*Chapter 1*

# Introduction

Agriculture is the largest sector of economic activity in India. Agriculture which is considered as the backbone of India, not only provides food and raw materials but also employment to a very large proportion of population. Though its contribution to the overall GDP has declined from about 50 per cent in 1950-51 to lower at 15 per cent in 2010-11, the growth of agriculture and allied activities continue to be a critical factor in overall performance of Indian economy (MoA, 2012). Since agriculture forms the resource base for a number of agro-based industries and agro-services; it would be more meaningful to view agriculture not as farming alone but as a holistic value chain, which includes farming whole selling, warehousing, processing and retailing.

Indian agriculture has undergone considerable transformations overtime. The transformations are seen in the form of changes in agrarian structure, technology interventions, cropping pattern, enterprise mix and marketing system. More emphasis has been placed on increasing agricultural production through adoption of high yielding varieties along with use of chemicals, fertilizer and pesticides. Since land availability is limited, more emphasis have been put on in increasing productivity of crops. All these developments have entailed increased building up of pests and disease which have great negative effect on productivity and hence on production. In order to control pests and disease higher amount of pesticides is used which resulted in developing insects and disease resistance and it further led to reduction in crop yield.

At present scenario, there has been considerable increase in attention to the role of agriculture must play in order to meet the food security needs of the country. Increase in productivity is an essential component of vibrant agriculture sector. Loss in yield of any crops is due to variety of reasons. Improved pre and post harvest technologies are imperative to avoid yield losses in crops which account for a major share of harvested produce. It is also essential to ensure high income to farmers.

## 1.1 The Status of Agricultural Economy in Rajasthan

Rajasthan, with a geographical area of 3.42 lakh sq. km. is the largest state of the country, covering 10.41 per cent geographical area of the country and 5.67 per cent of the

national population (Census, 2011). Physiographically, the state can be divided into four major regions, namely the western deserts: with barren hills, rocky plains and sandy plains, the Aravalli hills: running south-west to north-east starting from Gujarat and ending in Delhi, the eastern plans: with rich alluvial soils and south-eastern. The state has varied climatic conditions ranging from semi-arid to arid. The region to the west and north-west of the hills comprising of 12 districts and spread in 61.11 per cent of the total area of state is either desert or semi desert. The state is administratively divided in 7 divisions and 33 districts.

***Agro-climatic zones***

Rajasthan is spread over four of the agro-climatic zones delineated by the Planning Commission, GoI.

(1) Upper Gangtic plans: Shri Ganganagar and Hanumangarh districts.
(2) Central plateau and Hill region: Ajmer, Alwar, Banswara, Baran, Bharatpur, Bhilwara, Bundi, Chittorgarh, Dholpur, Dungarpur, Dausa, Jaipur, Kota, Pali, Rajsamand, Sawai Madhopur, Karauli, Tonk, Sirohi, Pratapgarh and Udaipur.
(3) Western Plateau and Hill region: Jhalawar.
(4) Western Dry Region: Barmer, Bikaner, Churu, Jaisalmer, Jalore, Jhunjhunu, Jodhpur, Nagaur, and Sikar.

***Agro-economic zones of Rajasthan***

The Planning Commission has divided the country into four agro-economic zones on the basis of certain agro-economic characteristics like level of land productivity, incidence of rural poverty etc., these are as below.

**Zone I:** Area with relatively high level of productivity with either high level of irrigations or high assured rainfall and low incidence of poverty – no district of Rajasthan falls under this zone.

**Zone II:** Area with relatively low productivity, high rainfall, low level of irrigation and high incidence of poverty – Chittorgarh, Pratapgarh and Jhalawar.

**Zone III:** Area with low productivity, low rainfall and high incidence of poverty – Ajmer, Alwar, Banswara, Baran, Bharatpur, Bhilwara, Bundi, Dausa, Dholpur, Dungarpur, Sri Ganganagar, Hanumangadh, Jaipur, Karauli, Kota, Pali, Rajsamand, Sawai Madhopur, Sirohi, Tonk and Udaipur.

**Zone IV:** Ecological fragile areas of the north Himalayan belt, north-eastern region and desert area of Rajasthan and Gujarat. This zone has lot of intra-zonal variation in the levels of productivity, poverty and irrigation etc. The desert districts of Rajasthan, i.e., Barmer, Bikaner, Churu, Jaisalmer, Jalore, Jhunjhunu, Jodhpur, Nagaur, and Sikar are covered in this zone.

***Land utilization***

In 1985-86, 45.46 per cent of the state reporting area was utilized for crop production. This increased to 49.53 per cent in 2009-10. The gross cropped area had shown an increase of 10 per cent, from 52.98 to 63.45 per cent during this period which was mainly due to increase in irrigated area. Cultivable waste land has decreased considerable during these periods, from 17.49 per cent in 1985-86 to 13.06 per cent in 2009-10. While land used for non-agriculture purpose increased from 4.44 per cent to 5.76 per cent during the same period. Other categories of land use did not report much noticeable change during last two and half decades except some exceptional years. Area under forest and barren and uncultivable land each has remained between 6 to 8 per cent.

***Land holding***

In term of average size of land holding, the state ranks third after Punjab and Arunachal Pradesh in the country. The average size of land holding in the state reduced from 4.65 hectares in 1976-77 to 3.65 hectares in 2000-01.

***Agriculture***

Rajasthan is an agrarian state, where a large segment of the population reside in rural areas and is dependent on agriculture as the source of their livelihood. As per 2001 census, agriculture employed 71 per cent of the total workforce. Even though, the share of agriculture sector in the state income has been declining, it continues to be a large contributor to the state's economy. The share of agriculture was 62 per cent in the state domestic product in 1970-71, which reduced to around 23 per cent in 2009-10. Thus, over the years, the structure of the economy has shown definite indications for a change by a gradual shift from primary to other sectors.

