,20,260 for the large category of households with an average of Rs.83,632 for the average category of households (Table 3.17). These estimates showed an increase in value of output with the increase in land holding size of households. The

aggregated per acre value of output varied from Rs.11,448 for marginal category to Rs.13,295 for the small category with an average of Rs.12,959 for the average category of households. The aggregated per household value of marketed surplus was estimated at Rs.24,134 for marginal category, Rs.55,988 for small, Rs.1,09,866 for medium and Rs.2,00,615 for the large category of households with an average of Rs.73,893 for the average category of households. The aggregated per acre value of marketed surplus varied from Rs.9,242 for marginal category to Rs.11,827 for the small category with an average of Rs.11,450 for the average category of households. The average category of tur crop cultivator was found to market about 96 per cent of the quantity produced of various crops, which included perennial crops. However, when perennial crops were excluded, the average category of tur crop cultivator marketed about 88 per cent of the quantity produced with respect to various crops.

Table 3.17: Value of Output and Marketed Surplus (aggregate of all crops) for Tur Crop Farmers

	Value of output (main + byproduct)		Value of marketed surplus		% of output marketed (Including Perennial Crops)	% of output marketed (Excluding Perennial Crops)
	Rs Per household	Rs Per acre	Rs Per household	Rs Per Acre		
Marginal	29896	11448	24134	9242	90.37	80.71
Small	62941	13295	55988	11827	96.83	88.12
Medium	125076	13202	109866	11596	95.22	86.41
Large	220260	12695	200615	11563	96.82	92.20
Total	83632	12959	73893	11450	95.86	87.84

As for soyabean crop cultivators, the aggregated per household value of output was estimated at Rs.30,930 for marginal category, Rs.73,431 for small, Rs.1,31,373 for medium and Rs2,96,839 for the large category of households with an average of Rs.1,01,757 for the average category of households, showing thereby showed an increase in value of output with the increase in land holding size of households (Table 3.18). The aggregated per acre value of output varied from Rs.11,783 for marginal category to Rs.14,780 for the large category with an average of Rs.13,991 for the average category of households. The aggregated per household value of marketed surplus was estimated at Rs.28,145 for marginal category, Rs.68,566 for small, Rs.1,24,871 for medium and Rs.2,82,602 for the large category of households with an average of Rs.95,961 for the average category of households. The aggregated per acre value of marketed surplus varied from Rs.10,722 for marginal category to Rs.14,071 for the large category with an average of Rs.13,194 for the average category of households. The average category of soyabean crop cultivator was seen to market about 93 per cent of the quantity produced

of various crops, which included as well as excluded perennial crops. The inclusion and exclusion of perennial crops did not make much difference since only small category of soyabean crop cultivators marketed a small quantity of pomegranate.

Table 3.18: Value of Output and Marketed Surplus (aggregate of all crops) for Soyabean Crop Farmers

	Value of output (main + byproduct)		Value of marketed surplus		% of output marketed (Including Perennial Crops)	% of output marketed (Excluding Perennial Crops)
	Rs Per household	Rs Per acre	Rs Per household	Rs Per Acre		
Marginal	30930	11783	28145	10722	91.54	91.54
Small	73431	13853	68566	12935	92.32	90.60
Medium	131373	13951	124871	13261	94.38	94.38
Large	296839	14780	282602	14071	93.56	93.56
Total	101757	13991	95961	13194	93.30	92.75

The foregoing observations clearly underscore the fact that, as against the tur crop cultivators, the sampled soyabean crop cultivators not only showed higher aggregated value of output but also higher aggregated value of marketed surplus. This held true not only per household basis but also per acre basis. However, the proportion of quantity of output marketed was relatively higher for tur crop cultivators as against the soyabean crop cultivators when perennial crops were also included while estimating proportion of output market by various categories of households.

3.8 Summary

The demographic profile of sampled tur crop cultivators did not reveal much difference with respect to family size of households, which hovered at around 5-6 members per household across various land holding size categories. About 44 per cent of family members of tur crop cultivators were earners. The average family size of tur crop cultivators encompassed 42 per cent male members, 34 per cent female members and 24 per cent children. Majority of the respondents were head of the households, which held true for all the categories of tur crop cultivators. The average age of respondents was more than 25 years since 92 per cent of sampled respondents showed their age above 25 years. The education status of sampled tur crop cultivators revealed that majority of households were literate with 43 per cent households showing their education level up to secondary level, 18 per cent up to higher secondary level, and 29 per cent up to graduate and above. The caste profile showed that 51 per cent of sampled tur crop cultivators belonged to OBC category and 43 per cent to general category. The average annual family income of tur crop cultivators was found to be Rs.1,49,099. However, the family income increased with the increase in land holding size of households.

As for sampled soyabean crop cultivators, the family size varied from 5 to 8 across various land holding size categories with the average category showing 6 members in a family. About 50 per cent of family members of soyabean crop cultivators were earners. The average family size of soyabean crop cultivators consisted of 37 per cent male members, 33 per cent female members and 30 per cent children. About 81 per cent of respondents were head of the households. About 37 per cent of respondents showed their age between 25 to 40 and 61 per cent above 40 years of age. The literacy level of sampled soyabean crop cultivators was quite high as 23 per cent of them showed their education up to primary level, 33 per cent up to secondary level, 25 per cent up to higher secondary level, and 14 per cent up to graduation and above. The caste profile showed that 51 per cent of sampled soyabean crop cultivators belonged to OBC category, 32 per cent to SC, 4 per cent to ST, and 13 per cent to general category. The annual family income of average category of soyabean crop cultivator was estimated at Rs.1,32,599. The family income increased with the increase in land holding size of households.

The characteristics of operational holding did not reveal any significant difference between sampled tur crop cultivators and soyabean crop cultivators since the average size of owned land holding was estimated at 5.78 acres for tur crop cultivators and 5.99 acres for soyabean crop cultivators. However, the average category of soyabean crop cultivator showed relatively higher intensity of cropping as compared to the average category of tur crop cultivators. The intensity of cropping was estimated at 118 per cent for tur crop cultivators and 131 per cent for soyabean crop cultivators. The average category of soyabean crop cultivator also showed higher proportion of net operated area under irrigation. Further, while tur crop cultivators hardly showed any leased in and leased out land, a significant proportion owned land was leased out, particularly of large category of soyabean crop cultivators. The large category of soyabean crop cultivators also showed significant leased in land.

The nature of tenancy showed that none of sampled tur crop cultivators had any crop sharing or cost sharing agreement while leasing-in land. However, while leasing-out land, one small farmer had crop sharing agreement and another marginal farmer showed crop and cost sharing agreement. In fact, there were only three medium category of tur crop cultivators who leased-in land at fixed rent of Rs.12,154 per acre. In general, the average category of tur crop cultivator showed 0.92 per cent of net operated area under leased-in and similar proportion under leased-out. In the case of soyabean crop cultivators, none of the farmers had any crop sharing or cost sharing agreement while

leasing-out land. It was only in the case of two small category of soyabean crop cultivators who had crop sharing agreement while leasing-in land. In general, there were eight soyabean crop cultivators who leased-in land at fixed rent of Rs.9,643 per acre. Similarly, there were three soyabean crop cultivators who leased-out land at fixed rent of Rs.11,122 per acre. The proportion of tenancy in net operated area for soyabean crop cultivators was found to be 3.78 per cent in case of leased-in land and 5.59 per cent for leased-out land.

The open well irrigation system dominated on the farms belonging to tur and soyabean crop cultivators. The average category of tur crop cultivators showed 71 per cent of their total irrigated area under open well irrigation, 18 per cent under electric tube-well irrigation, 6 per cent under diesel tube-well irrigation, 4 per cent under canal plus tubewell irrigation and 1 per cent under canal irrigation. On the other hand, the average category of soyabean crop cultivators showed 66 per cent of their total irrigated area under open well irrigation, 17 per cent under canal irrigation, 11 per cent under canal plus tube-well irrigation, 1 per cent under diesel tube-well irrigation, 3 per cent under open well plus river irrigation and 1 per cent under river irrigation. Thus, aside from open well, the other major source of irrigation was electric tube-well for tur crop cultivators, and canal irrigation for soyabean crop cultivators.

The cropping pattern of sampled tur crop cultivators was seen to be in favour of cultivating tur, soyabean, cotton, jowar, mung, udid and sunflower in kharif season and wheat, gram and jowar in rabi season. Sugarcane, banana and Lucerne were cultivated as perennial crops by tur crop cultivators. The average category of tur crop cultivators showed 81 per cent of gross cropped area in kharif season, 15 per cent in rabi season and 4 per cent under perennial crops. Tur crop, in particular, showed 18 per cent share in gross cropped area of tur crop cultivators. As for the sampled soyabean crop cultivators, the cropping pattern was found to be in favour of cultivating soyabean, tur, cotton, and jowar in kharif season and wheat and gram in rabi season. The average category of soyabean cultivators showed 76 per cent of gross cropped area in kharif season and 24 per cent in rabi season. The share of soyabean crop in gross cropped area of average category of soyabean crop cultivator was found to be 42 per cent. In fact, both tur and soyabean crop cultivators showed about 50 per cent of their gross cropped area under tur and soyabean crops grown in kharif season.

The proportion of area under HYV seeds was significantly high for both tur and soyabean crop cultivators. In the case of tur crop cultivators, the area under HYV seeds

for the average category of farmers was found to be 86 per cent for tur, 98 per cent for soyabean, 97 per cent for kharif jowar, 67 per cent for mung, 90 per cent for udid, 33 per cent for vegetables, 93 per cent for wheat, 79 per cent for gram, 38 per cent for rabi jowar, and 100 per cent for cotton, kharif sunflower, bajra, sesame, maize, rabi sunflower, sugarcane and banana. As for soyabean crop cultivators, the area under HYV seeds for the average category of farmers was seen to be 87 per cent for tur, 92 per cent for mung, 89 per cent for vegetables, 91 per cent for gram, and 100 per cent for soyabean, cotton, kharif jowar, udid, rice, wheat and pomegranate. The sampled soyabean crop cultivators, therefore, showed higher area allocation under HYV seeds as against the sampled tur crop cultivators.

The productivity of various crops cultivated by sampled tur and soyabean crop farmers varied to some extent. In the case of tur crop cultivators, the average yield for the average category of farmers was estimated at 4.65 quintals per acre for tur, 4.99 quintals per acre for soyabean, 5.04 quintals per acre for cotton, 4.83 quintals per acre for jowar, 2.25 quintals per acre for mung, 2.23 quintals per acre for udid, 3.27 quintals per acre for kharif sunflower, 2.17 quintals per acre for rice, 2.08 quintals per acre for bajra, 1.00 quintal per acre for sesame, 5.33 quintals per acre for maize, 26.67 quintals per acre for vegetable, 5.87 quintals per acre for wheat, 4.82 quintals per acre for gram, 4.90 quintals for rabi jowar, 3.00 quintals per acre for rabi sunflower, 266.63 quintals per acre for sugarcane, 121.43 quintals per acre for banana, and 80.00 quintals per acre for Lucerne. As for the soyabean crop cultivators, the average yield for the average category of farmers was found to be 4.69 quintals per acre for tur, 5.81 quintals per acre for soyabean, 6.31 quintals per acre for cotton, 5.94 quintals per acre for kharif jowar, 3.25 quintals per acre for mung, 3.11 quintals per acre for udid, 3.44 quintals per acre for rice, 30.95 quintals per acre for vegetables, 5.46 quintals for wheat, 4.15 quintals per acre for gram, 5.17 quintals for rabi jowar, and 55.00 quintals per acre for pomegranate. Thus, soyabean crop cultivators showed higher productivity for almost all the crops cultivated by them as against the tur crop cultivators.

The sampled tur and soyabean crop cultivators were noticed to cultivate various crops on their farms mainly for the purpose of marketing since the proportion of output marketed for various crops for these farmers stood at very high. The proportion of output marketed by the average category of tur crop farmers was estimated at 81 per cent for tur, 41 per cent for kharif jowar, 67 per cent for mung, 90 per cent for udid, 46 per cent for rice, 80 per cent for bajra, 50 per cent for groundnut, 83 per cent for maize, 95 per cent

for vegetables, 64 per cent for wheat, 86 per cent for gram, 62 per cent for rabi jowar, and 100 per cent for soyabean, cotton, kharif sunflower, sesame, rabi sunflower, sugarcane and banana. As for the soyabean crop cultivators, the proportion of output marketed by the average category of farmers was 85 per cent for tur, 99.55 per cent for soyabean, 43 per cent for kharif jowar, 90 per cent for mung, 51 per cent for rice, 92 per cent for vegetables, 74 per cent for wheat, 94 per cent for gram, 69 per cent for rabi jowar, and 100 per cent for cotton and pomegranate. Thus, as against the tur crop farmers, the sampled soyabean crop cultivators were found to market relatively higher proportion of tur, rabi and kharif jowar, mung, udid, rice, wheat and gram.

The average category of tur crop cultivators showed the aggregated value of output at Rs.83,632 per household and Rs.12,959 per acre. The aggregated value of marketed surplus for these farmers was estimated at Rs.73,893 per household and Rs.11,450 per acre. About 96 per cent of the quantity of output of various crops was marketed by these tur crop cultivators. As for the soyabean crop cultivators, the aggregated value of output for the average category of farmer was estimated at Rs.95,961 per household and Rs.13,194 per acre. The aggregated value of marketed surplus for these farmers was estimated at Rs.95,961 per household and Rs.13,194 per acre. These soyabean crop cultivators were found to market about 93 per cent of the quantity of output of various crops produced by them.

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CHAPTER – IV

ASSESSMENT OF PRE HARVEST LOSSES OF TUR AND SOYABEAN CROPS

This chapter chiefly focuses on assessing constraints faced in the cultivation of tur and soyabean crops, incidences of pests and disease attack, magnitude of crop loss due to pests, diseases and weed infestation, methods of pests and diseases control adopted by various categories of sampled households, cost of chemicals, sources of information received by the households for of pests and diseases control, and household suggestions on minimizing pre-harvest losses.

4.1 Constraints Faced in Cultivation of Tur and Soyabean Crops

The sampled tur and soyabean crop cultivators faced several constraints in the cultivation of tur and soyabean crops mainly due to poor seed quality, water deficiency, pests and disease related problems, input costs, and output prices. Water deficiency was an obvious problem since both tur and soyabean cultivators belonged to rainfed area. The perceptions of the selected sampled households regarding constraints faced by them in the cultivation of tur and soyabean crops are brought out in Table 4.1 and Table 4.2.

About 10 per cent of the selected tur crop cultivators reported poor seed quality as an important problem faced by them in the cultivation of tur crop, whereas 4 per cent of households found this problem as most important and 37 per cent as least important. The major constraints relating to seed were poor germination, high prices, seed replacement, etc. About 20 of sampled tur crop cultivators reported water deficiency as the most important or an important problem in the cultivation of tur crop (Table 4.1). In this context, the major problem revolved around lack of irrigation facility, non-availability of water during rabi and summer seasons, decrease in water table due to low rainfall, etc. Another major problem confronted by tur crop cultivators was the pest and diseases. Majority of sampled tur crop cultivators showed concern for this problem. The constraints faced by tur crop cultivators in this respect were attack of Aphids, Pod borer, Plume moth, lack of information on pests and disease control, lack of information about use of pesticides, weedicides, loss of crop, poor growth of crop, high cost of pesticides, etc. Another problem confronted by tur crop cultivators was the high cost of input since about 42 per cent of tur crop cultivators showed their concern for this problem. The high prices of inputs led the tur crop cultivators to use limited quantity of inputs. High cost of machinery, seed cost, labour wages were cited as other problems relating to input. About

23 per cent of sampled tur crop cultivators cited low output price as the most important problem in the cultivation of tur crop. The farmers wanted a rise in output price of tur crop in view of rise in expenses on inputs.

