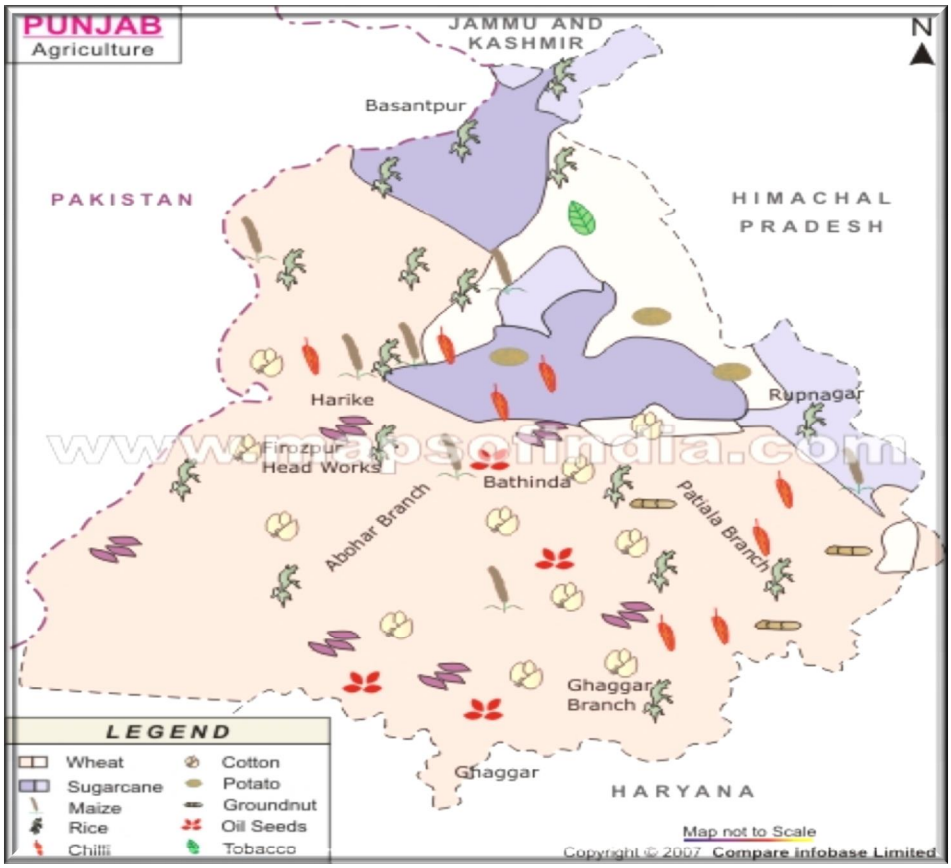
AERC STUDY No. 46

STATE AGRICULTURAL PROFILE – PUNJAB



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December, 2018

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PREFACE

The present report has been prepared by Agro Economic Research Centre, Ludhiana to update the information on various performance related indicators of agricultural sector in Punjab, encompassing state population, demography, structure, performance, natural resources management, farm input management, area, production and yield of major crops, status of agricultural research, education and extension, animal husbandry, dairying, fisheries, post harvest management and value addition etc. The Uniqueness of this report is that it contains recent updated trends based on time series data on various socio-economic parameters in the state. This document would serves as a ready - reckener as well as an effective quantitative tool for reaching to logical conclusions in the context of planning and public policy making.

We express our gratitude to the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, New Delhi for their financial support for preparation of this document.

Authors

Chapter 1

POPULATION DEMOGRAPHY AND ECONOMY

1.1 Introduction

Punjab is situated in the northwest parts of India. It is one of the smallest states of the country, encompassing an area of 50,362 sq. km i.e. 1.5% of Indiaôs geographical area but sustaining about 2.5% of India's population. The state is edged by Pakistan on the west, Jammu and Kashmir on the north, Himachal Pradesh on its northeast and Haryana and Rajasthan in the south. The word Punjab has derived from an Indo-Iranian word suggesting the land of five rivers Ravi, Beas, Satluj, Jhelam and Chenab, but the fragmentation of 1947 left Indian Punjab with only two of these rivers viz Beas and Sultej. The state was further fragmented in 1966 with the formation of Haryana and Himachal Pradesh. At present there are 22 districts in the state, which are again subdivided into three cultural zones; Majha, Malwa and Doaba and five agro-climatic zones; sub-mountain undulating zone, undulating plain zone, central plain zone, western plain zone and western zone.