Agriculture in the state is essentially rainfed which is susceptible and vulnerable of the vagaries of the monsoon. The state domestic product is also largely dependent on agricultural production, which is subject to wide fluctuations depending on the monsoon conditions. The salient features with regards to agriculture in the state are:

- Agriculture in the state is primarily rainfed. The period of monsoon is short, around three months.
- Cultivation under kharif season is about 61 per cent of the total cultivation which to a large extent is dependent on rains that mostly remain scanty low and irregular.
- Irrigated area under wells and tube wells is nearly about 70 per cent of the total irrigated area. The ground water table in the state is rapidly going down.
- Nearly 30 per cent of agriculture area is under irrigation.

State as a whole is deficient in water resources and do not have perennial river originating from the state. The groundwater resources are inadequate and fast depleting. The agriculture prospects in the state largely depend upon timely arrival of monsoon, quantum and distribution of rainfall. The rainfall is usually erratic, scanty, low and irregular.

***Area, production and yield of major crops***

Even though rich in natural resources, state continues to be backward essentially because of very low rainfall and vast arid and semi-arid areas. Recurring draught and uneven rainfall have become regular features in the state. More than 57 per cent of the state's area is under desert cloy type. In the state, out of the total net area sown and gross cropped area, only 35.48 per cent and 34.63 per cent area were under irrigation during 2008-09 respectively.

**Table 1.1: Area under major crops: Rajasthan state**

(Area in '00 ha.)

| Crops | TE 1977-80 | TE 1987-90 | TE 1997-00 | TE 2007-10 |
|---|---|---|---|---|
| Jowar | 12.47 | 9547.22 | 5502.04 | 6403.59 |
| Bajra | 52.89 | 47266.24 | 42096.17 | 51794.35 |
| Maize | 17.30 | 8793.18 | 9493.02 | 10698.77 |
| Wheat | 34.00 | 17009.89 | 26644.20 | 24269.65 |
| Total cereals | 149.78 | 86494.23 | 87843.19 | 97240.37 |
| Moong | 2058.10 | 2503.44 | 5266.48 | 9564.45 |
| Urad | 1142.28 | 1348.46 | 1665.07 | 1328.04 |
| Moth | 12917.20 | 9883.33 | 9209.15 | 12573.64 |
| Gram | 24.31 | 11023.50 | 19730.35 | 11251.30 |
| Total pulses | 18100.45 | 40996.97 | 55669.26 | 36478.85 |
| Total foodgrains | 18250.22 | 127491.20 | 143512.45 | 133719.23 |
| Sesamum (Til) | 4.98 | 3249.83 | 2382.21 | 4781.34 |
| Ground Nut | 11.95 | 2591.74 | 3076.60 | 3132.70 |
| Soybean | 0.00 | 1198.20 | 5569.96 | 8018.32 |
| Rape & Mustered | 11.19 | 13379.26 | 25051.04 | 24695.17 |
| Total oil seeds | 72.14 | 22912.45 | 40752.91 | 42784.11 |
| Guar | 18.37 | 16816.07 | 20798.44 | 29382.78 |
| GCA | 19908.66 | 175385.88 | 226882.55 | 216475.58 |

Source: GoR (Various years).

Tables 1.1 to 1.3 present growth in area, production and yield of major crops in Rajasthan. It can be seen from these tables that area and production of food grains increased up to late 90's then in next decade area of foodgrains decreased but production increased. The increased productivity resulted increase in production of foodgrains in the state. Yield of bajra, maize and wheat increased significantly. Rajasthan is main pulses producing state in the country but last decade noticed disappointing performance of pulses in terms of area, production and yield.

**Table 1.2: Production under major crops**

(Production in '00 tonnes)

| Crops | TE 1977-80 | TE 1987-90 | TE 1997-00 | TE 2007-10 |
|---|---|---|---|---|
| Jowar | 2.82 | 3611.74 | 1978.47 | 2774.04 |
| Bajra | 7.80 | 16807.05 | 17763.15 | 35296.60 |
| Maize | 6.33 | 9464.05 | 10692.93 | 16470.78 |
| Wheat | 26.80 | 35184.39 | 63998.18 | 73043.03 |
| Total cereals | 51.40 | 70399.56 | 100918.30 | 136857.26 |
| Moong | 356.67 | 703.21 | 878.95 | 2780.44 |
| Urad | 361.49 | 451.98 | 618.15 | 492.78 |
| Moth | 1866.10 | 2042.57 | 1433.72 | 2527.65 |
| Gram | 12.81 | 7850.65 | 15171.26 | 6967.32 |
| Total pulses | 2951.50 | 15354.86 | 23384.17 | 13602.98 |
| Total foodgrains | 3002.90 | 85754.42 | 124302.47 | 150460.24 |
| Sesamum (Til) | 0.55 | 656.47 | 276.00 | 1253.20 |
| Ground Nut | 1.64 | 2190.81 | 3261.12 | 4643.60 |
| Soybean | 0.00 | 1066.20 | 7087.36 | 9303.43 |
| Rape & mustered | 1.76 | 12132.04 | 22101.29 | 29100.70 |
| Total oil seeds | 14.85 | 17140.50 | 34653.24 | 46220.30 |
| Guar | 5.31 | 3667.97 | 4263.72 | 9025.12 |
| GCA | 3965.54 | 123173.62 | 191535.99 | 226747.86 |

Source: GoR (Various years).