Table 4.1: Constraints Faced in Cultivation of Tur Crop (percentage of households)

S. N.	Constraints	Most important	Important	Least important	Constraint faced.
1	Poor seed quality	4.10	10.24	36.67	a) Poor quality of seed b) Using local variety of seed c) Sometime poor seed germination d) High seed prices e) Every year requiring new seed
2	Water deficiency	22.05	18.90	23.33	a) Insufficient supply of water b) lack of irrigation facility c) Non availability of irrigation water in rabi season d) Shortage of water e) irregular electricity for water supply f) Decrease in water level due to low rainfall g) Water not enough during summer h) All season water deficiency
3	Pest and disease problems	27.18	47.24	6.67	a) Aphids problem; Pod borer problem b) Crop loss every year c) No proper information on pests and disease problems d) Plume moth problem e) No proper information about how to use pesticides, weedicide, etc. f) Pod borer problem; affecting crop growth; g) High cost of pesticides; poor quality of pesticides
4	High cost of inputs	24.10	18.11	33.33	a) Using limited quantity due to high price of inputs b) High cost of seed and labour c) Consistent rise in prices of inputs d) un-affordability of seed; high cost of machinery e) Limited use of inputs
5	Low output price	22.57	5.51	-	a) Need to increase tur price b) Low price of crop c) Selling produce at district headquarters d) All expenditure not recovered

The soyabean crop cultivators also faced various constraints in the cultivation of soyabean crop. Poor seed quality was cited as an important problem by 10 per cent of sampled soyabean cultivators (Table 4.2). Due to poor seed quality the germination was low. Since soyabean crop cultivators mainly belonged to dry land areas, water deficiency was one of the major problems faced by them. About 22 per cent of sampled soyabean crop cultivators showed their concern for water deficiency in the cultivation of soyabean crop. Water deficiency was mainly due to lack of irrigation facility and shortage of rainfall. Another major problem confronted by soyabean crop cultivators was the attack of pests and diseases. Majority of the soyabean cultivators showed their concern for this problem. About 22 per cent of soyabean crop cultivators reported high cost of input as the most important constraint, and another 22 per cent cited it as an important constraint in the cultivation of soyabean crop. Due to high cost of inputs, farmers were constrained to

use limited quantity of inputs. About 29 per cent of soyabean crop cultivators cited low output price of soyabean as the most important problem faced by them in the cultivation of soyabean crop, especially after the harvest. They demanded rise in output prices owing to rise in input prices in the cultivation of soyabean crop.

Table 4.2: Constraints Faced in Cultivation of Soyabean Crop (percentage of households)

S. N.	Constraints	Most important	Important	Least important	Constraint faced.
1	Poor seed quality	1.82	9.82	18.18	a) Poor germination b) Some seeds do not grow c) Sometimes low quality seed
2	Water deficiency	5.45	16.07	4.55	a) Lack of irrigation facility b) Insufficient water in rabi season c) Shortage of rainfall
3	Pest and disease problems	41.21	41.07	22.72	a) Rise in pest and disease problems every year b) Caterpillar attack on soybean
4	High cost of inputs	22.42	22.32	50.00	a) Unable to apply proper doses b) Limited use of input c) High fertilize and pesticides prices
5	Low output price	29.10	10.72	4.55	a) Low prices at the time of harvest b) No rise in soyabean output price despite rise in input price

In general, both tur and soyabean crop cultivators reported water deficiency and pests and disease problem as the major constraints faced by them in the cultivation of these important crops. The problem related to water deficiency was obvious to expect as these farmers belonged to dry land or rainfed area. The consistent rise in input prices and relatively lower increase in output prices was also cited some of the other problems faced by tur and soyabean crop cultivators.

4.2 Assessment of Incidences of Pests and Disease Attack and Crop Losses

All the sampled tur and soyabean crop cultivators were seen to identify the incidence of pests and disease attack on the selected tur and soyabean crops. The perceptions of sampled tur and soyabean crop cultivators in respect of identifying pests and disease attacks on tur and soyabean crops are brought out in Table 4.3.

Table 4.3: Identification of pests and disease attack (percentage of households)

Description		Crop – I: Tur	Crop - Soybean
HH able to distinguish pests and disease attack		100.00	100.00
Assessment about the severity of the attack	Quantitative assessment	8.33	15.00
	Qualitative assessment	65.00	59.17
	Both	26.67	25.83

The sampled tur crop cultivators were able to assess the severity of pests and disease attack on their tur crop, and 8 per cent among them could assess the severity

quantitatively, 65 per cent assessed it qualitatively, and the remaining 27 per cent could do both quantitative and qualitative assessment in this respect. Similarly, in the case of sampled soyabean crop cultivators, about 15 per cent of sampled households could do quantitative assessment of severity of pests and disease attack, 59 per cent could assess it qualitatively and the remaining 26 per cent were able to do both quantitative and qualitative assessment in this respect. Thus, majority of tur and soyabean crop cultivators were able to do both quantitative and qualitative assessment about the severity of pests and disease attack on their tur and soyabean crops. However, higher proportion of sampled soyabean crop cultivators could do quantitative assessment of severity of pests and disease attack on soyabean crop as against the tur crop cultivators.

The perceptions of sampled tur and soyabean crop cultivators regarding incidence of prevalence of pests and diseases, and also weed attack were recorded, and their perceptions with respect to severity, frequency of attack and loss of production of crop are brought out in Table 4.4 for tur crop and in Table 4.5 for soyabean crop.

A critical analysis into perceptions of sampled tur crop cultivators regarding pest attack on their crop revealed Pod Borer, Tur Pod Fly, and Aphids as the very important pests affecting the local as well as HYV variety of tur crop production (Table 4.4). Majority of the tur crop cultivators reported these pests as very important or important since these pests affected their tur crop production almost once in every season or once in two seasons. The other important pests that affected the HYV variety of tur crop were Plume Moth and Stem Fly, which also affected the crop almost once in every season or once in two seasons. Due to the prevalence of these pests, about 1-10 per cent of tur crop production was reported to be lost. The proportion of loss of tur crop production due to Pod Borer attack was reported to be even higher than 10 per cent. The major diseases affecting the tur crop production, both local and HYV variety, were reported to be Leaf spot, Dry root rot, Fusarium wilt, and Yellow mosaic. These diseases were reported to be very important or important since they affected tur crop production almost once in every season or once in two seasons. Another important disease affecting HYV variety of tur crop was reported to be Sterility mosaic, which affected the crop once in every season or once in two seasons. The disease infestation was more in case of HYV variety as compared to local variety of tur. The tur crop cultivators were reported to lose 1-10 per cent of tur crop production due to the prevalence of these diseases. Some of the sampled tur crop cultivators even reported higher proportions of loss of local variety of tur crop production, especially due to the prevalence of Leaf spot and Yellow mosaic diseases.

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

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 – Local variety											
Pod Borer	70.59	75.00	-	93.33	6.67	-	66.67	6.67	6.67	13.33	6.67
Plume Moth	-	-	-	-	-	-	-	-	-	-	-
Stem Fly	-	-	-	-	-	-	-	-	-	-	-
Tur Pod Fly	23.53	25.00	-	60.00	20.00	20.00	80.00	20.00	-	-	-
Aphids	5.88	-	-	100.00	-	-	100.00	-	-	-	-
Major Pests - HYV variety											
Pod Borer	65.88	58.93	42.86	81.52	18.48	-	27.17	25.00	35.87	10.87	1.09
Plume Moth	-	3.57	-	50.00	50.00	-	50.00	50.00	-	-	-
Stem Fly	-	14.29	-	37.50	50.00	12.50	62.50	37.50	-	-	-
Tur Pod Fly	18.82	16.07	-	84.00	12.00	4.00	76.00	24.00	-	-	-
Aphids	15.29	7.14	57.14	57.14	38.10	4.76	66.67	19.05	9.52	4.76	-
Major Diseases – Local variety											
Leaf Spot	9.09	66.67	-	100.00	-	-	66.67	-	-	-	33.33
Dry root rot	54.55	33.33	-	42.86	57.14	-	28.57	71.43	-	-	-
Fusarium Wilt	27.27	-	-	100.00	-	-	-	100.00	-	-	-
Powdery mildew	-	-	-	-	-	-	-	-	-	-	-
Sterility mosaic Disease	-	-	-	-	-	-	-	-	-	-	-
Yellow mosaic	9.09	-	-	-	100.00	-	-	-	-	-	100.00
Major Diseases – HYV variety											
Leaf Spot	24.59	58.62	42.86	46.15	48.08	5.77	65.38	28.85	5.77	-	-
Dry root rot	50.82	27.59	57.14	80.39	19.61	0.00	23.53	74.51	1.96	-	-
Fusarium Wilt	19.67	5.17	-	60.00	33.33	6.67	40.00	60.00	0.00	-	-
Powdery mildew	-	-	-	-	-	-	-	-	-	-	-
Sterility mosaic Disease	1.64	1.72	-	50.00	50.00	-	-	100.00	-	-	-
Yellow mosaic	3.28	6.90	-	50.00	50.00	-	66.67	33.33	-	-	-
Major Weeds – Local variety											
Spreading dayflower	11.11	35.00	-	87.50	12.50	-	25.00	50.00	25.00	-	-
Large crabgrass	55.56	35.00	-	91.67	8.33	-	50.00	25.00	25.00	-	-
Crowfoot grass	33.33	30.00	-	100.00	-	-	55.56	33.33	11.11	-	-
Major Weeds – HYV variety											
Spreading dayflower	16.42	16.46	22.22	81.82	18.18	-	65.91	29.55	4.55	-	-
Large crabgrass	31.34	26.83	29.63	76.71	23.29	-	63.01	35.62	1.37	-	-
Crowfoot grass	11.94	18.90	14.81	89.74	10.26	-	35.90	61.54	2.56	-	-
Indian helioptrope	40.30	37.80	33.33	93.02	6.98	-	39.53	53.49	6.98	-	-

Note: * very important=1; important=2; not important=3

** every season=1; once in two seasons=2; once in three seasons=3

*** <5%=1; 5-10%=2; 10-25%=3; 25-50%=4; >50%=5

The major weeds affecting the tur crop were Spreading dayflower, large crabgrass, and Crowfoot grass in case of both local and HYV variety. Another weed affecting the HYV variety of tur crop was Indian helioptrope. These weeds were reported to be very important or important since in most of the cases the frequency of attack of these weeds was almost once in every season. The extent of loss of tur crop production due to the prevalence of these weeds was reported to be 1-10 per cent. In the case of local variety of tur crop, a significant section of sampled tur crop cultivators even reported loss of tur crop to the extent of beyond 10 per cent of production.

A further analysis drawn from incidence of prevalence of pest, disease and weeds attack on soyabean crop revealed quite interesting observations in terms of severity, frequency of attack and crop loss on account of these problems. The major pests that affected the soyabean crop production were reported to be Hairy caterpillar, Tobacco Caterpillar, Thrips, Gram pod borer, and Girdle beetle/stem (Table 4.5). Majority of the sampled soyabean crop cultivators reported these pests as very important or important since the frequency of attack of these pests was almost once in every season, though some soyabean crop cultivators found these pests attack once in two seasons. It is to be further noted that the sampled soyabean crop farmers only grew high yielding variety (HYV) of soyabean crop, and, therefore, the estimates brought out in Table 4.5 mainly pertain to HYV only.

Table 4.5: Incidence of major pests and disease (percentage of households) – Soyabean

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 - HYV variety											
Hairy caterpillar	38.12	34.29	25.00	96.39	3.61	-	28.92	37.35	32.53	1.20	-
Tobacco Caterpillar	38.67	28.57	37.50	97.59	2.41	-	6.02	32.53	61.45	-	-
Thrips	4.42	20.00	25.00	58.82	41.18	-	29.41	70.59	-	-	-
Gram pod borer	0.55	8.57	-	75.00	25.00	-	25.00	75.00	-	-	-
Girdle beetle/stem borer	18.23	8.57	12.50	89.19	10.81	-	32.43	54.05	13.51	-	-
Major Diseases – HYV variety											
Leaf spot	42.86	76.67	66.67	25.58	69.77	4.65	53.49	46.51	-	-	-
Pod blight	2.38	6.67	-	33.33	66.67	-	66.67	33.33	-	-	-
Bacterial blight	-	10.00	-	-	100.00	-	33.33	66.67	-	-	-
Aerial blight/web blight	-	-	-	-	-	-	-	-	-	-	-
Charcoal rot/ stem blight/ dry root rot	-	3.33	33.33	50.00	50.00	-	-	50.00	50.00	-	-
Soybean mosaic virus	54.76	3.33	-	95.83	4.17	-	79.17	20.83	-	-	-
Major Weeds – HYV variety											
Echinochloa spp (Sanwa Grass),	8.50	16.90	45.00	91.30	6.52	2.17	71.74	23.91	4.35	-	-
Dinebra Arabica (Karna Grass)	17.65	14.08	-	93.62	6.38	-	53.19	46.81	-	-	-
Cynodon dactylon (Doob Grass)	10.46	11.97	10.00	91.43	8.57	-	22.86	65.71	11.43	-	-
Eleusine indica (Goose Grass),	31.37	26.06	15.00	78.41	21.59	-	42.05	54.55	3.41	-	-
Digitaria sanguinalis (Crab Grass)	13.73	17.61	10.00	95.83	4.17	-	27.08	72.92	-	-	-
Hemarthria compressa (Sattu),	18.30	13.38	20.00	84.31	9.80	5.88	41.18	52.94	5.88	-	-

Note: * very important=1; important=2; not important=3

** every season=1; once in two seasons=2; once in three seasons=3

*** <5%=1; 5-10%=2; 10-25%=3; 25-50%=4; >50%=5

The soyabean crop production loss on account of prevalence of various pests was reported to be 1-10 per cent. In some cases, the sampled soyabean crop cultivators even reported more than 10 per cent of loss of soyabean crop production due to these pests. The major diseases reported to be affecting soyabean crop production were Leaf spot, Pod blight, Bacterial blight, and Soybean mosaic virus. Another major disease affecting the soyabean crop production was Charcoal rot/ stem blight/ dry root rot, though found important by 3 per cent and not important by another 33 per cent of sampled soyabean crop cultivators. Most of these diseases were reported to affect the soyabean crop either once in every season or once in two seasons. The soyabean crop production loss due to the prevalence of these diseases was to the extent of 1-10 per cent. A number of weeds were also reported to attack soyabean crop production. The weeds affecting the soyabean crop production were Sanwa Grass, Karna Grass, Doob Grass, Goose Grass, Crab Grass, and Sattu. These weeds were reported to be very important or important since they affected the crop once in every season or once in two seasons. The loss of soyabean crop production due to the prevalence of these weeds was 1-10 per cent, and in some case beyond 10 per cent. Therefore, the pests, disease and weeds put together significantly affected soyabean crop production. It was not only soyabean but tur crop production was lost due to the frequent attacks of pests, diseases and weeds. The extent of loss of production of tur and soyabean crop was reported to be substantial since in majority of cases it was reported to be 1-10 per cent of total production of the crop.

The magnitude of crop loss due to various pests, diseases and weeds infestation for various categories of sampled farmers is presented in Table 4.6 for tur crop and in Table 4.7 for soyabean crop.