Punjab holds place of pride among the Indian States for its outstanding achievements in agricultural development. The state has witnessed tremendous increase in the agricultural production during the Green Revolution period, mainly due to healthy mix of institutional and technological factors. Agrarian economy, consolidation of landholdings, reclamation of new agricultural lands, development of irrigation, use of biochemical inputs comprising high yielding variety seeds, chemical fertilizers, insecticides and mechanical inputs were among the important factors which helped Punjab agriculture in making rapid strides. Dominating rural based political power with agricultural background provided favorable environment through thrust on rural and agricultural development. In this context, extension of irrigation network, rural link roads, rural electrification, establishment of focal points and agricultural market centers, efficient delivery system of credit and other agricultural inputs along with effective implementation of agricultural price policy for wheat and paddy played significant role in agriculture and rural development of state. Consequently, the Punjab state comprising only 1.5 percent of the total geographical area of country now contributes 13-14 percent towards the total food grain production of the country. State has earned a name of granary of India and during 2015-16 contributed about 27.33 per cent of rice and 46.22 per cent of wheat to the central pool.

Green Revolution sustained till the eighties, after which the agricultural production in the state started showing the signs of stagnation. In nineties, the escalating cost of cultivation of major crops further aggravated the situation through squeezing the profitability of agriculture, thus adversely affecting the socio-economic condition of farmers in the state. Thus, the agriculture in state has reached a plateau making it very hard to make further progress under available technologies and natural resource base. Its relative contribution in central pool of food grains both for wheat and paddy has also been declining during last few years, though, still being the largest contributor of wheat and second largest of paddy after Andhra Pradesh to central pool of the country.

The emerging scene of Punjab agriculture is not free from some serious concerns. The state cropping pattern dominated by wheat-rice rotation is causing a serious damage to the stateôs natural resource base. Paddy in particular, a water-intensive crop is blamed for water-table depletion in tube-well irrigated areas and water-logging in canal irrigated areas. Increasing incidence of nutrient deficiency in the soils, including micronutrients and insect-pest attacks on the crops are also posing major threats to productivity, food grain production and sustainability of agriculture in the long run. Diversification of cropping pattern towards environment friendly high value crops with emphasis on quality output and promotion of agro-processing industry is the need of hour.

The present study has been an attempt to update the information of the agricultural sector in Punjab state. For this available recent secondary data have been taken from various sources and interpreted.

1.2 Population

Total population of Punjab as per 2011 census is 27,743,338 of which male and female are 14,639,465 and 13,103,873 respectively (Table 1.1). In 2001, total population was 24,358,999 in which males were 12,985,045 while females were 11,373,954. The total population growth in this decade was 13.90 percent while in previous decade it was 20.10 percent. The population of Punjab forms 2.29 percent of India in 2011. In 2001, the figure was 2.37 percent. Literacy rate in Punjab has seen upward trend and is 75.80 percent as per 2011 population census. Of that, male literacy stands at 80.40 percent while female literacy is at 70.70 percent. In 2001, literacy rate in Punjab stood at 69.65 percent of which male and female were 75.23 percent and 63.36 percent literate, respectively. With total geographical area of Punjab at

50,362 sq. km the population density of Punjab during 2011 was 551 per sq km which is higher than national average of 382 per sq km. In 2001, density of Punjab was 484 per sq km, while national average at that time was 324 per sq km. Number of females in Punjab during 2011 was 895 per 1000 males, which was below national average of 943. In 2001, the sex ratio of female was 876 per 1000 males in Punjab. From 2001 to 2011, the share of rural population in the total population of state declined from 66.08 percent to 62.52 percent where as that of urban population increased from 33.92 percent to 37.48 percent (Table 1.2). During this time period the rural literacy rate increased from 64.7 percent to 71.40 percent and that of urban literacy from 79.1 percent to 83.20 percent (Population census, 2011).