Despite the natural constraints, the foodgrains production of the state could witness increase in production from 3 lakh tonnes in TE 1977-80 to 124 lakh tonnes in TE 1997-2000 and again increased to 150 lakh tonne in TE 2007-10. However, year to year wide fluctuations were reported in the production of foodgrains. Rajasthan state has achieved remarkable success in boosting agricultural sector mainly in terms of crop production and productivity of food crops and commercial crops.

Even with low level of agricultural infrastructures, Rajasthan was able to respond to the national priorities and its oilseed production grow from 0.01 lakh tonnes in TE 1977-80 to 34.65 lakh tonnes in TE 1997-2000 and 46.22 lakh tonnes in TE 2007-10.

**Table 1.3: Yield under major crops: Rajasthan state.**

(Kg./ ha.)

| Crops | TE 1977-80 | TE 1987-90 | TE 1997-00 | TE 2007-10 |
|---|---|---|---|---|
| Jowar | 226 | 378 | 360 | 433 |
| Bajra | 147 | 356 | 422 | 681 |
| Maize | 366 | 1076 | 1126 | 1540 |
| Wheat | 788 | 2068 | 2402 | 3010 |
| Total cereals | 343 | 814 | 1149 | 1407 |
| Moong | 173 | 281 | 167 | 291 |
| Urad | 316 | 335 | 371 | 371 |
| Moth | 144 | 207 | 156 | 201 |
| Gram | 527 | 712 | 769 | 619 |
| Total pulses | 163 | 375 | 420 | 373 |
| Total foodgrains | 165 | 673 | 866 | 1125 |
| Sesamum (Til) | 111 | 202 | 116 | 262 |
| Ground Nut | 137 | 845 | 1060 | 1482 |
| Soybean | 0 | 890 | 1272 | 1160 |
| Rape & mustered | 157 | 907 | 882 | 1178 |
| Total oil seeds | 206 | 748 | 850 | 1080 |
| Guar | 289 | 218 | 205 | 307 |
| GCA | 199 | 702 | 844 | 1047 |

Source: GoR (Various years).

***Cropping Pattern***

Details on cropping pattern are given in Table 1.4. Bajra is the single largest crop in terms of area in the state. Except some exceptional years, more than 20 per cent of GCA of the state is cultivated under this crop. Wheat is the most important rabi crop grown in the state. The GCA under wheat was around 0.17 Per cent during TE 1977-80, and it increased to 11.21 per cent in TE 2007-10. Gram is another important rabi crop, area under this crops has increased upto TE 1997-2000, then declined in TE 2007-10. The contribution of the total foodgrains crops in GCA has continuously declined over the period from 91.67 per cent of GCA in TE 1977-80 to 61.77 per cent in TE 2007-10.

Among the oilseeds, rapeseed and mustard is the most important crop in Rajasthan, recording a phenomenal rise in acreage. It covered 11.41 per cent of GCA during TE 2007-10 which was only 0.06 per cent during TE 1977-80. Soybean was not grown in Rajasthan upto 1980. It occupied only 0.68 per cent of GCA during TE 1987-90. Afterwards soybean gained popularity and it was grown on 3.70 per cent area of GCA during TE 2007-10.

The cropping pattern has changed over the years in Rajasthan as a result of development of irrigation, potential production technology, market price, etc. Still agriculture depends largely on monsoon as wide fluctuations are reflected in area,

production and yield over the years. The change in cropping pattern indicates that rainfall continues to play a major role in determining the pattern of land allocation.

**Table 1.4: Cropping pattern of Rajasthan state.**

(% of GCA)

| **Crops** | **TE 1977-80** | **TE 1987-90** | **TE 1997-00** | **TE 2007-10** |
|---|---|---|---|---|
| Jowar | 0.06 | 5.44 | 2.42 | 2.96 |
| Bajra | 0.27 | 26.95 | 18.55 | 23.93 |
| Maize | 0.09 | 5.01 | 4.18 | 4.94 |
| Total Kharif Cereal | 0.50 | 38.27 | 26.00 | 32.54 |
| Wheat | 0.17 | 9.70 | 11.74 | 11.21 |
| Barley | 0.08 | 1.35 | 0.97 | 1.17 |
| Total Rabi Cereal | 0.25 | 11.05 | 12.71 | 12.38 |
| Total Cereals | 0.75 | 49.32 | 38.71 | 44.92 |
| Moong | 10.34 | 1.43 | 2.32 | 4.42 |
| Urad | 5.74 | 0.77 | 0.73 | 0.61 |
| Moth | 64.88 | 5.64 | 4.06 | 5.81 |
| Total Kharif Pulses | 81.10 | 16.36 | 14.85 | 11.50 |
| Gram | 0.12 | 6.29 | 8.69 | 5.20 |
| Musur | 0.85 | 0.06 | 0.18 | 0.10 |
| Total Rabi Pulses | 9.81 | 7.01 | 9.68 | 5.35 |
| Total Pulses | 90.92 | 23.38 | 24.53 | 16.85 |
| **Total Foodgrains** | **91.67** | **72.69** | **63.23** | **61.77** |
| Sesamum (Til) | 0.03 | 1.85 | 1.05 | 2.21 |
| Ground Nut | 0.06 | 1.48 | 1.36 | 1.45 |
| Soybean | 0.00 | 0.68 | 2.45 | 3.70 |
| Total Kharif Oilseeds | 0.29 | 4.07 | 5.12 | 7.98 |
| Rape & Mustered | 0.06 | 7.63 | 11.04 | 11.41 |
| Taramira | 0.00 | 1.06 | 1.78 | 0.36 |
| Linseed | 0.02 | 0.27 | 0.05 | 0.01 |
| Sunflower | 0.00 | 0.04 | 0.00 | 0.00 |
| Total Rabi Oilseeds | 0.07 | 9.00 | 12.87 | 11.78 |
| **Total Oil seeds** | **0.36** | **13.06** | **17.96** | **19.76** |
| Cotton | 0.07 | 2.05 | 2.75 | 1.55 |
| Guar | 0.09 | 9.59 | 9.16 | 13.57 |
| Chillies | 2.12 | 0.20 | 0.16 | 0.08 |
| Sugarcane | 2.21 | 0.11 | 0.09 | 0.04 |
| Coriander | 3.11 | 0.89 | 0.81 | 1.06 |
| Ajwain | 0.00 | 0.00 | 0.07 | 0.08 |
| Garlic | 0.00 | 0.00 | 0.06 | 0.13 |
| Total Other crops | 7.97 | 14.24 | 18.78 | 18.47 |
| GCA | 100.00 | 100.00 | 100.00 | 100.00 |

Source: GoR (Various years).