In the case of tur crop, the magnitude of tur crop production loss in relation to normal production was estimated at 0.39 quintals per acre for marginal category, 0.37 quintals per acre for small, 0.40 quintals per acre for medium, and 0.40 quintals per acre for large category with an average of 0.38 quintals per acre for the average category of tur crop cultivators in case of local variety and 0.49 quintals per acre for marginal category, 0.61 quintals per acre for small, 0.66 quintals per acre for medium, and 0.70 quintals per acre for large category with an average of 0.63 quintals per acre for the average category of tur crop cultivators for HYV variety (Table 4.6). The proportion of tur crop production loss with respect to actual production, therefore, translated into 9.24 per cent for marginal category, 8.60 per cent for small, 9.09 per cent for medium, and 9.09 per cent for large category with an average of 8.84 per cent for the average category

of tur crop cultivators in case of local variety and 10.65 per cent for marginal category, 12.82 per cent for small, 13.92 per cent for medium, and 15.15 per cent for large category with an average of 13.38 per cent for the average category of tur crop cultivators for HYV variety. The proportion of tur crop production loss in relation to normal production translated into 8.46 per cent for marginal category, 7.92 per cent for small, 8.33 per cent for medium, and 8.33 per cent for large category with an average of 8.12 per cent for the average category of tur crop cultivators in case of local variety, and 9.63 per cent for marginal category, 11.38 per cent for small, 12.22 per cent for medium, and 13.16 per cent for large category with an average of 11.80 per cent for the average category of tur crop cultivators for HYV variety. These estimates clearly show an increase proportion of tur crop production loss with the increase in land holding size of tur crop cultivators.

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

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

All the sampled soyabean crop cultivators were noticed to cultivate only HYV variety of soyabean. The magnitude of soyabean crop production loss in relation to normal production was estimated at 0.56 quintals per acre for marginal category, 0.61 quintals per acre for small, 0.69 quintals per acre for medium, and 0.80 quintals per acre for large category with an average of 0.68 quintals per acre for the average category of soyabean crop cultivators (Table 4.7). Therefore, the proportion of soyabean crop production loss in relation to actual production was worked out at 10.31 per cent for marginal category, 10.89 per cent for small, 11.66 per cent for medium, and 13.20 per cent for large category with an average of 11.70 per cent for the average category of soyabean crop cultivators. The proportion of soyabean crop production loss with respect to normal production translated into 9.35 per cent for marginal category, 9.82 per cent for small, 10.44 per cent for medium, and 11.66 per cent for large category with an average of 10.48 per cent for the average category of soyabean crop cultivators. The soyabean crop cultivators also showed rising proportion of soyabean crop production loss with the increase in land holding size of farmers.

Table 4.7: The magnitude of crop loss due to pests, disease and weed infestation- Soyabean

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

In general, the proportion of tur crop production loss in relation to actual production on account of various pests, diseases and weeds varied from 8.60 per cent for small category to 9.24 per cent for marginal category in case of local variety, and from 10.65 per cent for marginal category to 15.15 per cent for large category for HYV variety. The proportion of tur crop production loss in relation to normal production varied from 7.92 per cent for small category to 8.46 per cent for small category in case of local variety, and from 9.63 per cent for marginal category to 13.16 per cent for large category for HYV variety. Similarly, the proportion of soyabean crop production loss in relation to actual production on account of various pests, diseases and weeds varied from 10.31 for marginal category to 13.20 per cent for large category. The proportion of soyabean crop production loss in relation to normal production varied from 9.35 for marginal category to 11.66 per cent for large category. In case of HYV variety, the tur crop cultivators showed higher proportion of loss of production as compared to soyabean crop cultivators.

4.3 Methods of Pests and Diseases Control Adopted by the Sampled Households

In order to control the infestation of pests, diseases and weeds, the sampled tur and soyabean farmers used various chemical methods. The estimates relating to cost of chemicals used, labour charges, number of sprays with respect to weedicide, insecticide and fungicide for various categories of tur and soyabean crop cultivators are furnished in Table 4.8 and Table 4.9.

In the case of tur crop cultivators, the per acre total cost of weedicide varied from Rs.1,026 for small category to Rs.993 for the large category with an average of Rs.1,013 for the average category of farmers (Table 4.8). The per acre cost of insecticide varied from Rs.1,595 for marginal category to Rs.1,856 for the medium category with an average of Rs.1,709 for the average category of tur crop farmers. The per acre total cost of fungicide was relatively low, and it varied from Rs.485 for small category to Rs.633

for the marginal category with an average of Rs.532 for the average category of tur crop farmers. All the categories of sampled tur crop cultivators used around 2 sprays of weedicide, insecticide and fungicide in order to control infestation of various pests, diseases and weeds on their farm.

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

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

The sampled soyabean crop cultivators also used various chemical methods to control infestation of pests, diseases and weeds on their farm by using various weedicide, insecticide and fungicide. The sampled soyabean crop cultivators showed the per acre cost of weedicide to vary from Rs.1,357 for marginal category to Rs.1,581 for the large category with an average of Rs.1,443 for the average category of farmers (Table 4.9). The per acre cost of insecticide varied from Rs.848 for marginal category to Rs.1,135 for the large category with an average of Rs.968 for the average category of soyabean crop farmers. The cost of weedicide and insecticide increased with the increase in land holding size of soyabean crop cultivators.

Table 4.9: Cost of Chemical methods adopted for pests and disease control (Rs/acre): Soyabean

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

The sampled soyabean crop cultivators also showed lowest per acre cost for fungicide, which varied from Rs.548 for medium category to Rs.648 for the large category with an average of Rs.583 for the average category of farmers. The sampled soyabean crop cultivators used 1-2 sprays per acre of various chemicals to control pests, diseases and weeds attack on their farms.

In general, while the per acre cost of insecticide was higher for tur crop cultivators, the soyabean crop cultivators showed higher per acre cost of weedicide as against sample tur crop cultivators. Further, the per acre insecticide cost increased with the land holding size of both tur and soyabean crop cultivators. The soyabean crops cultivators also showed rise in per acre cost of weedicide with the increase in their land holding size. The sampled tur and soyabean crop cultivators showed lowest per acre cost on fungicide as against weedicide and insecticide.

It is to be further noted that some of the sampled tur and soyabean crop cultivators used some biological methods to control pests and diseases on their farms. The information relating to biological methods used by sampled tur and soyabean crop cultivators to control pests and diseases is furnished in Table 4.10.

Table 4.10: Details of biological methods adopted for pests and disease control

Item	Crop – I (Tur)		Crop – II (Soyabean)	
	Percentage of HH adopted this method	Details about the method	Percentage of HH adopted this method	Details about the method
Biological methods	13.33	Used Trichoderma, Nimboli Ark	5.83	Used Nimboli Ark, Humic Acid
Other Control measures	1	Shaken tur crop and collected insects	0.83	Shaken Soyabaen crop and collected insects
	2	-	-	-

About 13 per cent of sampled tur crop cultivators used Trichoderma and Nimboli Ark on their farms as biological methods to control infestation of pests and diseases. Similarly, about 6 per cent of sampled soyabean crop cultivators used Nimboli Ark and Humic Acid on their farms to control infestation of pests and diseases. The other control measures adopted by sampled farmers included shaking of tur and soyabean crops to collect insects, which was adopted by 7 per cent of tur crop cultivators and nearly 1 per cent of soyabean crop cultivators. Thus, the sampled tur and soyabean crop cultivators adopted all possible means to control infestation various pests, diseases and weeds on their farms, which not only included chemical methods but also biological methods. However, lower proportion of soyabean crop cultivators used various biological methods.

4.4: Sources of Information for Pests and Disease Control by the Selected Households

All the sampled tur and soyabean crop cultivators were found to receive advise on pests and disease control measures from various sources, which included government extension agents, private input dealers, fellow farmers, TV, radio service/newspaper, and agricultural university/KVK. The perceptions of the sampled tur and soyabean crop cultivators regarding source of advise on pests and disease control measures and details of advise in this respect are brought out in Table 4.11.

Table 4.11: Extension services on pests and disease control management (percentage of hh)

	Crop – I (Tur)				Crop – II (Soyabean)			
Percentage of HH seeking advice	100.00				100.00			
Sources of advice								
Rank of sources	Most imp	Impor-tant	Least imp	Details of advice	Most imp	Impor-tant	Least imp	Details of advice
Government extension agent	32.68	32.11	21.42	a) Share information about crop cultivation b) Organise workshop on Tur crop cultivation	35.16	32.73	16.67	a) Given demonstration on pest management b) Given information on fertilizer and other inputs
Private input dealer	47.52	21.10	17.86	a) Use of insecticides & pesticides b) Information about new pesticides	62.64	40.00	33.33	a) They suggest use of pesticides b) Provide information about new pesticide
Fellow farmers	19.80	44.95	46.43	a).Share information on pesticide use b) Provide general information	2.20	27.27	50.00	a) Share experience on pesticide use b) Give information on cultivation of crop
TV/Radio service/Newspaper	-	0.92	14.29	a) New varieties, diseases, insecticide & pesticide use b) Farm problems and govt. plan & initiatives	-	-	-	No information
Agricultural University/KVK	-	0.92	-	a) Got advice on the farmers' problems through Kisan call center	-	-	-	No information
Any other	-	-	-		-	-	-	-

In the case of tur crop cultivators, government extension agent was one of the sources of advise on pests and disease control measures, and 33 per cent of sampled households found it most important and 32 per cent of households considered it as important source of advise (Table 4.11). Another source of advise was private input dealer, which was perceived to be most important source of advise by 48 per cent of households and an important source of advise by 21 per cent of households. About 45 per cent of sampled tur crop cultivators considered fellow farmers as an important source of advise on pests and disease control measures. Interestingly, only 1 per cent of sampled tur crop cultivators considered agricultural university/KVK as an important source of advice

on pests and disease control measures. These sources provided information to the sampled farmers relating to use of insecticides, pesticides, government plans and initiatives, crop cultivation practices, etc.

The sampled soyabean crop cultivators received advise on pests and disease control measures from government extension agents, private input dealers, and fellow farmers. About 35 per cent of sampled soyabean crop cultivators found government extension agent as the most important source of advise on pests and disease control measures, whereas 33 per cent of soyabean crop cultivators considered it as an important source of advise. Similarly, about 63 per cent of sampled soyabean crop cultivators found private input dealer as the most important source of advise on pests and disease control measures, whereas 40 per cent of soyabean crop cultivators considered it as an important source of advise. Another source of advise on pests and disease control measure was the fellow farmers, which was considered as an important source of advise by 27 per cent of soyabean crop cultivators. The soyabean crop cultivators did air any view in terms of receiving any advise on pests and disease control measures from TV, radio service/newspaper, and agricultural university/KVK. The advise received by soyabean crop cultivators was in terms of use of pesticides, cultivation of crop, use of fertilizer and other inputs, demonstration conducted by government officials on pest management, etc.

4.5 Household Suggestions on How to Minimize Pre Harvest Losses

The suggestion of sampled tur and soyabean crop cultivators regarding minimization of pre-harvest losses of the crop on their farms were recorded and their suggestions in this respect are brought out in Table 4.12.

Table 4.12: Household Suggestion on Minimizing Pre-Harvest Losses

Sr. No.	Tur Crop Cultivators	Soyabean Crop Cultivators
1.	Proper guidance on pests and disease control measures	Proper guidance on pests and disease control measures
2.	Use of insecticides, pesticides and weedicides	Use of insecticides, pesticides and weedicides
3.	Subsidy on insecticides, pesticides and weedicides in order to use adequate doses	Timely and early harvesting of crop
4.	Timely availability of pesticides and reduction in prices	Adequate doses of insecticides and pesticides
5.	Need protection from wild animals to reduces losses	Need protection from wild animals to reduces losses
6.	Early identification and detection of pests, diseases and weeds problem to minimize losses	Timely use of insecticides, pesticides and weedicides
7.	Provision of better irrigation facilities	Use trichoderma for soybean
8.	Purchase of better quality of seeds, intercropping and use of insecticides	
9.	Proper care during the growth of crop	
10.	Timely use of insecticides, pesticides and weedicides	
11.	Soil testing on farms	

In order to minimize pre-harvest losses, the suggestion of sampled tur crop cultivators mainly revolved around extension of proper guidance on pests and disease control measures, adequate and timely use of insecticides, pesticides and weedicides, timely availability of pesticides and reduction in prices, an element of subsidy on insecticides, pesticides and weedicides in order to use adequate doses, protection from wild animals, soil testing on farm, adequate care during growth of crop, etc. The suggestions of sampled soyabean crop cultivators to minimize pre-harvest losses revolved around extension of proper guidance on pests and disease control measures, adequate doses and timely use of insecticides, pesticides and weedicides, timely and early harvesting of crop, protection from wild animals, and use of trichoderma. Interestingly, a large number of sampled tur and soyabean crop cultivators showed concern for wild animals that were destroying their crop and causing considerable pre-harvest losses of the crop. Therefore, their suggestion also revolved around protection from wild animals to minimize pre-harvest losses of crop.

4.6 Summary

A critical analysis relating to perceptions of farmers regarding constraints faced by them in the cultivation of tur and soyabean crops revealed poor seed quality, water deficiency, pest and diseases, high cost of inputs and low output prices as the major problems faced in the cultivation of selected crops. About 14 per cent of tur crop cultivators reported poor seed quality as the most important or an important problem in the cultivation of crop. Water deficiency was shown as the major cause of concern by nearly 40 per cent of tur crop cultivators. Nearly 75 per cent of tur crop cultivators perceived pests and diseases as the most important or an important problem in the cultivation of crop. About 42 per cent of sampled tur crop cultivators reported high cost of input as the major constraint in cultivation of tur crop. Low output prices was cited as the other problem by about 30 per cent of the tur crop cultivators. As for the soyabean crop cultivators, about 11 per cent of households reported poor seed quality as the most important or an important constraint in the cultivation of soyabean crop. Water deficiency was cited as the major constraint by 21 per cent of soyabean crop cultivators. About 82 per cent of households reported pests and diseases as the major constraint in the cultivation of soyabean crop. A significant section of sampled soyabean crop cultivators showed their concern for high cost of inputs and low output prices for soyabean crop.

As for the identification and assessment of severity of pests and disease attack, about 8 per cent of the sampled tur crop cultivators were able to assess attack

quantitatively, 65 per cent assessed it qualitatively and the remaining 27 per cent could do both quantitative and qualitative assessment. In the case of soyabean crop cultivators, about 15 per cent of sampled households were able to assess the severity of pests and disease attack quantitatively, 59 per cent could do qualitative assessment and the remaining 26 per cent assessed it both quantitatively and qualitatively. Thus, majority of sampled tur and soyabean crop cultivators were able to do qualitative as well as quantitative assessment about severity of pests and disease attack on their crops.

An analysis with respect to perceptions of sampled tur crop cultivators regarding incidence of major pests and disease revealed that Pod Borer in the case of local variety and Pod Borer as well as Tur Pod Fly and Aphids for HYV variety were the major pests affecting their tur crop. These pests were found to attack tur crop almost once in every season. Majority of the sampled tur crop cultivators reported about 5 per cent loss of tur crop production on account of these pests attack. As for the disease, Leaf spot, Dry root rot, Fusarium wilt, and Yellow mosaic were the major diseases affecting both local and HYV variety of tur crop. The severity of attack of these diseases was once in every season or once in two seasons. Majority of the tur crop cultivators reported about 5-10 per cent loss of tur crop production on account of these diseases. The major weeds affecting the tur crop were Spreading dayflower, large crabgrass, and Crowfoot grass in case of both local and HYV variety. Another important weed affecting the HYV variety of tur crop was Indian helioptrope. Majority of sampled tur crop cultivators found these as important weeds. These weeds were found to attack tur crop once in every season. About 5-10 per cent of tur crop production was reported to be lost due to the emergence or attack of these weeds.

The perceptions of sampled soyabean crop cultivators regarding the incidence of prevalence of major pests and diseases revealed that Hairy caterpillar, Tobacco Caterpillar, Thrips, Gram pod borer, and Girdle beetle/stem borer were the important pests that affected soyabean crop production. These pests affected soyabean crop production almost once in every season, and the crop loss on account of these pests was 1-10 per cent of total production of soyabean crop. The major diseases reported to be affecting soyabean crop production were Leaf spot, Pod blight, Bacterial blight, and Soybean mosaic virus. The soyabean crop cultivators were seen to report these diseases as important or very important, since in most of the cases they affected the crop either once in every season or once in two seasons. The soyabean crop loss due to these diseases was reported to be 1-10 per cent. Another problem faced by the soyabean crop

cultivators was the weed attack. The major weeds that affected the soyabean crop production were Sanwa Grass, Karna Grass, Doob Grass, Goose Grass, Crab Grass, and Sattu. These weeds were reported to be very important or important since they affected the crop once in every season. The soyabean crop loss on account of prevalence of these weeds was 1-10 per cent. Therefore, the pests, disease and weeds put together significantly affected soyabean crop production.