Table 1.1: Population statistics of Punjab state

(Number)

Population	**2001**	**2011**
Total state population	24358999	27743338
Male population	12985045 (53.31)	14639465 (52.77)
Female population	11373954 (46.69)	13103873 (47.23)
Population density/sq. km	484	551
Decennial population growth (%)	20.10	13.90
Sex ratio (no. of female per 1000 male)	876	895
Percentage to the total population of India	2.37	2.29
Total literates	14756970	18707137
Male literates	8442293	10436056
Female literates	6314677	8271081
Literacy rate (%)	69.65	75.80
Male literacy rate (%)	75.23	80.40
Female literacy rate (%)	63.36	70.70
Child sex ratio (no. of female per 1000 male)	798	846
Total child population (0-6 age)	3171829	3076219
Male child population	1763801	1665994
Female child population	1408028	1410225

*Literacy has been calculated after excluding 0-6 age group
Figures in the parentheses are percentages to the total population
Source: Statistical Abstract, Punjab

Table 1.2: Description of rural and urban population in Punjab

(Number)

Population	2001		2011	
	Rural	Urban	Rural	Urban
Rural/urban population	16096488	8262511	17344192	10399146
Percentage to total population of the state	66.08	33.92	62.52	37.48
Male population	8516596	4468449	9093476	5545989
Female population	7579592	3794062	8250716	4853157
Sex ratio (no. of female per 1000 male)	890	849	907	875
Total literates	9008631	5748239	10997657	7709480
Literacy rate of the state (%)	64.7	79.1	71.4	83.2
Male literacy rate (%)	71.0	83.0	76.6	86.7
Female literacy rate (%)	57.5	75.5	65.7	79.2
Child population (0-6 age)	2176726	995103	1945502	1130717
Percentage child population	13.52	12.04	11.22	10.87
Child sex ratio(no. of female per 1000 male)	799	796	843	851

Source: Statistical Abstract, Punjab

1.3 Work force structure

With the advent of Green Revolution, Punjab has emerged as the most advanced state in agricultural development. Overtime, though agricultural sector experienced a decline in the importance in terms of its share in GSDP and work force, yet it remains the single most important sector of the state economy. As per 2011 census data, total workforce of state was 9897362, out of which 3522966 were dependent on agriculture and allied activities (Table 1.3). Cultivators and agricultural labours directly dependent on agriculture accounted for about 36 percent of the total workforce of state. Out of the total agricultural work force, cultivators and agricultural labours accounted for 54.92 and 45.08 percent, respectively. Agriculture being the backbone of state economy, other major activities like agro-processing, transportation, trade, storage, etc. are directly or indirectly dependent on it. Thus, performance of agriculture sector determines the scope and rate of development and employment in other sectors as well as overall state economy.

Table 1.3: Distribution of work force in Punjab

(Number)

Particulars	1961	1971	1981	1991	2001	2011
Total cultivators	1602666	1665153	1767286	1917210	2065067	1935000
Total agri. Labour	334610	786705	1092225	1452828	1489861	1588000
Total agri. work force*	1937276	2451858	2859511	3370038	3554928	3522966
Total work force	3466269	3912592	4927759	6098374	9127474	9897362
Share of workers engaged in agri. in total work force	55.89	62.67	58.02	55.26	38.95	35.59
Share of agri. labour in total agri. work force	17.27	32.09	38.20	43.11	41.61	45.08
Share of cultivators in total agri. work force	82.73	67.91	61.80	56.89	58.09	54.93
Share of agri. labour in total work force	9.65	20.11	22.16	23.82	16.32	16.04
Share of cultivators in total work force	46.24	42.56	35.86	31.44	22.96	19.55

*includes main and marginal workers
Source: Statistical Abstract, Punjab

1.4 Overview of the state economy

Economic activities in state are showing structural changes over a period of time and primary sector is experiencing a decline in terms of share in Gross State Value Added (GSVA). Sectoral distribution of GSVA of Punjab state at constant prices (2011-12) and current prices along with percent distribution has been presented through Tables 1.4 to 1.7. Table 1.4 revealed that GSVA of Punjab at constant prices (2011-12) has increased from Rs 25377429 lakhs in 2011-12 to Rs 32408939 lakhs in 2016-17. Overall economy of Punjab state has witnessed a growth rate of 4.23, 5.80 and 6.58 percent during 2014-15, 2015-16 and 2016-17, respectively. At constant prices (2011-12), the contribution of primary sector consisting of agricultural and allied activities towards GSVA has increased from Rs 7820507 lakhs in 2011-12 to Rs 8475553 lakhs in 2016-17. This sector had shown growth of 1.34 and 6.21 percent during 2015-16 and 2016-17 respectively. However, during 2014-15, the primary sector had shown a negative growth of 3.44 per cent.