## 1.2 Importance of Soybean Crop in Rajasthan

Soybean originated in China and was introduced to India centuries ago through the Himalayan routes. As a result, soybean has been traditionally grown on a small scale in

Himachal Pradesh, Uttar Pradesh (Uttaranchal), Eastern Bengal, the Khasi hills, Manipur, the Naga hills and parts of central India covering Madhya Pradesh.

Through the well coordinated and collective efforts of number of national, international and private sector organizations over the years, soybean has become an important crop in India. From about 11000 hectares in 1961, soybean occupies over 6 million hectares in 2003 and 9.33 million hectares in 2011-12 in the country. This has made India as 5$^{th}$ largest producer of soybean in the world today.

**Table 1.5: Major soybean crop producing states in India**

| States/UTs | Area ( '000 ha.) | | | Production ( '000 Tonnes) | | | Yield (Kg. / ha.) | | |
|---|---|---|---|---|---|---|---|---|---|
| | TE 1987-90 | TE 1997-2000 | TE 2007-10 | TE 1987-90 | TE 1997-2000 | TE 2007-10 | TE 1987-90 | TE 1997-2000 | TE 2007-10 |
| Andhra Pradesh | 0 (0.00) | 16 (0.25) | 129 (1.37) | 0 (0.00) | 15 (0.22) | 165 (1.61) | 0 | 954 | 1285 |
| Gujarat | 17 (0.90) | 6 (0.10) | 79 (0.85) | 12 (0.81) | 5 (0.07) | 51 (0.50) | 696 | 813 | 647 |
| Karnataka | 12 (0.64) | 66 (1.06) | 144 (1.53) | 7 (0.49) | 60 (0.86) | 90 (0.88) | 589 | 902 | 626 |
| Madhya Pradesh | 1561 (84.69) | 4499 (72.16) | 5166 (55.10) | 1192 (84.14) | 4742 (68.77) | 5912 (57.52) | 764 | 1054 | 1144 |
| Maharashtra | 97 (5.26) | 1025 (16.44) | 2915 (31.09) | 60 (4.26) | 1312 (19.03) | 2977 (28.96) | 623 | 1281 | 1021 |
| Nagaland | 2 (0.12) | 11 (0.18) | 26 (0.27) | 1 (0.10) | 12 (0.17) | 31 (0.31) | 677 | 1045 | 1223 |
| Rajasthan | 120 (6.50) | 557 (8.93) | 802 (8.55) | 107 (7.52) | 709 (10.28) | 931 (9.05) | 890 | 1272 | 1160 |
| Uttar Pradesh | 18 (1.00) | 42 (0.67) | 8 (0.08) | 22 (1.58) | 30 (0.44) | 7 (0.07) | 1212 | 718 | 886 |
| Others | 17 (0.90) | 13 (0.21) | 108 (1.15) | 16 (1.09) | 11 (0.16) | 115 (1.12) | 934 | 834 | 1071 |
| All India | 1843 (100.00) | 6235 (100.00) | 9376 (100.00) | 1417 (100.00) | 6896 (100.00) | 10279 (100.00) | 769 | 1106 | 1096 |

Note: Figures in parenthesis indicates percentage share in all india.
Source: GoI ( various years)

In India, Madhya Pradesh and Maharashtra are top two soybean producing states accounting for 86 per cent of both the total area and production of the country. Rajasthan stands third in its importance in soybean production in the country. Even though, Madhya Pradesh is the largest soybean producer, its share in the total area and production in the country has significantly declined over the years. Madhya Pradesh accounted for 84.69 per cent of the total area under soybean in the country during TE 1987-90 and subsequently it reduced to 55.10 per cent in TE 2007-10. Maharashtra witnessed increase in the share from 5.26 to 31.09 per cent for the same.

Rajasthan accounted for 6.50 per cent of the total area cultivated for soybean in the country in TE 1987-90 and it remained between 8 to 9 per cent during late 90's and early 2000's. Among these three states, Rajasthan is characterized by the highest per hectare yield (1160 kg.) followed by Madhya Pradesh (1144 kg.) and Maharashtra (1021 kg.). After rapeseed and mustard, soybean is next important oilseed crop in the state. Table 1.5 present the details on it. Table 1.6 and Table 1.7 indicate distribution and overall share of soybean in the total area and production of the total oilseeds in the state and among districts.