The magnitude of tur crop production loss due to various pests, disease and weed infestation for average category of farmers was estimated at 8.84 per cent of actual production and 8.12 per cent of normal production in case of local variety, and 13.38 per cent of actual production and 11.80 per cent of normal production for HYV variety of tur crop. In the case of soyabean crop, the magnitude of crop loss due to various pests, disease and weed infestation for average category of farmers was estimated at 11.70 per cent of actual production and 10.48 per cent of normal production. Thus, the magnitude of loss on account of prevalence of various pests, disease and weeds was relatively high in the case of tur crop as compared to soyabean crop production.

In order to control the infestation of pests, diseases and weeds, the sampled farmers were noticed to adopt various chemical methods. In the case of sampled tur crop cultivators, the per acre total cost of chemical for the average category of farmers was estimated at Rs.1,013 for weedicide, Rs.1,709 for insecticide, and Rs.532 for fungicide. The sampled tur farmers used around 2 sprays per acre of various chemicals to control pests, diseases and weeds attack on their farms. As for soyabean crop cultivators, the per acre total cost of chemical for the average category of farmers was worked out at Rs.1,443 for weedicide, Rs.968 for insecticide, and Rs.583 for fungicide. The sampled soyabean crop cultivators used 1-2 sprays per acre of various chemicals to control pests, diseases and weeds attack on their farms. Thus, while the per acre cost of insecticide was higher for tur crop cultivators, the soyabean crop cultivators showed higher per acre cost of weedicide as against sample tur crop cultivators.

The sampled tur and soyabean crop cultivators not only used chemical methods but also various biological methods to control pests and diseases on their farms. About 13 per cent of sampled tur crop cultivators used Trichoderma and Nimboli Ark on their farms. Similarly, about 6 per cent of sampled soyabean crop cultivators used Nimboli Ark and Humic Acid on their farms. The other control measures included shaking of tur and soyabean crops to collect insects, which was adopted by 7 per cent of tur crop cultivators and nearly 1 per cent of soyabean crop cultivators.

All the sampled tur and soyabean cultivators received information and advise on pests and disease control measures from various sources. In the case tur crop cultivators, about 65 per cent of households considered government extension agent as the most important or an important source of advise on pests and disease control, 69 per cent of households considered private input dealer as the most important or an important source of advise, 65 per cent of households found fellow farmers as an important source in this respect, and 1 per cent of households found agricultural university/KVK as an important source of advise on pests and disease control. These sources provided information to the sampled farmers relating to use of insecticides, pesticides, government plans and initiatives, crop cultivation practices, etc. The sampled soyabean crop cultivators also received advise on pests and disease control measures from government extension agent, private input dealer and fellow farmers. Majority of the sampled soyabean crop cultivators found government extension agent and private input dealer as the most important or important source of advise in this respect. In this context, fellow farmers were also considered as an important source of advise by 27 per cent of sampled soyabean crop cultivators. Like tur crop cultivators, the advise received by soyabean crop cultivators was in terms of use of pesticides, cultivation of crop, use of fertilizer and other inputs, etc. The soyabean crop cultivators also received demonstrations on pest management conducted by government extension agents.

In order to minimize pre-harvest losses, the suggestion of sampled tur and soyabean crop cultivators mainly revolved around extension of proper guidance on pests and disease control measures, adequate and timely use of insecticides, pesticides and weedicides, timely availability of pesticides and reduction in prices, an element of subsidy on insecticides, pesticides and weedicides in order to use adequate doses, protection from wild animals, soil testing on farm, adequate care during growth of crop, use of trichoderma for soyabean, timely and early harvesting of crop, etc.

CHAPTER – V

ASSESSMENT OF POST HARVEST LOSSES OF TUR AND SOYABEAN CROPS

The major focus of this chapter is on assessing the extent of losses of the selected crops during various post-harvest operations, which include losses occurring during threshing, winnowing, transportations, handling and storage. This chapter also covers various other aspects like quantitative aspects of storage and their pests control measures adopted by the selected sampled households, and suggestions of the selected households regarding minimization of post-harvest losses of selected crops.

5.1 Production Loss during Harvest

The sampled tur and soyabean crop cultivators were found to harvest their crops during early, mid and late stages. The estimates relating to the extent of harvesting of selected crops during early, mid and late stages, proportion of area harvested during these stages, severity of loss, and the magnitude of loss during these stages are provided in Table 5.1 for tur crop and in Table 5.2 for soyabean crop.

In the case of tur crop cultivators, the per household area harvested was estimated at 1.75 acres during early, 1.34 acres during mid and 1.00 acre during late stage for local variety of tur, and 1.08 acres during early, 1.22 acres during mid and 0.90 acre during late stage for HYV variety (Table 5.1). The per household area harvested of tur crop was, therefore, relatively higher during early and mid stages as against the late stage. However, the proportion of total area harvested was as much as more than 90 per cent during early and mid stages put together for both local and HYV variety of tur crop. The entire tur crop area was harvested manually for both local and HYV variety, and the proportion of tur crop area harvested manually stood at more than 90 per cent during early and mid stages. Further, the sampled tur crop cultivators aired their own opinion in terms ranking of losses ranging from high to low. In general, the losses of tur crop during harvesting were reported to be low to high, especially for HYV variety. The per acre quantity of tur crop loss was estimated at 2.29 kg during early, 4.31 kg during mid and 8.00 kg during late stage for the local variety, and 6.51 kg during early, 8.31 kg during mid and 14.00 kg during late stage for HYV variety, showing thereby a rise in quantity of tur crop loss from early to mid and mid to late stage of harvesting. The per quintal loss of tur crop production was estimated at 0.39 kg during early, 1.10 kg during mid and 1.78 kg during late stage for local variety, and 1.36 kg during early, 1.76 kg during mid and

3.25 kg during late stage, showing again a rise in quantity of tur crop loss from early to mid and mid to late stage of harvesting.

Table 5.1: Quantity lost at different stages of harvest – Tur Crop

Stages of harvest and variety		Early		Mid		Late	
		Local	HYV	Local	HYV	Local	HYV
Area harvested per hh (acres)		1.75	1.08	1.34	1.22	1.00	0.90
Percentage area harvested (early, mid and late)		18.18	53.07	76.62	39.30	5.20	7.63
Area manually harvested (percentage)		18.18	53.07	76.62	39.30	5.20	7.63
Area mechanically harvested (percentage)		-	-	-	-	-	-
Rank of loss (percentage of households)	High	50.00	3.45	18.18	-	-	10.00
	Medium	50.00	15.52	18.18	52.63	100.00	10.00
	Low	-	81.03	63.64	47.37	-	80.00
Quantity lost during harvest	Kg per acre of harvest	2.29	6.51	4.31	8.31	8.00	14.00
	Kg per quintal of harvest	0.39	1.36	1.10	1.76	1.78	3.25
	Loss % of harvest amount	0.39	1.36	1.10	1.76	1.78	3.25

The soyabean crop cultivators showed a decline in per household area harvested from early to mid and mid to late stage, which declined from 3.14 acres in early to 2.87 acres in mid, and further to 2.33 acres in late stage (Table 5.2). It is to be noted that about 73 per cent of soyabean crop cultivators harvested their soyabean crop in the early stage, and 24 per cent harvested it in the mid stage. The harvesting of soyabean crop was noticed to be manually. The loss of soyabean crop was reported to be low to high. The per acre quantity of soyabean crop loss was estimated at 7.26 kg in early, 4.47 kg in mid and 6.14 kg in late stage of harvesting for HYV variety. The sampled farmers did not grow local variety of soyabean crop. The loss of soyabean crop on per quintal basis was estimated at 1.24 kg in early, 0.78 kg in mid and 1.15 kg in late stage of harvesting, showing higher loss in early, followed by late and mid stage. Similarly, the proportion of loss of harvest was estimated at 1.24 per cent in early, 0.78 per cent in mid and 1.15 per cent in late stage of harvesting.

Table 5.2: Quantity lost at different stages of harvest – Soyabean Crop

Stages of harvest and variety		Early		Mid		Late	
		Local	HYV	Local	HYV	Local	HYV
Area harvested per hh (acres)		-	3.14	-	2.87	-	2.33
Percentage area harvested (early, mid and late)		-	72.51	-	23.64	-	3.85
Area manually harvested (percentage)		-	72.51	-	23.64	-	3.85
Area mechanically harvested (percentage)		-	-	-	-	-	-
Rank of loss (percentage of households)	High	-	5.95	-	26.67	-	50.00
	Medium	-	21.43	-	40.00	-	50.00
	Low	-	72.62	-	33.33	-	-
Quantity lost during harvest	Kg per acre of harvest	-	7.26	-	4.47	-	6.14
	Kg per quintal of harvest	-	1.24	-	0.78	-	1.15
	Loss % of harvest amount	-	1.24	-	0.78	-	1.15

The foregoing observations clearly underscore that fact that the magnitude of loss of crop during harvesting was higher for tur crop as against soyabean crop. However, while the magnitude of loss of tur crop during harvesting increased from early to mid and mid to late stage, this magnitude of loss of soyabean crop was higher in early stage, followed by late and mid stage. Further, the area harvested per household was higher for soyabean crop as against soyabean crop. Both tur and soyabean farmers showed manual harvesting of crop during various stages of harvesting.

5.2 Production Loss during Threshing and Winnowing

It is to be noted that while some of the tur crop cultivators used manual threshing of tur crop, the others used either mechanical or both the methods of threshing. Similarly, the sampled tur crop cultivators either winnowed their tur crop manually or mechanically. On the other hand, the sampled soyabean crop cultivators only used mechanical method of threshing and winnowing. The estimates relating to the quantity of tur and soyabean crop lost during threshing and winnowing are furnished in Table 5.3.

The estimates presented in Table 5.3 showed that the sampled tur crop cultivators followed manual, mechanical and combined method of threshing. In the case of local variety of tur crop, about 64 per cent of the total farmers followed manual method of threshing, 7 per cent followed mechanical method of threshing and the remaining 29 per cent of farmers followed combined method of threshing. As for HYV variety of tur crop, about 30 per cent of the total farmers followed manual method of threshing, 12 per cent followed mechanical method of threshing and the remaining 58 per cent of farmers followed combined method of threshing. In general, the loss of tur crop was medium to low in manual and mechanical method of threshing. Further, majority of tur crop cultivators followed manual method of winnowing. The per acre loss of tur crop was found to be 2.18 kg for local variety and 1.38 kg for HYV variety in manual threshing, 0.05 kg for local variety and 0.83 kg for HYV variety in mechanical threshing, and 1.51 kg for local variety and 3.86 kg for HYV variety in both methods of threshing. The per quintal loss of tur crop was estimated at 0.51 kg for local variety and 0.29 kg for HYV variety in manual threshing, 0.01 kg for local variety and 0.18 kg for HYV variety in mechanical threshing, and 0.35 kg for local variety and 0.82 kg for HYV variety in both methods of threshing. Similarly, the per acre loss tur crop was estimated at 3.14 kg for local variety and 1.41 kg for HYV variety in manual winnowing and 0.57 kg for local variety and 1.18 kg for HYV variety in mechanical winnowing. The per quintal loss of tur crop was worked out at 0.73 kg for local variety and 0.30 kg for HYV variety in

manual winnowing and 0.13 kg for local variety and 0.25 kg for HYV variety in mechanical winnowing. The proportion of loss of tur crop in relation to total production was worked out at 0.51 per cent for local variety and 0.29 per cent for HYV variety in manual threshing, 0.01 per cent for local variety and 0.18 per cent for HYV variety in mechanical threshing, and 0.35 per cent for local variety and 0.82 per cent for HYV variety in both methods of threshing. As for winnowing, the proportion of loss of tur crop in relation to total production was worked out at 0.73 per cent for local variety and 0.30 per cent for HYV variety in manual winnowing and 0.13 per cent for local variety and 0.25 per cent for HYV variety in mechanical winnowing. Therefore, the loss of tur crop in relation to total production was much higher during threshing as against winnowing.

Table 5.3: Quantity lost during threshing and winnowing – Tur and Soyabean Crops

Stages of harvest and variety		Crop – I (Tur)		Crop – II (Soyabean)	
		Local	HYV	Local	HYV
Area/quantity manually & mechanically threshed (% of hh)		100.00	100.00	-	100.00
- Manual		64.29	30.19	-	-
- Mechanical		7.14	12.26	-	100.00
- Both		28.57	57.55	-	-
Rank of loss Manually (Percentage of hh)	High	22.22	6.25	-	-
	Medium	33.33	46.88	-	-
	Low	44.44	46.88	-	-
Rank of loss Mechanically (Percentage of hh)	High	-	-	-	-
	Medium	-	46.15	-	31.67
	Low	100.00	53.85	-	68.33
Rank of loss Both (Percentage of hh)	High	-	-	-	-
	Medium	25.00	19.67	-	-
	Low	75.00	80.33	-	-
Quantity lost during manual threshing	Average loss (Kg per acre)	2.18	1.38	-	-
	Average loss (Kg per qt)	0.51	0.29	-	-
	Loss % of threshed amount	0.51	0.29	-	-
Quantity lost during mechanical threshing	Average loss (Kg per acre)	0.05	0.83	-	2.88
	Average loss (Kg per qt)	0.01	0.18	-	0.50
	Loss % of threshed amount	0.01	0.18	-	0.50
Quantity lost during both threshing	Average loss (Kg per acre)	1.51	3.86	-	-
	Average loss (Kg per qt)	0.35	0.82	-	-
	Loss % of threshed amount	0.35	0.82	-	-
Area/quantity manually & mechanically winnowed (% of hh)				-	
- Manual		80.00	55.56	-	-
- Mechanical		20.00	44.44	-	100.00
Rank of loss Manually (Percentage of hh)	High	12.50	4.00	-	-
	Medium	62.50	44.00	-	-
	Low	25.00	52.00	-	-
Rank of loss Mechanically (Percentage of hh)	High	50.00	5.00	-	0.83
	Medium	-	45.00	-	16.67
	Low	50.00	50.00	-	82.50
Quantity lost during manual winnowing	Average loss (Kg per acre)	3.14	1.41	-	-
	Average loss (Kg per qt)	0.73	0.30	-	-
	Loss % of threshed amount	0.73	0.30	-	-
Quantity lost during mechanical winnowing	Average loss (Kg per acre)	0.57	1.18	-	2.09
	Average loss (Kg per qt)	0.13	0.25	-	0.36
	Loss % of threshed amount	0.13	0.25	-	0.36

In the case of soyabean crop, all the sampled farmers followed mechanical method of threshing as well as winnowing. The extent of loss of soyabean crop in mechanical threshing and winnowing was reported low by majority of the sampled farmers. The per acre loss of soyabean crop was estimated at 2.88 kg in threshing and 2.09 kg in winnowing. The per quintal loss of soyabean crop was found to be 0.50 kg in threshing and 0.36 kg in winnowing. The proportion of loss of soyabean crop in relation to total production was estimated at 0.50 per cent in threshing and 0.36 per cent in winnowing. Thus, tur crop cultivators showed higher magnitude of loss of crop during threshing and winnowing as compared to soyabean crop cultivators, which could be due to threshing and winnowing of crop done by mechanical as well as manual method.