Table 1.4: Gross State Value Added by sectors in Punjab at constant prices (base 2011-12)
(Rs.Lakh)

Sector	2011-12	2013-14	2014-15(R)	2015-16(P)	2016-17(Q)
Agriculture, forestry and fishing	7816825	8147237	7866141	7976491	8471216
Crops	5007937	5173765	4824441	4795355	5122402
Livestock	2034580	2220929	2286234	2403993	2548046
Forestry and logging	715707	690100	686562	705080	721119
Fishing	58601	62444	68903	72063	79650
Mining and quarrying	3682	7659	8158	3298	4337
Sub-total : Primary	**7820507**	**8154996**	**7874299 (-3.44)**	**7979788 (1.34)**	**8475553 (6.21)**
Manufacturing	3750728	4096020	4298654	4548062	4800504
Electricity, Gas & water supply and other utility services	714903	801289	921702	1053200	1162449
Construction	1978423	1997838	2025364	2061538	2074027
Sub-total : Secondary	**6444054**	**6895147**	**7245721 (5.08)**	**7662799 (5.76)**	**8006980 (4.49)**
Trade, Hotel & restaurants	2532467	3004909	3237423	3463035	3698350
Trade and repair services	2371685	2828781	3056097	3270413	3492503
Hotel & restaurants	160781	176127	181326	192622	205846
Transport, storage & communication related to broadcasting	132324	1517980	1638757	1756459	1881733
Railways	190402	199649	211077	224604	230111
Road transport	625062	728759	776484	822429	883618
Water transport	0	0	0	0	0
Air Transport	2464	3520	9753	15316	19264
Services incidental to transport	32147	37875	4144	44248	47158
Storage	48043	22391	22708	23138	24179
Communication & services related to broadcasting	423205	525987	577592	626724	677403
Financial services	1464304	1602959	1651615	1731383	1800057
Real estate, ownership of dwelling & business services	2274674	2618777	2818121	3014996	3209015
Public administration	1269455	1458937	1574931	1657840	1763888
Other services	2250644	2671396	2968523	3273026	3573363
Sub-total : Tertiary	**11112868**	**12874958**	**13889371 (7.88)**	**14896739 (7.25)**	**15926406 (6.91)**
1.Gross State Value Added	**25377429**	**27925101**	**29009391**	**30539326**	**32408939**

2.Product Taxes	**2192500**	**2810436**	**2999774**	**3299751**	**3612237**
3.Product Subsidies	**907100**	**790564**	**796632**	**815432**	**824738**
Gross State Domestic Product (At market prices) (1+2+3)	**26662829**	**29944973**	**31212533 (4.23)**	**33023645 (5.80)**	**35196448 (6.58)**

Source: Statistical Abstract, Punjab; Figures in parenthesis are percent change over the previous year
Note: P (Provisional), Q (Quick estimates) R (Revised)

Table 1.5: Percentage distribution of Gross State Value Added by sectors in Punjab at constant prices (base 2011-12)