**Table 1.6: Major soybean growing districts in Rajasthan: Area**

| Name of Districts | Area in hectare | % of total area under soybean (State) | % of total area under kharif oilseed of respective districts | % of total oilseeds area of respective district | % to GCA of respective district |
|---|---|---|---|---|---|
| **TE 1987-90** | | | | | |
| Kota | 75085 | 62.66 | 78.26 | 40.16 | 10.45 |
| Baran | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| Bundi | 12725 | 10.62 | 52.71 | 23.36 | 4.03 |
| Jhalawar | 19379 | 16.17 | 51.01 | 37.92 | 4.68 |
| Banswara | 504 | 0.42 | 29.84 | 20.77 | 0.14 |
| Chittorgarh | 11982 | 10.00 | 15.29 | 10.01 | 2.43 |
| Pratapgarh | - | - | - | - | - |
| Rajasthan | 119820 | 100.00 | 16.80 | 5.23 | 0.68 |
| **TE 1997-2000** | | | | | |
| Kota | 110807 | 19.89 | 98.85 | 54.59 | 26.69 |
| Baran | 114213 | 20.51 | 97.50 | 49.22 | 25.17 |
| Bundi | 37593 | 6.75 | 92.66 | 31.66 | 8.70 |
| Jhalawar | 172901 | 31.04 | 97.38 | 82.83 | 32.54 |
| Banswara | 8966 | 1.61 | 96.22 | 93.82 | 2.04 |
| Chittorgarh | 106603 | 19.14 | 70.23 | 51.68 | 16.39 |
| Pratapgarh | - | - | - | - | - |
| Rajasthan | 556996 | 100.00 | 47.95 | 13.52 | 2.36 |
| **TE 2007-10** | | | | | |
| Kota | 126287 | 15.75 | 88.30 | 55.61 | 29.39 |
| Baran | 201097 | 25.08 | 96.08 | 64.48 | 37.17 |
| Bundi | 69332 | 8.65 | 81.91 | 44.02 | 17.65 |
| Jhalawar | 235048 | 29.31 | 98.41 | 85.59 | 43.09 |
| Banswara | 21774 | 2.72 | 96.82 | 96.23 | 6.56 |
| Chittorgarh | 74310 | 9.27 | 72.41 | 43.43 | 14.38 |
| Pratapgarh | 65905 | 8.22 | 65.57 | 61.18 | 24.46 |
| Rajasthan | 801832 | 100.00 | 46.02 | 18.67 | 3.63 |

Source: GoR (Various years).

Soybean is grown in kharif season. Its share in the area of total kharif oilseeds in the state was 16.80 per cent during TE 1987-90 which increased to 47.95 per cent in TE 1997-2000 then it reduced slightly to 46.02 per cent in TE 2007-10. Similarly, its contribution in the total area under oilseeds was 5.23 per cent and 13.52 per cent during TE 1987-90 and

TE 1997-2000 respectively. Further, it increased to 18.67 per cent in TE 2007-10. Soybean was not grown in Rajasthan upto early 80's. Area under soybean cultivation was only 0.68 per cent of GCA in TE 1987-90 and it was 2.36 and 3.63 per cent in TE 1997-00 and TE 2007-10 respectively. In absolute term this crop was grown only on 119 thousand hectares in TE 1987-90 and it rose to 802 thousand hectares in TE 2007-10, i.e. about 600 per cent.

**Table 1.7: Major soybean growing districts in Rajasthan: Production**

| Name of Districts | Soybean | % of total soybean | % of total kharif oilseeds production of respective district | % of total oilseeds production of respective district | Total production of all crops (%) |
|---|---|---|---|---|---|
| **TE 1987-90** | | | | | |
| Kota | 73838 | 69.25 | 82.92 | 46.60 | 9.40 |
| Baran | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| Bundi | 6993 | 6.56 | 73.01 | 20.02 | 1.09 |
| Jhalawar | 13261 | 12.44 | 49.59 | 41.60 | 4.10 |
| Banswara | 422 | 0.40 | 44.75 | 30.94 | 0.10 |
| Chittorgarh | 11991 | 11.25 | 16.70 | 11.04 | 1.84 |
| Pratapgarh | - | - | - | - | - |
| Rajasthan | 106620 | 100.00 | 26.64 | 6.22 | 0.86 |
| **TE 1997-2000** | | | | | |
| Kota | 153327 | 21.63 | 99.31 | 60.02 | 22.74 |
| Baran | 139758 | 19.72 | 98.48 | 57.03 | 24.57 |
| Bundi | 35812 | 5.05 | 94.62 | 32.13 | 3.61 |
| Jhalawar | 210823 | 29.75 | 97.74 | 86.99 | 34.51 |
| Banswara | 12363 | 1.74 | 98.90 | 97.88 | 2.24 |
| Chittorgarh | 149100 | 21.04 | 74.71 | 63.46 | 15.29 |
| Pratapgarh | - | - | - | - | - |
| Rajasthan | 708736 | 100.00 | 63.47 | 20.21 | 3.43 |
| **TE 2007-10** | | | | | |
| Kota | 151326 | 16.27 | 94.31 | 51.15 | 18.08 |
| Baran | 227692 | 24.47 | 97.53 | 58.46 | 24.12 |
| Bundi | 71754 | 7.71 | 93.06 | 47.34 | 8.56 |
| Jhalawar | 277917 | 29.87 | 99.05 | 84.66 | 32.88 |
| Banswara | 19064 | 2.05 | 97.54 | 96.96 | 4.11 |
| Chittorgarh | 83410 | 8.97 | 75.04 | 43.34 | 7.89 |
| Pratapgarh | 91524 | 9.84 | 66.59 | 62.61 | 20.08 |
| Rajasthan | 930343 | 100.00 | 54.76 | 20.04 | 3.97 |

Source: GoR (Various years).

On the production side, the share for soybean production in the total kharif oilseeds production increased from 26.64 per cent in TE 1987-90 to 63.47 per cent in TE 1997-2000 and then it reduced to 54.76 per cent in TE 2007-10. Soybean contributed 6.22 per cent in the total oilseeds production in TE 1987-90 and it remained around 20 per cent in next two decades. In absolute term production of soybean increased from 1.06 lakh tonnes in TE

1987-90 to 9.30 lakh tonnes in TE 2007-10. However, both area and production of soybean increased between TE 1997-2000 and TE 2007-10, increase in area was more than increase in production and yield of soybean decreased during this period. Hence, increase in production was due to rise in area under soybean cultivation.