5.3 Production Loss during Transportation and Handling

The sampled tur and soyabean crop cultivators were seen to transport their tur and soyabean crops from field to home and from home to market. However, four soyabean crop cultivators were found to transport their soyabean crop directly from field to market. The magnitude of loss of crop during transportation and handling using various modes of transportation is worked out from the total production of the crop and subsequently added up to ascertain the extent of total loss of the crop, which obviously captures the break-up of loss of crop at various modes of transportation and handling. The major transportation modes were head load, bullock cart, trolley and tempo. The estimates relating to the magnitude of crop loss during transportation and handling using various modes of transportation for tur and soyabean crops are brought out in Table 5.4 and Table 5.5.

In the case of tur crop, the average per household quantity transported from field to home was worked out at 5.32 quintals, covering a distance of 1.97 km. The per quintal transportation cost from field to home was estimated at Rs.5.17 (Table 5.4). The loss of tur crop was reported to be low by majority of the households. The per quintal loss in relation to total production of tur crop during transportation from field to home was estimated at 0.24 kg, which encompassed major loss of crop during its transportation through bullock cart. The per quintal handling loss in relation to total production of tur crop during transportation from field to home was estimated at 0.22 kg, which also included major handling loss of crop when transported through bullock cart.

During the stage of transportation of tur crop from home to market, the average per household quantity transported was estimated at 4.34 quintals. The average distance covered in transportation from home to market was 20.50 km with a transportation cost of Rs.8.61 per quintal. The loss of tur crop was reported to be medium to high during its

transportation from home to market. The per quintal loss in relation to total production of tur crop during transportation from home to market was estimated at 0.30 kg, which included major loss of crop during its transportation through tempo. The per quintal handling loss in relation to total production of tur crop during transportation from home to market was estimated at 0.51 kg, which also included major handling loss of crop when transported through tempo. Thus, handling loss of tur crop was relatively higher than transportation loss, especially during transportation of crop from home to market.

Table 5.4: Quantity lost during transportation and handling – Tur Crop

Mode of transportation		Head load	Bullock cart	Trolley	Tempo	Truck	Others	Total
Field to Home								
Average quantity transported (qtls per hh)		5.43	5.35	4.50	5.00	-	-	5.32
Average distance covered (kms)		0.45	2.13	1.33	2.42	-	-	1.97
Transportation cost (Rs per quintal)		4.69	5.15	5.56	6.33	-	-	5.17
Rank of loss (percentage of hh)	High	-	-	-	-	-	-	-
	Medium	-	4.00	-	-	-	-	3.33
	Low	100.00	96.00	100.00	100.00	-	-	96.67
Quantity lost during transport	Average loss (Kg per qtl of amount transported)	0.01	0.22	0.003	0.005	-	-	0.24
	% of amount transported	0.01	0.22	0.003	0.005	-	-	0.24
Quantity lost during handling	Average loss (Kg per qtl of amount handled)	0.004	0.19	0.003	0.02	-	-	0.22
	% of amount handled	0.004	0.19	0.003	0.02	-	-	0.22
Home to Market								
Average quantity transported (qtls per hh)		-	3.58	3.25	4.44	-	-	4.34
Average distance covered (kms)		-	34.67	22.00	20.00	-	-	20.50
Transportation cost (Rs per quintal)		-	5.35	6.54	8.79	-	-	8.61
Rank of loss (percentage of hh)	High	-	-	-	0.92	-	-	0.83
	Medium	-	66.67	25.00	20.18	-	-	21.67
	Low	-	33.33	75.00	78.90	-	-	77.50
Quantity lost during transport	Average loss (Kg per qtl of amount transported)	-	0.002	0.02	0.28	-	-	0.30
	% of amount transported	-	0.002	0.02	0.28	-	-	0.30
Quantity lost during handling	Average loss (Kg per qtl of amount handled)	-	0.01	0.05	0.45	-	-	0.51
	% of amount handled	-	0.01	0.05	0.45	-	-	0.51

As for soyabean crop, the average per household quantity transported from field to home was estimated at 17.67 quintals, which covered a distance of 1.40 km with a transportation cost of Rs.6.94 per quintal (Table 5.5). The loss of soyabean crop during transportation from field to home was reported to be low by majority of the households.

Table 5.5: Quantity lost during transportation and handling – Soyabean Crop

Mode of transportation		Head load	Bullock cart	Trolley	Tempo	Truck	Others	Total
Field to Home								
Average quantity transported (qtls per hh)		6.00	17.85	9.00	-	-	-	17.67
Average distance covered (kms)		1.00	1.41	1.00	-	-	-	1.40
Transportation cost (Rs per quintal)		5.33	6.94	8.33	-	-	-	6.94
Rank of loss (percentage of hh)	High	-	0.88	-	-	-	-	0.86
	Medium	-	3.51	-	-	-	-	3.45
	Low	100.00	95.61	100.00	-	-	-	95.69
Quantity lost during transport	Average loss (Kg per qtl of amount transported)	0.004	0.25	0.003	-	-	-	0.26
	% of amount transported	0.004	0.25	0.003	-	-	-	0.26
Quantity lost during handling	Average loss (Kg per qtl of amount handled)	-	0.22	-	-	-	-	0.22
	% of amount handled	-	0.22	-	-	-	-	0.22
Field to Market								
Average quantity transported (qtls per hh)		-	-	-	15.75	-	-	15.75
Average distance covered (kms)		-	-	-	27.75	-	-	27.75
Transportation cost (Rs per quintal)		-	-	-	10.71	-	-	10.71
Rank of loss (percentage of hh)	High	-	-	-	50.00	-	-	50.00
	Medium	-	-	-	-	-	-	-
	Low	-	-	-	50.00	-	-	50.00
Quantity lost during transport	Average loss (Kg per qtl of amount transported)	-	-	-	0.006	-	-	0.006
	% of amount transported	-	-	-	0.006	-	-	0.006
Quantity lost during handling	Average loss (Kg per qtl of amount handled)	-	-	-	0.02	-	-	0.02
	% of amount handled	-	-	-	0.02	-	-	0.02
Home to Market								
Average quantity transported (qtls per hh)		-	5.50	12.00	17.79	-	-	17.59
Average distance covered (kms)		-	10.00	9.50	19.67	-	-	19.34
Transportation cost (Rs per quintal)		-	7.27	7.71	8.20	-	-	8.19
Rank of loss (percentage of hh)	High	-	-	-	4.42	-	-	4.31
	Medium	-	-	-	12.39	-	-	12.07
	Low	-	100.00	100.00	83.19	-	-	83.62
Quantity lost during transport	Average loss (Kg per qtl of amount transported)	-	0.001	0.003	0.19	-	-	0.19
	% of amount transported	-	0.001	0.003	0.19	-	-	0.19
Quantity lost during handling	Average loss (Kg per qtl of amount handled)	-	-	0.008	0.37	-	-	0.38
	% of amount handled	-	-	0.008	0.37	-	-	0.38

The per quintal loss in relation to total production of soyabean crop during transportation from field to home was estimated at 0.26 kg, which encompassed major

loss of crop during its transportation through bullock cart. The per quintal handling loss in relation to total production of soyabean crop during transportation from field to home was estimated at 0.22 kg, which also included major handling loss of crop when transported through bullock cart.

In the case of soyabean crop, four households were seen to market 63 quintals of their soyabean crop directly from field to market with an average per household quantity transported being 15.75 quintals and distance covered being 27.75 km. The per quintal transportation cost from field to market was estimated at Rs.10.71. The transportation and handling loss during the stage of marketing of crop from field to market stood at negligible since it was estimated from total production of soyabean crop for all the households put together.

During the stage of transportation of soyabean crop from home to market, the average per household quantity transported was estimated at 17.59 quintals. The average distance covered in transportation from home to market was 19.34 km with a transportation cost of Rs.8.19 per quintal. The loss of soyabean crop was reported to be low during its transportation from home to market. The per quintal loss in relation to total production of soyabean crop during transportation from home to market was estimated at 0.19 kg, which included major loss of crop during its transportation through tempo. The per quintal handling loss in relation to total production of soyabean crop during transportation from home to market was estimated at 0.38 kg, which also included major handling loss of crop when transported through tempo. Thus, handling loss of soyabean crop was also relatively higher than transportation loss, especially during the transportation of crop from home to market.

5.4 Production Loss during Storage

Generally, farmers store their crop either in Kutcha/ Pucca house or in scientific godown/warehouse. The sampled tur and soyabean crop cultivators were found to store their crop either in Kutcha house or in Pucca house, and they did not use any scientific method of storage. The mode of storage was gunny/plastic bags, Kothi/bin, open space, etc. The estimates relating to amount of total production of tur and soyabean crops stored using various modes of storage, average number of days stored, ranking of loss, loss of crop due to various reasons, etc. are shown in Table 5.6.

In the case of tur crop, 90 per cent of the total production kept in kutcha house was stored in gunny/plastic bags, 9 per cent in open space and 1 per cent in Kothi/bin. Similarly, 89 per cent of the total production of tur kept in pucca house was stored in

gunny/plastic bags, 4 per cent in open space, 6 per cent in Kothi/bin, and 1 per cent in steel drums (Table 5.6). The per household amount of tur crop stored was estimated at 4.21 quintals in Kutcha house and 5.76 quintals in Pucca house. About 55 per cent of households dried their tur crop before storage. The sampled tur crop farmers stored their crop for 100 days in Kutcha house and 93 days in Pucca house. The loss of tur crop in storage was reported to be low by majority of farmers. The per quintal loss of tur crop was estimated at 0.75 kg due to weight loss, 0.44 kg on account of rodents, and 0.15 kg due to fungus. Thus, the loss of tur crop during storage was worked out at 1.34 kg per quintal, mainly due to weight loss, rodents and fungus. The major loss of tur crop during storage was accounted for by weight loss, followed by rodents and fungus. The storage cost of tur crop was estimated at Rs.2.22 per quintal in Kutcha house and Rs.4.06 per quintal in Pucca house.

Table 5.6: Quantity lost during storage

Place of storage*		Crop I (Tur)				Crop II (Soybean)			
		1	2	3	4	1	2	3	4
Mode of storage (percentage of amount stored)	Open	9.44	3.63	-	-	1.45	-		
	Gunny/plastic bag	89.86	89.10	-	-	85.41	79.32		
	Kothi/bin kuchha, Pucca	0.70	6.46	-	-	13.14	20.68		
	Steel drums	-	0.81	-	-	-	-		
	Others			-	-	-	-		
Amount stored (Qtls per hh)		4.21	5.76	-	-	14.33	21.24		
Percentage of hh who dried before storing		55.88	54.65	-	-	3.33	30.36		
Average number of days stored (per hh)		100.12	92.69	-	-	15.53	44.05		
Rank of loss in storage	High	-	2.33	-	-	7.40	1.92		
	Medium	29.41	17.44	-	-	7.40	21.15		
	Low	70.59	80.23	-	-	85.20	76.93		
Quantity lost during storage (kgs per quintal of storage)	Due to weight loss	0.22	0.53	-	-	0.20	0.26		
	Due to rodents	0.17	0.27	-	-	0.05	0.06		
	Due to fungus	0.01	0.14	-	-	0.003	0.008		
Storage cost Rs. per quintal		2.22	4.06	-	-	1.82	6.38		

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

As for soyabean crop, 85 per cent of the total production kept in kutcha house was stored in gunny/plastic bags, 1 per cent in open space and 13 per cent in Kothi/bin. Similarly, 79 per cent of the total production of soyabean kept in pucca house was stored in gunny/plastic bags, and the remaining 21 per cent in Kothi/bin (Table 5.6). The per household amount of soyabean crop stored was estimated at 14.33 quintals in Kutcha house and 21.24 quintals in Pucca house. Interestingly, only 30 per cent of the total soyabean crop cultivators dried their soyabean crop before storage in Pucca house and 3 per cent dried it before storage in Kutcha house. The sampled soyabean crop farmers stored their crop for 44 days in Pucca house and 16 days in Kutcha house. The loss of soyabean crop in storage was reported to be low by majority of farmers. The per quintal

loss of soyabean crop was estimated at 0.46 kg due to weight loss, 0.11 kg due to rodents, and 0.01 kg due to fungus. Thus, the loss of soyabean crop during storage was estimated at 0.58 kg per quintal on account of weight loss, rodents and fungus. The storage cost of soyabean crop was estimated at Rs.1.82 per quintal in Kutcha house and Rs.6.38 per quintal in Pucca house.

The foregoing observations clearly underscore the fact that the loss of production in storage was much higher for tur crop as against the soyabean crop. The weight loss was the major reason for loss of crop in storage, followed by loss caused by rodents and fungus. Although storage loss was higher for tur crop, the soyabean crop cultivators showed much higher per household amount of soyabean crop kept in storage as compared to tur crop cultivators.

5.5 Capacity Utilization of Storage by the Selected Households

Although majority of the sampled tur and soyabean crop cultivators used gunny/plastic bags to store their produce, a significant section of tur and soyabean crop cultivators were found to store their produce in Kothi/bin. Some of these farmers also used open space to store their tur and soyabean crop. Steel drum was also used as a mode of storage by tur crop cultivators. The estimates relating to storage capacity, actual storage of crop, and capacity utilization by the tur and soyabean crop cultivators are brought out in Table 5.7.

Table 5.7: Capacity utilization of storage by the households

Mode of storage	Crop I (Tur)			Crop II (soyabean)		
	Capacity (qtls)	Actual storage (qtls)	Capacity utilization (%)	Capacity (qtls)	Actual storage (qtls)	Capacity utilization (%)
Open	75.00	31.50	42.00	13.00	12.50	96.15
Gunny Plastic bag	1349.00	569.90	42.25	1976.00	1678.00	84.92
Kothi/bukhari/bin kachha	95.00	33.00	34.74	424.00	359.00	84.67
Kothi/bukhari/bin made of cement	-	-	-	-	-	-
Steel drums	15.00	4.00	26.67	-	-	-
Others	-	-	-	-	-	-

The sampled tur crop cultivators utilized 42 per cent of the capacity available for storage in gunny/plastic bags, 35 per cent in Kothi/bin, 42 per cent in open space and 27 per cent in steel drum. As for sampled soyabean crop cultivators, the capacity utilized for storage was found to be 85 per cent in gunny/plastic bags and Kothi/bin, and 96 per cent in open space. Thus, the soyabean crop cultivators utilized maximum capacity of storage available with them as against the sampled tur crop cultivators. Both tur and soyabean crop cultivators showed higher capacity utilization in open space and gunny bags.

The estimates relating to total post-harvest loss of crop on account of harvesting, threshing, winnowing, transportation, handling and storage for various categories of tur and soyabean crop cultivators are brought out in Table 5.8. The total post harvest losses of crop on per acre basis for various categories of tur and soyabean crop cultivators are also shown in Table 5.8.