Soybean cultivation has spread into more districts of Rajasthan in last two decades. The soybean growing areas were mainly Kota, Bundi, Jhalawar and Chittorgarh districts in TE 1987-90. Subsequently farmers of Baran, Banswara also started growing soybean. Area under Soybean reported phenomenon increase over the period. Soybean was cultivated in 10.45%, 4.03%, 4.68% and 2.43 per cent of GCA in Kota, Bundi, Jhalawar and Chittorgarh districts respectively in TE 1987-90. The same was 29.39 per cent for Kota, 17.65 per cent for Bundi, 43.09 per cent for Jhalawar and 14.38 per cent for Chittorgarh in TE 2007-10. Pratapgarh was carved out from Chittorgarh district during this period; hence soybean share in GCA of Chittorgarh was less. If both districts are included then it comes to around 39 per cent of their GCA. Thus soybean crop occupies an important place in agriculture economy of few districts in Rajasthan.

### 1.3 Background of Pre and Post Harvest Losses

At present, increased productivity is an essential component of a vibrant agricultural sector and improved pre and post harvest technology is essential to ensure high yield, quantity and quality of products. Large quantity of crops is being lost at pre and post harvest stages. Assessment of pre-post harvest losses at the various stages of production would help to increase yield and would help in identifying factors responsible for such loss and the extent of lost.

***Pre-harvest losses***

Pre-harvest lost is mainly due to pests and disease. The estimation of crop loss due to pests and disease is a complex subject. It is 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 condition. Further, extent of crop loss either physical or financial depends on the type of variety, stage of crop growth, pest population and weather conditions.

Generally, 'Pests' is an organism that causes damage resulting economic loss to plant or animal. The expression of pest is used broadly to insects, other invertebrates like rats, birds, etc., that cause damage to crops, stored products or animal. Disease producing pathogens of plants and weeds are also referred as crop pest.

India with diversified agro-ecosystems responded spontaneously to the technologies of green revolution with introduction of several components in crop production like developing and adopting HYV, usage of high dose of chemical fertilizer, adoption of intensive crop cultivation techniques etc. These had led to development of variety types pests, resistance toward these chemicals use. The ability of some of pests to develop resistance curbs the effectiveness of many commercial chemicals. There were frequent set back to crop production, experienced in the shape of abiotic and biotic stresses during the last two decades in several food crops where intensive farm practices were adopted. In country like India, insects are dominating over other pests by acquiring character like resistance to toxic, chemicals and resurgence particularly in intense crop management of practices adopted by the farmers. In the past one and half decades, the periodical unabated explosions of aphids, whiteflies, bollworms, pod borers, defoliators, coccids, cut worms, plant happens etc., are direct damagers to crops and diseases transmitters in different regions of the country have made agriculture less remunerative and highly risk prone. It was reported that more than 500 insect and mite species are immune to one or more insecticides at present. Similarity about 150 plant pathogens such as fungus and bacteria are now shielded against fungicides. Some of the weedicides also found effective earlier failed to control weeds now-a-days.

Hence, there is need to reduce if not eliminate these losses by protecting the crops from different pests through appropriate techniques. At present day the role of crop protection in agriculture is of great important and a challenging process than before, as the so called resistance spices should be brought under control, if it is not done, yield of crops may reduced drastically.

***Post harvest losses***

India faces large scale losses in crop production especially food crops. The losses are not merely at the farm level for a variety of reasons including non standard quality of inputs, pests and disease attacks, and lack of scientific pre harvest practices. Importantly, there is lack of awareness about post harvest technologies. After the crop is harvested, it undergoes several operations that if improperly done, may result in serious losses. Damage to grain may happen due to improper application of post harvest practices such as threshing, drying or transportation, lack of adequate storage facilities, absence of primary grading and sorting, render food unusable or cause food to rot. At the processing level, use of primitive technology, lack of modernization and inefficiency in energy use result in a huge losses.

Thus there is a sizable quantitative and qualitative loss of crops during different post harvest operations like threshing, winnowing, transportation, processing, storage and marketing.

Among post harvest operations, storage is responsible for the maximum losses. In the field and during storage; the products are threatened by insects, rodents, birds and other pests. Moreover, the products may be spoiled by infection from fungi, yeasts or bacteria. Foodgrains stocks suffer quantitative and qualitative losses while in storage. The quantitative losses are generally caused by factors, such as incidence of insect infestation, rodents, birds and also due to physical changes in temperature, moisture content etc. The qualitative loss is caused by reduction in nutritive value due to the factors, such as attack of insects, pests, 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 at it depends upon agro-climatic conditions. Besides post harvest technology are commodity and location specific.

Farmers store grain in bulk using different type of storage structure made from locally available materials. The major construction material for storage structures in rural area 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 the total six per cent loss of foodgrains is in such storage structures; about half is due to rodent and rest half is due to insects and fungi. The storage at farm level includes: coal tar dram bin, domestic hapur bin, chittor store 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 and grain marketing cooperatives.

Thus infusion of new technologies, better practices, coordination and investment in infrastructure from food production to consumption are critical for reducing food losses and waste at post harvest stages.