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

Particulars	Crop – I (Tur)					Crop – II (Soyabean)				
	Margi nal	Small	Medi um	Large	Total	Margi nal	Small	Medi um	Large	Total
Quantity lost in harvest (kg per qtl)	2.02	2.04	1.26	0.78	1.56	1.87	1.49	1.05	0.54	1.13
Quantity lost in threshing (kg per qtl)	1.67	1.62	0.85	0.82	1.24	0.92	0.69	0.40	0.25	0.50
Quantity lost in winnowing (kg per qtl)	1.35	0.83	0.25	0.14	0.59	0.51	0.52	0.31	0.18	0.36
Quantity lost in transport (kg per qtl)	0.89	0.62	0.45	0.28	0.54	0.82	0.68	0.38	0.17	0.46
Quantity lost in handling (kg per qtl)	1.47	0.95	0.40	0.29	0.73	1.41	0.91	0.44	0.28	0.63
Quantity lost in storage (kg per qtl)	1.97	1.78	0.86	0.85	1.34	1.20	0.70	0.53	0.30	0.58
Total post harvest loss (kg per qtl)	9.37	7.84	4.07	3.16	6.00	6.73	4.99	3.11	1.72	3.66
Total post harvest loss (kg per acre)*	41.88	36.77	19.21	14.54	27.90	36.54	27.94	18.41	10.42	21.26

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

A critical analysis drawn from Table 5.8 revealed wide variations in post harvest losses of tur crop across various categories of sampled farmers. The per quintal total loss of tur crop was estimated at 6.00 kg, which encompassed 1.56 kg in harvesting, 1.24 kg in threshing, 0.59 kg in winnowing, 0.54 kg in transportation, 0.73 kg in handling, and 1.34 kg in storage. These figures clearly underscore the fact that the highest per quintal post harvest loss of tur crop took place in harvesting operation, followed by storage, threshing, handling, winnowing and transportation. The per quintal post harvest loss of tur crop declined sharply with the increase in land holding size of farmers, which declined from 9.37 kg for marginal category to as low as 3.16 kg for large category of farmers. The declining trend in post harvest losses with rise in land holding size was witnessed with respect to all the post harvest operations viz. harvesting, threshing, winnowing, transportation, handling and storage operations. The per acre post harvest losses of tur crop also declined with the increase in land holding size of farmers, which decline from 41.88 kg for marginal farmers to 14.54 kg for the large farmers with an average of 27.90 kg for the average category of tur farmers.

As for soyabean crop, the per quintal total post harvest loss was estimated at 3.66 kg, which encompassed 1.13 kg in harvesting, 0.50 kg in threshing, 0.36 kg in winnowing, 0.46 kg in transportation, 0.63 kg in handling, and 0.58 kg in storage, showing thereby highest per quintal loss of soyabean crop in harvesting, followed by handling, storage, threshing, transportation and winnowing. The per quintal post harvest

loss of soyabean crop also declined sharply with the increase in land holding size of farmers, which declined from 6.73 kg for marginal category to as low as 1.72 kg for large category of farmers. The declining trend in post harvest losses with rise in land holding size was seen with respect to all the post harvest operations viz. harvesting, threshing, winnowing, transportation, handling and storage operations. The per acre post harvest losses of soyabean crop also declined with the increase in land holding size of farmers, which decline from 36.54 kg for marginal farmers to 10.42 kg for the large farmers with an average of 21.26 kg for the average category of soyabean farmers. These figures are concomitant of the fact that post harvest losses were much higher for tur crop as against the soyabean crop not only on per quintal basis but also on per acre basis.

5.6 Quantitative Aspects of Storage and their Pests Control Measures Adopted by the Selected Households

The perceptions of the sampled tur and soyabean cultivators with respect to various aspects of storage and pests control measures adopted by them were also recorded. In this context, the perceptions of the households were mainly recorded with respect to the nature of storage structure, physical condition of storage, cost of storage, maintenance status, and measures adopted to control storage pests. The quantitative aspects of storage and their pests control measures adopted by the selected tur and soyabean crop farmers are delineated in Table 5.9.

In the case of tur crop, more than 80 per cent of households were reported to have the roof of their storage structure to be made of metal/ cemented with walls made of burnt bricks/cemented and floor made of concrete or earth. The remaining households were reported to have the roof of the storage structure to be made of plastic cover, grass thatched, crop by product and asbestos sheet with walls made of mud, crib or tin. About 80 per cent of households were reported to have platform in the storage structure, and majority of them revealed the height of platform to be less than 6 inches. As for physical condition of storage structure, about 30 per cent of households reported leaking roof and the remaining 70 per cent of households reported the roof to be in good condition. Similarly, about 25 per cent of households reported the walls of the storage structure to be damaged and the remaining 75 per cent of households maintained that the walls were in good condition. Interestingly, only 17 per cent of tur crop cultivators installed rat guards and others did not use any rat guard. About 53 per cent of households maintained that the floor of the storage structure was broken with mud coming out and the remaining households reported the floor to be in good condition.

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

Description		Tur	Soyabean
1. Nature of storage structure			
Roof made of	Grass thatched	6.67	2.50
	Crop by product	1.67	4.17
	Plastic cover	5.00	-
	Metal/cemented	81.67	91.66
	Asbestos sheet	5.00	1.67
	Others	-	-
Walls made of	Burnt bricks/cemented	91.67	50.83
	Woven basket	0.00	0.83
	Mud	5.00	45.83
	Crib	1.67	-
	Open wall	-	1.67
	Others	1.67	0.83
Floor made of	Concrete	66.67	40.00
	Earth	33.33	60.00
	Woven basket	-	-
	Wooden	-	-
	Others	-	-
Percentage of households having platform		80.00	30.00
Height of the platform	Less than 6 inches	81.25	72.22
	6-12 inches	16.67	25.00
	Above 12 inches	2.08	2.78
	Others	-	-
2. Physical condition of storage			
Roof	Leaking roof	30.00	40.83
	Good roof	70.00	59.17
Walls	Damaged wall	25.00	38.33
	Good condition walls	75.00	61.67
Guards	Rat guard installed	16.67	35.00
	No rat guards	83.33	65.00
Floor	Cemented good condition roof	46.67	43.33
	Broken floor, mud coming out	53.33	56.67
3. Cost of storage			
The average age of the storage structure (years per household)		15.2	19.49
Cost of permanent storage, e.g., steel drums etc. (Rs per household)		1215.18	1419.22
Cost of kutcha or cemented house for storage (Rs. Per household)		578.50	887.34
4. Maintenance status – Frequency of repair of grain storage			
Roof	Every year	11.67	52.50
	Every two years	13.33	12.50
	2-5 Years	23.33	5.00
	No maintenance required	51.67	30.00
Walls	Every year	8.33	42.50
	Every two years	5.00	10.83
	2-5 Years	13.33	9.17
	No maintenance required	73.33	37.50
Rat guards	Every year	48.33	42.50
	Every two years	1.67	0.83
	2-5 Years	1.67	3.33
	No maintenance required	48.33	53.33
5. Storage pests control measures			
Sun drying	Monthly	46.67	6.67
	Quarterly	6.67	-
	By-annual	6.67	-
	Annual	18.33	15.83
	Never	21.67	77.50
Removal of infested grain from storage and destroying it	Monthly	5.00	0.83
	Quarterly	10.00	-
	By-annual	3.33	-
	Annual	6.67	5.00
	Never	75.00	94.17

Description		Tur	Soyabean
Admixing with ash and other plant materials	Monthly	5.00	-
	Quarterly	1.67	-
	By-annual	-	-
	Annual	21.67	7.50
	Never	71.67	92.50
Smoking	Monthly	-	-
	Quarterly	1.67	-
	By-annual	-	-
	Annual	-	-
	Never	98.33	100.00
Others	Monthly	-	-
	Quarterly	-	-
	By-annual	-	-
	Annual	-	-
	Never	-	-

The per household cost of storage for tur crop was estimated at Rs.1215 for permanent structure and Rs.579 for Kutcha or cemented structure. The per household average age of storage structure for tur crop was stated to be 15 years. As for maintenance of storage structure, about 52 per cent of tur crop cultivators maintained that the roof of the storage structure did not require repair work, and the remaining 48 per cent aired their view in favour of repair work one in 2-5 years or once in two ears or every year. Similarly, 73 per cent of tur crop cultivators maintained that the walls of storage structure did not require any repair work, while the remaining were in favour of repair work of wall once in 2-5 years or once in two ears or every year. About 48 per cent of tur crop cultivators maintained that the rat guards in storage structure did not require any repair work, whereas another 48 per cent were in favour of repair work of rat guards once in every year. As for storage pests control measures, the sun drying of tur crop was performed on monthly basis by 47 per cent of households, quarterly basis by 7 per cent of households, by-annual basis by another 7 per cent of households, annual basis by 18 per cent of households, and the remaining 22 per cent of households did not opt for sun drying of tur crop. About 75 per cent of tur crop cultivators never removed infested grain from storage to destroy it, while the remaining 25 per cent of households were in favour of removal of infested grains from storage and their destruction either on monthly basis or quarterly or by-annual or annual basis. As for admixing with ash and other plant materials, 72 per cent of households never did this, 22 per cent did this on annual basis, 5 per cent on monthly basis, and two per cent on quarterly basis. Almost all the tur crop cultivators never used smoking to control storage pests.

As for soyabean crop, about 92 per cent of households were reported to have the roof of their storage structure to be made of metal/ cemented. However, while 51 per cent

of households reported the walls of storage structure to be made of burnt bricks/cemented, about 46 per cent of households were in favour of having walls made of mud. The floor of the storage structure was reported to be made of concrete or earth. About 30 per cent of households were reported to have platform in the storage structure with height ranging from less than 6 inches to 6-12 inches. As for physical condition of storage structure, about 41 per cent of households reported leaking roof and the remaining 59 per cent of households reported the roof to be in good condition. Similarly, about 38 per cent of households reported the walls of the storage structure to be damaged and the remaining 62 per cent of households maintained that the walls were in good condition. About 35 per cent of soyabean crop cultivators installed rat guards and others did not use any rat guard. About 57 per cent of tur crop households maintained that the floor of the storage structure was broken with mud coming out and the remaining households reported the floor to be in good condition.

The per household cost of storage for soyabean crop was estimated at Rs.1419 for permanent structure and Rs.887 for Kutcha or cemented structure. The per household average age of storage structure for soyabean crop was reported to be 19 years. As for maintenance of storage structure, about 30 per cent of soyabean crop cultivators maintained that the roof of the storage structure did not require repair work, while 53 per cent of households were in favour of repair work of roof of storage structure once in every year, and the rest favour it once in two years or once in 2-5 years. About 38 per cent of soyabean crop cultivators maintained that the walls of storage structure did not require any repair work, whereas 43 per cent favoured it once in every year, 11 per cent favoured it once in two years, and 9 per cent favoured it once in 2-5 years. About 53 per cent of soyabean crop cultivators maintained that the rat guards in storage structure did not require any repair work, whereas another 43 per cent were in favour of repair work of rat guards once in every year. As for storage pests control measures, the sun drying of soyabean crop was performed on monthly basis by 7 per cent of households, annual basis by 16 per cent of households, and the remaining 77 per cent of households did not opt for sun drying of soyabean crop. About 95 per cent of soyabean crop cultivators never removed infested grain from storage for its destruction, while 5 per cent of households did it on annual basis and 1 per cent on monthly basis. As for admixing with ash and other plant materials, 73 per cent of households never did this and the remaining households did this on annual basis. Further, none of the soyabean crop cultivators used smoking to control storage pests.

In general, majority of tur and soyabean crop cultivators did not use storage pests control measures, though maintenance of storage structure was done by a significant number of households. The cost of storage and age of storage structure were relatively high for soyabean crop cultivators as against tur crop cultivators. The physical condition of storage structure of tur and soyabean crop was reported to be good by majority of the households. However, while majority of tur crop cultivators had a platform in their storage structure, this proportion of households having platform was very low for soyabean crop. By and large, both tur and soyabean crop cultivators were in favour of having metal or cemented roof and walls in their storage structure.

5.7 Households Suggestions How to Minimize Post Harvest Losses

The sampled tur and soyabean crop cultivators aired their own suggestion to minimize post-harvest losses of crops at various stages. Although the suggestions of sampled tur and soyabean crop cultivators were by and large same, some of the suggestions of tur crop cultivators differed from soyabean crop cultivators. The suggestions of sampled tur and soyabean crop cultivators with respect to minimization of post harvest losses are brought out in Table 5.10.

Table 5.10: Household Suggestion on Minimizing Post-Harvest Losses

Sr. No.	Tur Crop Cultivators	Soyabean Crop Cultivators
1.	Careful handling of crop during various post harvest stages	Take care while handling and marketing
2.	Immediate marketing of crop after harvest to avoid any weight loss	Do not store more than one month to minimize rodent attack, pests and fungus
3.	Storing of produce in good storage conditions	Improvement in marketing practices
4.	Careful handling of crop during storage	Mix BHC powder with soyabean to avoid pests
5.	Sun drying of crop every three months	Sun drying of soyabean crop
6.	Improvement in marketing practices	Protection from rats and keeping produce in dry place
7.	Clean the store with earth, lime or ashes to prevent storage losses	Proper care at marketing stage
8.	Mix BHC powder with tur to avoid pests	Timely harvesting
9.	Prevention of crop from rats and insects and installation of rat guards	Adequate and proper care during threshing and winnowing
10.	Keeping crop away from rats and sun drying	Adequate and proper care during transportation and marketing
11.	Adequate and proper care during threshing and winnowing	Keeping away from rats and wet places
12.	Adequate and proper care during transportation and marketing	Quick selling of produce to avoid any problem
13.	Inspection of stored grains and proper hygiene	Mix Boric Acid Powder with soyabean to avoid insects and pests
14.	Store fumigation and store disinfestations	Use of good and large size storage bags

In order to minimize post-harvest losses, the suggestion of sampled tur crop cultivators mainly revolved around careful handling of crop during various post-harvest stages, quick disposal of crop after harvesting to avoid weight loss, storing of produce in good and hygienic conditions, quarterly sun drying of crop, improvement in marketing practices, cleaning of store with earth, lime or ash to prevent storage losses, mixing of BHC powder with tur to avoid pests, prevention of crop from rats and insects and installation of rat guards, adequate care during threshing, winnowing, transportation, etc., inspection of stored grains, store fumigation, etc.

The sampled soyabean crop cultivators also aired by and large same suggestions as aired by tur crop cultivators. However, some of the suggestions of soyabean crop cultivators were little bit removed from the suggestions extended by tur crop cultivators. In general, the suggestions of the sampled soyabean crop cultivators to minimize post harvest losses mainly revolved around careful handling of crop at various post-harvest stages, storing of crop not beyond one month to minimize rodent attack, pests and fungus, improvement in marketing practices, mixing of BHC powder with soyabean to avoid pests, sun drying of crop, protection from rats and keeping produce in dry places, timely harvesting, proper care during threshing, winnowing, transportation, etc., quick selling of produce, mixing of boric acid powder with soyabean to avoid insects and pests, use of good and large size storage bags, etc.

5.8 Summary

A critical analysis carried out in terms of per acre quantity of tur crop loss revealed a rise in loss of tur crop from early to mid and mid to late stage of harvesting, which increased from 2.29 kg in early to 8.00 kg in late stage for local variety, and from 6.51 kg in early to 14.00 kg in late stage for HYV variety. Similarly, the per quintal quantity of loss of tur crop increased from 0.39 kg in early to 1.78 kg in late stage for local variety, and 1.36 kg in early to 3.25 kg in late stage for HYV variety. The area harvested per household varied from 1.00 acre in late to 1.75 acres in early stage for local variety and from 0.90 in late to 1.22 acres in mid stage for HYV variety. The proportion of total area harvested was as much as more than 90 per cent during early and mid stages put together for both local and HYV variety of tur crop.

The per acre quantity of soyabean crop loss was estimated at 7.26 kg in early, 4.47 kg in mid and 6.14 kg in late stage of harvesting for HYV variety. The sampled farmers did not grow local variety of soyabean crop. The loss of soyabean crop on per quintal basis was estimated at 1.24 kg in early, 0.78 kg in mid and 1.15 kg in late stage of

harvesting. The area harvested per household for soyabean crop varied from 2.33 acres in late to 3.14 acres in early stage of harvesting. Majority of the sampled soyabean crop cultivators harvested their soyabean crop in the early stage, and showed low level of loss of the crop. However, those sampled farmers harvesting soyabean crop in mid stage showed high to medium range of loss. In general, the magnitude of loss of crop during harvesting was noticed to be higher for tur crop as against soyabean crop.