### 1.4 Need for the Study

As per the available data, the crop losses caused by pests and diseases are huge. But, the knowledge on the crop loss at the farm level is very much limited. In addition to losses that occur during the growth period of the crop, there is a huge quantity of grains lost during the different process of harvesting, threshing, transportation and storage. Therefore, the present study makes a comprehensive attempt to estimate the dimension of losses occurring during the pre and post harvest stages of selected soybean crop in Rajasthan. For the pre

harvest losses, generally animal pests (insects, mites, rodents, snails and birds), plant pathogens (bacteria, fungi, virus and nematodes) and weeds which are collectively called as 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 of states. 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.

With this in view, the Directorate of Economics and Statistics, Department of Agriculture and Co-operation, Ministry of Agriculture, Government of India entrusted Agro-Economic Research Centre, Vallabh Vidyanagar, Gujarat state to undertake this study for Rajasthan state with the objectives shown below.

### 1.5 Objectives of the Study

The following are the specific objectives of the study:

1. To estimate the physical and financial losses caused by pests and diseases in soybean at farm level.
2. To examine the measures of pests and disease management to reduce the crop loss due to pests and diseases at farm level.
3. To arrive at post harvest losses in 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.

***Framework of the study***

This study makes an attempt to assess the pre and post harvest losses of soybean crop in the Rajasthan state. This common study was conducted for selected crops in 10 states and it is to be co-ordinate by Agricultural Development and Rural Transformation Centre (ADRTC), Institute for Social and Economic Change (ISEC), Bangalore. The survey

proposal, instruments, guidelines, tabulation and chapter scheme, technical inputs and guidance for the study were provided by ADRTC, Institute for Social and Economic Change (ISEC), Bangalore.

### 1.6 Data Base and Methodology

The sampling design used in the study for selection of study districts, blocks, villages and sample farmers along with methodology used for collection and analysis of data is as given below.

***Sampling design***

The study is based on the both primary as well as secondary data. The primary data were collected for agriculture year 2011-12 (July to June). The selection of sample districts, sample blocks, sample villages, sample farmers were made in the following manner:

**i) Selection of sample districts:** As per sampling design provided by the coordinating centre, it was decided to select two districts from Rajasthan state for soybean crop. The selected districts must be the major producing districts of the study crops and should represent the different agro-climatic regions of the state.

On the basis of the area under selected crops and keeping in mind with considering different agro climatic zones, two districts namely 1) Jhalawar and 2) Chittorgarh for studying Soybean in Rajasthan state. District-wise data on area under soybean is given in Table 1.8. The data shows state that first two districts having highest area under soybean were Chittorgarh and Jhalawar districts in Rajasthan.

**ii) Selection of sample blocks:** From each selected districts, one major soybean producing block was selected purposively. As per available data of area under soybean crop, Nimbahera and Jhalarapatan blocks were selected for Chittorgarh and Jhalawar districts respectively.

**iii) Selection of villages:** From each selected block, two sample villages using distance criteria from market /mandi were selected purposively. From each selected block, two villages one nearby the market/mandi centre and one far off from the market centre were selected for canvassing the questionnaire. On the basis of discussion with Deputy Director (Agriculture)/ Assistant Director (Agriculture) and Extension Officials of agriculture of selected blocks, two sample villages were selected from each selected block. The list of selected villages from each districts/blocks and category-wise number of sample farmers selected for study is given in Table 1.9.

**Table 1.8: District-wise area under soybean crop in Rajasthan state**

(Area in '00 ha.)

| Name of Districts | TE 1987-90 | TE 1997-2000 | TE 2007-10 |
|---|---|---|---|
| Ajmer | 0.01 | 0.64 | 0.24 |
| Jaipur | 0.01 | 0.01 | 0.00 |
| Dausa | 0.00 | 0.00 | 0.00 |
| Sikar | 0.01 | 0.01 | 0.00 |
| Jhunjhunu | 0.00 | 0.00 | 0.00 |
| Alwar | 0.00 | 0.12 | 0.01 |
| Bharatpur | 0.00 | 0.08 | 0.00 |
| Dholpur | 0.01 | 0.12 | 0.00 |
| S. Madhopur | 0.24 | 27.35 | 11.96 |
| Karauli | - | 0.00 | 0.06 |
| Bikaner | 0.00 | 0.00 | 0.00 |
| Churu | 0.00 | 0.00 | 0.00 |
| Sri Ganganagar | 0.01 | 0.40 | 0.00 |
| Hanumangarh | - | 0.07 | 0.04 |
| Jodhpur | 0.00 | 0.00 | 0.00 |
| Jaisalmer | 0.00 | 0.00 | 0.00 |
| Jhalore | 0.00 | 0.00 | 0.00 |
| Barmer | 0.00 | 0.00 | 0.00 |
| Nagaur | 0.00 | 0.01 | 0.01 |
| Pali | 0.00 | 0.03 | 0.01 |
| Sirohi | 0.00 | 0.03 | 0.00 |
| Kota | 750.85 | 1108.07 | 1262.87 |
| Baran | 0.00 | 1142.13 | 2010.97 |
| Bundi | 127.25 | 375.93 | 693.32 |
| Jhalawar | 193.79 | 1729.01 | 2350.48 |
| Tonk | 0.03 | 2.28 | 1.09 |
| Banswara | 5.04 | 89.66 | 217.74 |
| Dungarpur | 0.00 | 0.39 | 6.00 |
| Udaipur | 1.01 | 10.22 | 27.02 |
| Bhilwara | 0.12 | 17.21 | 34.25 |
| Chittorgarh* | 119.82 | 1066.03 | 743.10 |
| Rajsamand | 0.00 | 0.20 | 0.10 |
| Pratapgarh* | - | - | 659.05 |
| Rajasthan | 1198.20 | 5569.96 | 8018.32 |

Notes: *Pratapgarh was covered from Chittorgarh recently. For selection purpose data of both are considered as one district (i.e. Chittorgarh).
Source: GoR (Various years).