The estimates relating to threshing and winnowing carried out by sampled tur crop cultivators revealed that while threshing of tur crop was done by following manual, mechanical as well as both methods, the farmers followed either manual or mechanical method while winnowing their tur crop. The per acre loss of tur crop was found to be 2.18 kg for local variety and 1.38 kg for HYV variety in manual threshing, 0.05 kg for local variety and 0.83 kg for HYV variety in mechanical threshing, and 1.51 kg for local variety and 3.86 kg for HYV variety while following both methods of threshing. The per quintal loss of tur crop was estimated at 0.51 kg for local variety and 0.29 kg for HYV variety in manual threshing, 0.01 kg for local variety and 0.18 kg for HYV variety in mechanical threshing, and 0.35 kg for local variety and 0.82 kg for HYV variety while following both methods of threshing. Similarly, the per acre loss tur crop was estimated at 3.14 kg for local variety and 1.41 kg for HYV variety in manual winnowing and 0.57 kg for local variety and 1.18 kg for HYV variety in mechanical winnowing. The per quintal loss of tur crop was worked out at 0.73 kg for local variety and 0.30 kg for HYV variety in manual winnowing and 0.13 kg for local variety and 0.25 kg for HYV variety in mechanical winnowing. The sampled soyabean crop cultivators followed only mechanical method of threshing and winnowing for the HYV variety of the crop. The per acre loss of soyabean crop was estimated at 2.88 kg in threshing and 2.09 kg in winnowing. The per quintal loss of soyabean crop was found to be 0.50 kg in threshing and 0.36 kg in winnowing. Thus, tur crop cultivators showed higher magnitude of loss of crop during threshing and winnowing as compared to soyabean crop cultivators.

An assessment of loss of crop during transportation and handling revealed that the sampled tur crop cultivators transported their crop from field to home and from home to market using various methods of transportation like head load, bullock cart, trolley and tempo. During the stage of transportation of tur crop from field to home, the per quintal loss of crop in relation to total production was estimated at 0.24 kg in transportation and 0.22 kg in handling. The per quintal loss of tur crop in relation to total production, while transporting from home to field, was estimated at 0.30 kg in transportation and 0.51 kg in

handling. The extent of loss in transportation and handling was reported to be medium to low by majority of tur crop cultivators. As for soyabean crop cultivators, the per quintal loss of crop in relation to total production was estimated at 0.26 kg in transportation and 0.22 kg in handling while transporting the crop from field to home. During the stage of transportation of soyabean crop from home to market, the per quintal loss of crop in relation to total production was estimated at 0.19 kg in transportation and 0.38 kg in handling. A few farmers transported their soyabean crop directly from field to market and the loss of soyabean crop in relation to total production was almost negligible in this case as during this stage the loss per quintal was estimated at 0.006 kg in transportation and 0.02 kg in handling. Thus, the transportation and handling loss was relatively higher for tur crop as against the soyabean crop.

Although there are many possible ways to store crop, the sampled tur and soyabean crop cultivators were found to store their crop either in Kutcha house or in Pucca house using gunny/plastic bags, Kothi/bin, open space, etc. In the case of tur crop, 90 per cent of the total production kept in kutcha house was stored in gunny/plastic bags, 9 per cent in open space and 1 per cent in Kothi/bin. Similarly, 89 per cent of the total production of tur kept in pucca house was stored in gunny/plastic bags, 4 per cent in open space, 6 per cent in Kothi/bin, and 1 per cent in steel drums. The per quintal loss of tur crop was estimated at 0.75 kg due to weight loss, 0.44 kg on account of rodents, and 0.15 kg due to fungus. Thus, the loss of tur crop during storage was worked out at 1.34 kg per quintal, mainly due to weight loss, rodents and fungus. As for soyabean crop, 85 per cent of the total production kept in kutcha house was stored in gunny/plastic bags, 1 per cent in open space and 13 per cent in Kothi/bin. Similarly, 79 per cent of the total production of soyabean kept in pucca house was stored in gunny/plastic bags, and the remaining 21 per cent in Kothi/bin. The per quintal loss of soyabean crop was estimated at 0.46 kg due to weight loss, 0.11 kg due to rodents, and 0.01 kg due to fungus. Thus, the loss of soyabean crop during storage was estimated at 0.58 kg per quintal on account of weight loss, rodents and fungus.

The sampled tur and soyabean crop cultivators mainly used gunny/plastic bags to store their produce, followed by Kothi/bin, open space and steel drum. The sampled tur crop cultivators utilized 42 per cent of the capacity available for storage in gunny/plastic bags, 35 per cent in Kothi/bin, 42 per cent in open space and 27 per cent in steel drum. As for sampled soyabean crop cultivators, the capacity utilized for storage was found to be 85 per cent in gunny/plastic bags and Kothi/bin, and 96 per cent in open space. Thus, the

soyabean crop cultivators used maximum capacity of storage available with them as against the sampled tur crop cultivators.

An analysis into total post harvest loss revealed wide variation in loss of tur and soyabean crop across various categories of sampled farmers. The per quintal total loss of tur crop was estimated at 6.00 kg, which encompassed 1.56 kg in harvesting, 1.24 kg in threshing, 0.59 kg in winnowing, 0.54 kg in transportation, 0.73 kg in handling, and 1.34 kg in storage. The total post harvest loss of tur crop decreased with the increase in land holding size of farmers, and it varied from 3.16 kg for large category to as much as 9.37 kg for the marginal category of farmers. As against tur crop, the per quintal total loss of soyabean crop was estimated at 3.66 kg, which encompassed 1.13 kg in harvesting, 0.50 kg in threshing, 0.36 kg in winnowing, 0.46 kg in transportation, 0.63 kg in handling, and 0.58 kg in storage. The soyabean crop cultivators also showed a decline in post harvest losses of soyabean crop with the increase in land holding size of farmers, which decreased from 6.73 kg for marginal category to as low as 1.72 kg for large category. The per acre post harvest loss was estimated at 27.90 kg for tur crop and 21.26 kg for soyabean crop, which also declined with the increase in land holding size of farmers. Thus, post harvest losses were higher for tur crop as against soyabean crop, both on per quintal and per acre basis.

The perceptions of sampled tur and soyabean crop cultivators regarding various aspects of storage and pests control measures adopted by them were also recorded. In the case of tur crop cultivators, majority of households reported the roof of their storage structure to be made of metal/ cemented with walls made of burnt bricks/cemented and floor made of concrete or earth. About 80 per cent of households were reported to have platform in the storage structure with less than 6 inches height. As for the physical condition of storage, majority of tur crop cultivators reported the roof and walls to be in good condition with no rat guards, and the condition of floor to be broken with mud coming out. The per household cost of storage was estimated at Rs.1215 for permanent structure and Rs.579 for Kutcha or cemented structure. The per household average age of storage structure for tur crop was 15 years. Further, majority of tur crop cultivators maintained that the roof and wall of storage structure did not require maintenance, though repairing of rat guards was needed every year. Interestingly, majority of tur crop cultivators never used storage pests control measures, though monthly sun drying of crop was done by 47 per cent of households.

As for quantitative aspects of storage for soyabean crop cultivators, majority of households reported the roof of storage structure to be made of metal/cemented with walls made of burnt bricks/cemented or mud and floor made of earth or concrete. Interestingly, only 30 per cent of soyabean crop cultivators were reported to have platform in the storage structure with less than 6 inches height of the platform. As for the physical condition of storage, majority of soyabean crop cultivators reported the roof and walls to be in good condition with no rat guards, and the condition of floor to be broken with mud coming out. The per household average age of storage structure for soyabean crop was 19 years. The per household cost of storage was estimated at Rs.1419 for permanent structure and Rs.887 for Kutcha or cemented structure. Further, majority of soyabean crop cultivators maintained that roof and walls of storage required repairing every year, and rat guards also required maintenance. Like tur crop, majority of soyabean crop cultivators never used storage pests control measures.

The sampled tur and soyabean crop cultivators aired a number of suggestions to minimize post-harvest losses, which mainly revolved around careful handling of crop during various post-harvest stages, good storage conditions, sun drying of crop, mixing of BHC powder with crop to avoid pests, prevention of crops from rats and insects, installation of rat guards, early and quick marketing of crop to avoid weight loss, adequate and proper care during threshing, winnowing, transportation, etc., inspection of stored grains, store fumigation, use of dry places for storage, timely harvesting, mixing of Boric Acid powder with soyabean, large storage bags, etc.

CHAPTER – VI

CONCLUDING REMARKS AND POLICY SUGGESTIONS

India at present is passing through a complex type of situation due to shift in consumption pattern in favour of high value crops and consequent crop diversification drive. The crop diversification drive has raised concern about food security in the country. Very slow growth in agriculture sector of India has further raised doubts about bridging demand supply gap in foodgrain production. Although government policies envisage to focus on quality aspects at all stages of farm operations, including sowing to processing activity, the developments witnessed in recent past have also caused widespread prevalence of pests and diseases and consequent use of higher amount of pesticides to raise the productivity of crops. The increased use of pesticides has also resulted in developing insects and disease resistance, which further led to reduction in crop yield. Almost all the foodgrain and oilseed crops cultivated across states in the country are seen to have been affected by such measures, and the state of Maharashtra is not an exception to this phenomenon. The state of Maharashtra, which cultivates a significant production volume of pulses and oilseeds of the country, is seen to have witnessed crop loss owing to increasing use of pesticides and insecticides. In fact, the major problem faced by the agricultural production system is the pre as well as post-harvest losses. There are many sources of leakage between production and consumption that not only include loss of grains before harvesting of crop but also during various post-harvest operations viz. threshing, cleaning, winnowing, drying, storage, transportation, packaging, etc. The losses of grain may occur due to destruction by pests, losses in transportation and storage, threshing to storage point, and also on account of damage caused by mechanical agents such as birds, animals, hailstorms, rains, over drying, shattering in the fields during harvesting, rodents, mites and insects, changes in moisture content, dust and broken grains, reduction in germination power, loss of palatability, heating and caking, etc. The present study, therefore, attempts to evaluate the extent of pre- and post harvest losses for important pulse and oilseed crops in the state of Maharashtra. The pre- and post harvest losses have been assessed for tur among pulses and soyabean among oilseed crops.

A critical analysis relating to perceptions of farmers regarding constraints faced by them in the cultivation of tur and soyabean crops revealed poor seed quality, water deficiency, pest and diseases, high cost of inputs and low output prices as the major

problems faced in the cultivation of selected crops. The incidence of prevalence of pests, diseases and weeds caused considerable pre-harvest losses of tur and soyabean crops. In the case of tur crop, the widespread prevalence and attack of Pod Borer, Tur Pod Fly and Aphids among pests, Leaf spot, Dry root rot, Fusarium wilt, and Yellow mosaic among diseases, and Spreading dayflower, large crabgrass, and Crowfoot grass among weeds caused high magnitude of loss of tur crop production, which was found to be 8.84 per cent of actual production and 8.12 per cent of normal production in case of local variety, and 13.38 per cent of actual production and 11.80 per cent of normal production for HYV variety of tur crop. The perceptions of soyabean crop cultivators regarding the incidence of prevalence of major pests and diseases revealed that Hairy caterpillar, Tobacco Caterpillar, Thrips, Gram pod borer, and Girdle beetle/stem borer were the important pests that affected soyabean crop production. The major diseases reported to be affecting soyabean crop production were Leaf spot, Pod blight, Bacterial blight, and Soybean mosaic virus. On the other hand, the major weeds that affected the soyabean crop production were Sanwa Grass, Karna Grass, Doob Grass, Goose Grass, Crab Grass, and Sattu. Due to various pests, disease and weed infestation, the magnitude of soyabean crop loss was found to be 11.70 per cent of actual production and 10.48 per cent of normal production. The magnitude of loss of production on account of prevalence of various pests, disease and weeds was relatively high for tur crop as against the soyabean crop.

The tur and soyabean crop farmers aired a number of suggestions to minimize pre-harvest losses, which mainly revolved around extension of proper guidance on pests and disease control measures, adequate and timely use of insecticides, pesticides and weedicides, timely availability of pesticides and reduction in prices, an element of subsidy on insecticides, pesticides and weedicides in order to use adequate doses, protection from wild animals, soil testing on farm, adequate care during growth of crop, use of trichoderma for soyabean, timely and early harvesting of crop, etc.

An assessment of the extent of losses of the selected crops during various post-harvest operations, which included losses occurring during threshing, winnowing, transportations, handling and storage, revealed a significant loss of tur crop production. The per quintal total loss was estimated at 6.00 kg for tur crop and 3.66 kg for soyabean crop, showing higher magnitude of loss for tur as against soyabean crop. The magnitude of post-harvest loss for tur crop was the highest during harvesting, followed by storage, threshing, handling, winnowing, and transportation. The soyabean crop showed the highest magnitude of post-harvest loss during harvesting, followed by handling, storage,

threshing, transportation and winnowing. Among various post-harvest operations, harvesting and storage operations put together showed almost 50 per cent of total post-harvest losses of tur and soyabean crops.

The selected farmers in the present study were quite concerned about post-harvest losses at various stages and, therefore, aired a number of suggestions to minimize post-harvest losses, which mainly revolved around careful handling of crop during various post-harvest stages, good storage conditions, sun drying of crop, mixing of BHC powder with crop to avoid pests, prevention of crops from rats and insects, installation of rat guards, early and quick marketing of crop to avoid weight loss, adequate and proper care during threshing, winnowing, transportation, etc., inspection of stored grains, store fumigation, use of dry places for storage, timely harvesting, mixing of Boric Acid powder with soyabean, large storage bags, etc.

It is to be noted that pre-and post harvest losses put together accounted for 14-18 per cent of total production, implying loosing 14-18 kg of production of selected crops during various pre- and post harvest operations. Such high magnitude of loss of crop production is certainly a matter of great concern. Therefore, efforts need to be initiated to curb such losses by adopting appropriate measures. It is expected that measures and programme initiatives such as adoption of improved pre- and post-harvest technology and water and paste control practices will not only increase the productivity of individual crops and their quality but these are also likely to substantially minimize the post-harvest losses, increase the total crop area cover and generate adequate quality surplus for their conversion into value-added food products.

Policy Suggestions

A critical analysis drawn from changes in costs and profitability during the last one decade based on CACP report clearly showed reasonable rate of net returns for tur crop and very low rate of net returns for soyabean crop. In fact, the per hectare net returns from soyabean crop in Maharashtra though increased from Rs.1,336 in 1996-97 to Rs.8,088 in 2007-08, there were several instances when there stood negative net returns from soyabean crop during the period between 1996-97 and 2007-08. The cost and returns estimates clearly showed positive returns from soyabean crop only over variable cost during the period between 1996-97 and 2007-08. In order to boost cultivation of soyabean crop, there is need to reduce cost and increase yield, aside from raising MSP for this important oilseed crop cultivated in the state of Maharashtra. These measures will certainly raise profitability in the cultivation of soyabean crop in Maharashtra.

In order to curb pre-harvest losses, there is need to provide proper guidance to the farmers on pests and disease control measures. It is the responsibility of government agencies, including agricultural universities, to impart proper training to the farmers about timely and low cost controlling measures of insects, pests and disease attacks, which will ultimately lead to minimization of losses of crop production. Further, an element of subsidy on insecticides, pesticides and weedicides will induce the farmers to use adequate doses of various pests and disease control measures. It is to be noted that while prices of various inputs, including weedicides, insecticide and fungicide, have grown over time, the returns are not seen to increase in tandem. There is, therefore, a need to control prices of inputs.

The minimization of post-harvest losses will chiefly depend upon adoption of scientific methods of various post-harvest operations, aside from improvement in marketing practices. The scientific methods of harvesting, threshing, winnowing, transportation and storage operations will certainly lead to minimization of total post-harvest losses. It is important for the government agencies to impart training and demonstration to the farmers about adoption of scientific methods of various post-harvest operations. The quick diversion of produce in the market after harvest will also minimize post-harvest losses to a greater extent. However, early market clearance may also lead to low prices on offer. Therefore, there is need to develop such mechanism in which farmers do not suffer when they look for early and timely sale of produce. In such cases, exploitation of farmers from private traders should be prevented. Further, timely harvesting of crop may ensure minimization of losses at harvesting stage. In brief, in order to reduce, post-harvest losses, it is important to develop technologies and techniques that are more appropriate to the needs of small scale as well as large farmers.