**iv) Selection of farmers:** From each selected village, total 30 sample farmers growing soybean crop were selected at random. The selected farmers were of different farm size categories i.e. marginal (< 2.50 acres), small (2.51 to 5.00 acres.), medium (5.01 to 10.00 acres) and large (>10.01 acres) and representing different social strata such as SCs, STs, OBCs and General castes. Thus, from each selected district, total 60 sample farmers were selected at random for study. Altogether, 120 sample households were selected for primary survey of the study. The village-wise and farm size-wise distribution of sample farmers is presented in Table 1.9.

**Table 1.9: List of selected districts, blocks, villages and category-wise sample households in Rajasthan state**

| State | Districts | Blocks | Villages | MF | SF | MDF | LF | Total |
|---|---|---|---|---|---|---|---|---|
| Rajasthan state | Chittorgarh | Nimbahera | 1. Ranikheda | 6 | 8 | 9 | 7 | 30 |
| | | | 2. Binota | 8 | 8 | 8 | 6 | 30 |
| | Jhalawar | Jhalara-Patan | 3. Piplod | 7 | 6 | 10 | 7 | 30 |
| | | | 4. Dungargaon | 7 | 8 | 10 | 5 | 30 |
| *Grand Total* | | | | *28* | *30* | *37* | *25* | *120* |

Note: MF=Marginal Farmers (< 2.50 acres), SF= Small Farmers (2.51 to 5.00 acres), MDF=Medium Farmers (5.01 to 10.00 acres) and LF=Large Farmers (>10.01 acres)

***Methods of primary data collection:***

The primary survey instrument was prepared and finalized by Agricultural Development and Rural Transformation Centre (ADRTC), Institute for Social and Economic Change (ISEC), Bangalore after consultation with associated AERCs. The season wise primary data were collected by recall method from the selected sample households by interviewing the decision makers or head of the households. Quantitative/ qualitative information was collected in the schedule on various related aspects such as demographic profile, landholding, season wise cropping pattern, pre and post harvest losses and pest, diseases problems of soybean crop and different chemical and biological methods adapted to control pests and diseases. The quantified data on pre and post harvest losses during the crop, process of harvesting, collection, threshing, transportation and storage were collected from the sample farmers. Opinions of farmers were collected on various aspects such as details of biological methods adopted and nature and physical structure, cost, storage pest controls measures, maintenance of storage structure. Suggestions with respect to minimize pre and post harvest losses of soybean crop were also obtained. In addition to household schedule, a pests and diseases of local and hybrid variety was also administered to capture the data to know and to study the crop losses of both variety.

In addition to field survey, other related important information and data were also collected through personal discussion with District Agriculture Officials, Deputy director (Agriculture) and Officials of State Agriculture and State's different agencies like KVK, Agriculture Universities and research centre of selected crop. In addition to the primary data collected from the farmers, discussed and compiled the crop loss estimates (if any) for pre and post harvest losses with concerned district offices of the Department of Agriculture of state government. The reference year for primary survey was agricultural year 2011-12 (July to June).

***Secondary data collection***

The secondary data required for the study were collected from the various government departments such as Commissionerate of Agriculture, Rajasthan government, Directorate of Economics and Statistics of Rajasthan states and Central/ States government publications and websites. District-wise data on area under soybean crop were collected from above mentioned sources. Block-wise data on area under soybean crop was collected from district level officials like District Agriculture Officials, District Statistical Officials etc.

***Analytical framework***

The main objective of the study is to examine the physical and financial losses caused during pre and post harvest of soybean crop. To study the measures of pests and disease management, the crop loss due to pests and diseases at farm level were collected and analyzed. The data on post harvest losses of soybean crop was also analyzed. 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 were analyzed.

The crop production constraints particularly infestation by pests and diseases, and losses caused by them was worked out based on the estimates provided by the farmers. As not only pests and diseases cause crop damage, there are also other bio-economic factors like soil fertility, water scarcity, poor seed quality, high input costs and low output prices result in consider financial loss to farmers. Thus, data on these bio-economic variables were also collected from the farmers. The post harvest losses during the process of harvesting, collection and threshing, transportation and storage be quantified based on the estimates provided by the farmers. Storage material used by the farmers is generally mud, bamboo, stone, plant materials etc. It is essential to identify the structure of storage at the farmers' level and enumerate the losses occurring in the process of storage at the farmer level.

Qualitative questions were put to farmers on various aspects such as constraints faced in the cultivation of soybean crop, details of biological and other measures to control pests and diseases, advice for pest and diseases management, nature of storage structure, physical condition of storage structure, cost and maintenance of storage structure and storage pest and control measures were also analyzed.

Suggestions with respect to problems faced by farmers and how to minimize pre and post harvest losses with regard to soybean crop production were also obtained from the respondents. In addition to field survey, information on current major problems of soybean

crop, production losses at various stages and the possible solutions to eliminate it were also collected through personal discussion with District Agriculture Officials, Deputy Director (Agriculture) and Officials of State Agriculture Universities, Research centre and State Agriculture Department.

### 1.7 Organization of Report

The present study report is divided into six chapters including this introductory chapter. The trend and growth of area, production and productivity of selected crop using secondary data for study has been presented in chapter two. Chapter three presents socio economic characteristics of sample households, status of production of selected crop, irrigation, cropping pattern and crop productivity, marketed surplus and value of output by farmers. The chapter four presents pre harvest losses of reference crop due to different pest and diseases, different methods of pests and diseases control adopted by sample farmers and household suggestions to minimize the losses. Chapter five provides post harvest losses of reference crop and qualitative and quantitative aspects of storage and their pests control measures adopted by the sample households. Chapter six highlights conclusion and policy recommendations.