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APPENDIX

Appendix 1: Demographic Profile of the Selected Tur and Soyabean Crop Farmers (% of households)

Characteristics		Marginal	Small	Medium	Large	Total
No of HH		51	108	59	22	240
Household size (numbers)		5.64	5.27	5.40	6.77	5.52
Average numbers of earners (M&F)		2.50	2.46	2.67	3.13	2.58
Proportion of Male/Female/Children (%)	Male >15	38.54	38.25	42.32	39.60	39.44
	Female >15	29.86	27.89	21.94	26.17	26.70
	Children <15	31.60	33.86	35.74	34.23	33.86
Identity of respondent (%)	Head	82.36	82.41	86.44	77.27	82.92
	Others	17.64	17.59	13.56	22.73	17.08
Average age of the respondent (% households)	Less than 25	3.92	6.48	6.78	9.09	6.25
	Between 25 to 40	47.06	37.04	27.12	18.18	35.00
	Above 40	49.02	56.48	66.10	72.73	58.75
Highest Education status of a family member (% households)	Illiterate	1.96	6.48	-	-	3.33
	Up to primary	17.65	20.37	10.17	4.55	15.83
	Up to secondary	47.06	39.81	28.81	31.82	37.92
	Higher secondary	15.69	16.67	30.51	27.27	20.83
	Graduate and above	17.65	16.67	30.51	36.36	22.08
Caste (% households)	SC	23.53	15.74	23.73	9.09	18.75
	ST	-	2.78	3.39	-	2.08
	OBC	33.33	60.19	45.76	59.09	50.83
	General	43.14	21.30	27.12	31.82	28.33
Distance from the main market (km)		23.23	18.91	19.96	22	20.37
Annual family income (Rs)		1,02,917	1,14,613	1,71,563	2,75,204	1,40,849

Appendix 2: Characteristics of operational holdings (acres per household) of Tur and Soyabean Crop Farmers

Farm size	Owned land	Un cultivated land	Leased-in	Leased - out	NOA	Irrigated area	GCA	Cropping intensity
Marginal	2.09	0.03	-	0.02	2.04	0.72	2.62	128.43
Small	4.16	0.10	0.09	0.06	4.09	1.61	5.02	122.74
Medium	7.47	0.42	0.26	-	7.31	3.36	9.44	129.14
Large	18.91	1.98	0.27	1.59	15.61	7.64	18.84	120.69
Total	5.89	0.33	0.13	0.18	5.51	2.40	6.86	124.50

Appendix 3: Nature of Tenancy in Leasing-in/ Leasing-out Land (% households) for Tur and Soyabean Crop Farmers

Farm size	Crop sharing	Crop and cost sharing	Fixed rent in cash	Others	Total	% share of tenancy in NOA	Rent amount Rs. Per acre
(Leasing-in)							
Marginal	-	-	-	-	-	-	-
Small	2 (100.00)	-	5 (45.45)	-	7 (53.85)	2.24	8,917
Medium	-	-	5 (45.45)	-	5 (38.46)	3.60	10,600
Large	-	-	1 (9.09)	-	1 (7.69)	1.75	10,500
Total	2 (100.00)	-	11 (100.00)	-	13 (100.00)	2.38	10,236
(Leasing-out)							
Marginal	-	1(100.00)	-	-	1 (20.00)	0.96	-
Small	1 (100.00)	-	1933.33)	-	2 (40.00)	1.56	-
Medium	-	-	-	-	-	-	12,000
Large	-	-	2 (66.67)	-	2 (40.00)	10.19	11,071
Total	1 (100.00)	1 (100.00)	3 (100.00)	-	5 (100.00)	3.24	11,122

Appendix 4: Source of irrigation of net irrigated area (%) for Tur and Soyabean Crop Farmers

Farm size	Irrigated area (acres)	Only canal	Canal + tube-well	Only electric tube-well	Only diesel tube-well	Tanks	Open well	Open well+ River	Others (River)
Marginal	36.50	2.75 (7.53)	1.50 (4.11)	7.5 (20.55)	2.00 (5.48)	-	22.75 (62.33)	-	-
Small	173.75	18.50 (10.65)	10.00 (5.76)	24.5 (14.10)	8.50 (4.89)	-	112.25 (64.60)	-	-
Medium	198.50	16.50 (8.31)	7.50 (3.78)	10.5 (5.29)	7.00 (3.53)	-	143.00 (72.04)	10.00 (5.04)	4.00 (2.01)
Large	168.00	20.00 (11.90)	28.00 (16.67)	4.00 (2.38)	-	-	116.00 (69.05)	-	-
Total	576.75	57.75 (10.01)	47.00 (8.15)	46.50 (8.07)	17.50 (3.04)	-	394.00 (68.31)	10.00 (1.73)	4.00 (0.69)

Appendix 5: Cropping Pattern of Selected Tur and Soyabean Crop Farmers (% of GCA for the whole year)

(in per cent)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Tur	17.04	12.92	11.62	11.58	12.48
Soybean	40.54	32.80	35.44	41.86	36.60
Cotton	8.15	22.98	18.17	18.58	19.04
Jowar	3.75	4.84	5.56	4.58	4.93
Mung	1.12	1.04	1.35	1.09	1.16
Udid	4.87	2.54	1.26	1.81	2.11
Sunflower	0.94	0.55	0.45	0.60	0.56
Rice	0.75	0.74	0.18	0.84	0.58
Bajra	-	0.37	-	0.24	0.18
Sesame	-	0.18	-	-	0.06
Groundnut	-	0.28	-	-	0.09
Maize	-	-	0.54	-	0.18
Vegetable (Chilly, Coriander and Turmeric)	-	0.42	0.81	0.24	0.47
Total	77.16	79.65	75.37	81.42	78.45
Rabi crops					
Wheat	6.37	10.20	10.45	7.36	9.26
Gram	9.36	6.37	10.14	9.05	8.56
Jowar	6.37	1.66	1.44	1.21	1.85
Sunflower	-	-	0.18	-	0.06
Total	22.10	18.22	22.21	17.61	19.73
Perennial crops					
Sugarcane	0.75	2.03	1.70	0.97	1.55
Banana	-	-	0.63	-	0.21
Lucerne	-	-	0.09	-	0.03
Pomegranate	-	0.09	-	-	0.03
Total	0.75	2.12	2.42	0.97	1.82
Gross cropped area	100.00	100.00	100.00	100.00	100.00

Appendix 6: Percentage of area under HYV Seeds for Tur and Soyabean Crop Farmers

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Tur	68.13	84.65	96.14	84.38	86.38
Soybean	98.14	98.31	100.00	100.00	99.34
Cotton	99.95	100.00	100.00	100.00	100.00
Jowar	100.00	94.29	100.00	100.00	98.15
Mung	50.00	68.92	80.00	66.67	71.25
Udid	100.00	96.36	100.00	66.67	91.37
Sunflower	100.00	100.00	100.00	100.00	100.00
Rice	50.00	100.00	0.00	100.00	84.21
Bajra	-	100.00	-	100.00	100.00
Sesame	-	100.00	-	-	100.00
Groundnut	-	0.00	-	-	0.00
Maize	-	-!	100.00	-!	100.00
Vegetable (Chilly, Coriander and Turmeric)	-	55.56	66.67	100.00	67.74
Rabi crops					
Wheat	100.00	98.19	96.57	100.00	98.03
Gram	90.00	79.71	91.15	86.67	87.06
Jowar	35.29	77.78	0.00	0.00	32.79
Sunflower	-	-	100.00	-	100.00
Perennial crops					
Sugarcane	100.00	100.00	100.00	100.00	100.00
Banana	-	-	100.00	-	100.00
Lucerne	-	-	0.00	-	0.00
Pomegranate	-	100.00	-	-	100.00

Appendix 7: Average Yield of Major Crops Grown by the Sampled Tur and Soyabean Crop Households
(Quintals per Acre)

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Tur	4.44	4.54	4.73	4.86	4.66
Soybean	5.31	5.30	5.62	5.57	5.48
Cotton	5.47	5.65	5.76	6.18	5.81
Jowar	4.40	5.10	5.06	5.53	5.14
Mung	2.43	2.66	2.19	2.44	2.41
Udid	2.23	2.35	2.25	2.57	2.35
Sunflower	3.20	3.25	3.20	3.40	3.27
Rice	3.00	3.38	2.25	3.43	3.24
Bajra	-	2.00	-	2.25	2.08
Sesame	-	1.00	-	-	1.00
Groundnut	-	5.33	-	-	5.33
Maize	-	-	4.00	-	4.00
Vegetable (Chilly, Coriander and Turmeric)	-	30.22	27.78	34.00	29.29
Rabi crops					
Wheat	5.12	5.54	5.56	5.80	5.58
Gram	3.90	4.17	4.27	4.88	4.38
Jowar	4.82	4.72	5.16	5.20	4.94
Sunflower	-	-	3.00	-	3.00
Perennial crops					
Sugarcane	300.00	287.27	284.21	300.00	288.63
Banana	-	-	121.43	-	121.43
Lucerne	-	-	80.00	-	80.00
Pomegranate	-	55.00	-	-	55.00

Appendix 8: Percentage of Output Marketed by the Selected Tur and Soyabean Crop Households

Name of the crop	Marginal	Small	Medium	Large	Total
Kharif crops					
Tur	79.78	79.48	82.52	88.44	82.66
Soybean	100.00	100.00	99.59	99.48	99.71
Cotton	100.00	100.00	100.00	100.00	100.00
Jowar	18.18	31.34	45.22	55.24	41.87
Mung	27.40	91.67	72.95	59.09	72.13
Udid	91.38	89.92	95.24	93.51	92.05
Sunflower	100.00	100.00	100.00	100.00	100.00
Rice	16.67	66.67	44.44	41.67	50.41
Bajra	-	100.00	-	44.44	80.00
Sesame	-	100.00	-	-	100.00
Groundnut	-	50.00	-	-	50.00
Maize	-	-	83.33	-	83.33
Vegetable (Chilly, Coriander and Turmeric)	-	95.59	92.00	91.18	92.95
Rabi crops					
Wheat	59.77	73.37	70.06	72.88	71.31
Gram	85.13	92.01	91.10	91.80	91.05
Jowar	51.22	63.53	72.73	65.38	63.02
Sunflower	-	-	100.00	-	100.00
Perennial crops					
Sugarcane	100.00	100.00	100.00	100.00	100.00
Banana	-	-	100.00	-	100.00
Lucerne	-	-	0.00	-	0.00
Pomegranate	-	100.00	-	-	100.00

Appendix 9: Value of Output and Marketed Surplus (aggregate of all crops) for Tur and Soyabean Crop Farmers

	Value of output (main + byproduct)		Value of marketed surplus		% of output marketed (Including Perennial Crops)	% of output marketed (Excluding Perennial Crops)
	Rs Per household	Rs Per acre	Rs Per household	Rs Per Acre		
Marginal	30383	11606	26022	9938	90.35	85.75
Small	68186	13574	62277	12381	95.25	89.72
Medium	128278	13583	117496	12443	94.56	90.08
Large	262030	13832	245335	12931	95.14	92.55
Total	92695	13475	84927	12322	94.69	90.30

**ANNEXURE I: COMMENTS ON DRAFT REPORT BY DESIGNATED AERC
UNIT, INSTITUTE FOR SOCIAL AND ECONOMIC CHANGE,
BANGALORE, KARNATAKA**

1. Title of the Draft Report Examined: Assessment of Pre and Post Harvest
Losses in Tur and Soyabean in Maharashtra

2. Date of Receipt of the Draft Report: 17th April, 2013

3. Date of Dispatch of the Comments: 2nd 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. However, estimates in some tables need to be changed for uniformity and comparison of results across the states.

6. Comments on Analysis, Organization, Presentation etc.

- (i) Since the study has focused on tur and soybean in Maharashtra, wheat and rice mentioned in the objectives should be removed.
- (ii) In Chapter III, author has made appreciable efforts to present the socio-economic and other information of tur and soybean sample farmers. However, author is requested to compute similar tables for entire sample (tur 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. Further, pooling of data will also help to overcome the problem of limited observations on certain variables used in different tables. Along with these tables prepared for pooled sample, author may retain details of crop specific sample farmers in the Chapter.
- (iii) In Chapter IV, Table 4.1 and Table 4.2 should be modified. From the current results given in these tables, it is not possible to state the proportion of the farmers out of the total sample farmers who have faced a particular constraint in the study area 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., 120 households for each crop) rather than the sum of households falling within each constraint.
- (iv) Table 4.4 and Table 4.5 should also be modified in the light of the comment (iii). That is, estimate the percentage of households by each rank out of total sample households (i.e., 120 households) rather than the sum of households falling within each pest/disease/weed category. Likewise, in Table 4.11, page 87, work out the per cent households out of the total sample households.
- (v) In Table 4.5, rows for local variety may be removed. Mention somewhere in the text that the sample farmers grew only HYV and therefore results pertained to HYV only.
- (vi) In Chapter V, Table 5.1 and Table 5.2, calculate the percentage of households for rank of loss vertically (high, medium and low) for each period and variety. Please refer Tables 5.3 and 5.4 in the report where it has been worked out correctly.

(vii) In Table 5.6, workout the percentages by column, i.e. place of storage like kutcha house, pucca house, godown and others. Table 5.9 has been spilt improperly and it requires realignment.

7. Overall view on acceptability of report:

Overall, the report is written well. Author is requested to incorporate all the comments and submit the final report for consolidation.

ANNEXURE II: ACTION TAKEN BY THE AUTHOR ON THE COMMENTS OF THE DESIGNATED CENTRE FOR THE STUDY ENTITLED

“ASSESSMENT OF PRE AND POST HARVEST LOSSES IN TUR AND SOYABEAN CROPS IN MAHARASHTRA”

The author is thankful to the reviewer for the keen interest taken and the suggestions made by him on the report. The comments have been taken care of at length and replies to these comments are given as follows:

4. COMMENTS ON OBJECTIVES: No Revision Required

5. COMMENTS ON THE METHODOLOGY: No Revision Required in Methodology.
Appropriate changes have been made in tables.

6. COMMENTS ON ANALYSIS, ORGANIZATION, PRESENTATION, Etc.:

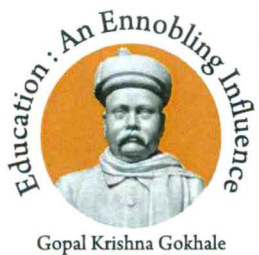
- (i) Correction has been made and incorporated in the objectives.
- (ii) The socio-economic and other information of tur and soyabean farmers provided separately in Chapter III have been computed for entire sample of tur and soyabean farmers put together, and this information is furnished in Appendix 1 to 9. A note about this is extended in the text of Chapter III at appropriate places.
- (iii) Necessary modifications have been made and incorporated in Table 4.1 and Table 4.2. Text has been revised accordingly.
- (iv) Necessary modifications have been made and incorporated in Table 4.4 and Table 4.5. Percentage of households has been computed for each rank of severity for each pest/ disease/ weed category. Necessary changes have been incorporated in Table 4.11. Text has been revised accordingly.
- (v) Rows for local variety have been removed from Table 4.5. It has been mentioned in page 81 that the sampled farmers grew only HYV and, therefore, results pertain to HYV only.
- (vi) Necessary changes have been incorporated in Table 5.1 and 5.2.
- (vii) Necessary modifications have been made and incorporated in Table 5.6, and accordingly, text has been revised. Realignment has been done in Table 5.9 to rectify the problem.

7. OVERALL VIEW ON ACCEPTABILITY OF REPORT:

The report has been recommended for acceptance and submission after necessary corrections. The necessary corrections have been made and incorporated in the report.

July 10, 2013

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