Sector	**2011-12**	**2012-13**	**2013-14(R)**	**2014-15(P)**	**2015-16(Q)**
Agriculture, forestry and fishing	30.80	29.71	29.17	27.10	26.14
Crops	19.73	18.89	18.53	16.63	15.72
Livestock	8.02	7.95	7.96	7.88	7.88
Forestry and logging	2.82	2.65	2.47	2.36	2.30
Fishing	0.23	0.22	0.22	0.23	0.24
Mining and quarrying	0.01	0.01	0.03	0.03	0.03
Sub-total : Primary	**30.81**	**29.72**	**29.20**	**27.13**	**20.17**
Manufacturing	14.78	14.67	14.67	14.84	14.88
Electricity, Gas & water supply and other utility sevices	2.82	2.84	2.87	3.14	3.43
Construction	7.80	7.32	7.15	6.99	6.73
Sub-total : Secondary	**25.40**	**24.83**	**24.69**	**24.97**	**25.04**
Trade, Hotel & restaurants	9.98	10.39	10.76	11.17	11.32
Trade and repair services	9.35	9.76	10.13	10.54	10.69
Hotel & restaurants	0.63	0.63	0.63	0.63	0.63
Transport, storage & communication related to broadcasting	5.21	5.51	5.43	5.65	5.76
Railways	0.75	0.86	0.71	0.72	0.72
Road transport	2.46	2.52	2.61	2.68	2.70
Water transport	0.00	0.00	0.00	0.00	0.00
Air Transport	0.01	0.02	0.01	0.03	0.05
Services incidental to transport	0.13	0.13	0.14	0.14	0.15
Storage	0.19	0.32	0.08	0.08	0.08
Communication & services related to broadcasting	1.67	1.66	1.88	2.00	2.06

Financial services	5.77	5.85	5.74	5.70	5.68
Real estate, ownership of dwelling & business services	8.96	9.22	9.38	9.72	9.88
Public administration	5.00	5.26	5.22	5.43	5.44
Other services	8.87	9.22	9.58	10.23	10.71
Sub-total : Tertiary	43.79	45.45	46.11	48.90	48.79
Gross State Value Added	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: Statistical Abstract, Punjab,
Note: P (Provisional), Q (Quick estimates) R (Revised)

Secondary sector mainly consisting of manufacturing, construction and power sectors has increased at rate of 5.08, 5.76 and 4.49 percent at constant prices during 2014-15, 2015-16 and 2016-17, respectively. In absolute terms, contribution of this sector in GSVA increased from Rs 6444054 lakhs in 2011-12 to Rs 8006980 lakhs in 2016-17. The contribution of tertiary sector of state comprising trade, transport, banking, insurance and public administration towards GSVA had increased from Rs 11112868 lakhs in 2011-12 to Rs 15926406 lakhs in 2016-17. Per annum increase in this sector was recorded at 7.88, 7.25 and 6.91 percent during 2014-15, 2015-16 and 2016-17 respectively.

Table 1.6: Gross State Value Added by sectors in Punjab at current prices (Rs. Lakh)

Sector	**2011-12**	**2013-14**	**2014-15(R)**	**2015-16(P)**	**2016-17(Q)**
Agriculture, forestry and fishing	7816825	9101469	9488170	10155548	11290641
Crops	5007937	5760170	5715593	5952648	6648936
Livestock	2034580	2490291	2804686	3210558	3603612
Forestry and logging	715707	758790	860233	873723	900216
Fishing	58601	92217	107657	118619	137878
Mining and quarrying	3682	8830	9285	3633	3910
Sub-total : Primary	**7820507**	**9110299**	**9497455 (4.25)**	**10159182 (6.97)**	**11294551 (11.18)**
Manufacturing	3750728	4437477	4458534	4919181	5339889
Electricity, Gas & water supply and other utility sevices	714903	959428	1237287	1438406	1607818
Construction	1978423	2256358	2308915	2328300	2387205
Sub-total : Secondary	**6444054**	**7653264**	**8004736 (4.59)**	**8685887 (8.51)**	**9334912 (7.47)**
Trade, Hotel & restaurants	2532467	3368080	3648583	3820775	4077817
Trade and repair services	2317685	3173848	3442746	3593062	3824637
Hotel & restaurants	160781	194232	205836	227713	253180
Transport, storage & communication related to broadcasting	1321324	1663148	1818092	2019379	2268416
Railways	190402	215046	240649	264430	286411

Road transport	625062	786899	845212	900665	983069
Water transport	0	0	0	0	0
Air Transport	2464	4102	6492	11120	17289
Services incidental to transport	32147	40850	44101	47261	56154
Storage	48043	22524	23012	23303	24636
Communication & services related to broadcasting	42305	593727	658626	772600	900857
Financial services	1464304	1706932	1696078	1858225	1933111
Real estate, ownership of dwelling & business services	2274674	2881610	3147413	3354031	3598022
Public administration	1269455	1539947	1753289	1821726	1938391
Other services	2250644	2909626	3312290	3716896	4138893
Sub-total : Tertiary	**11112868**	**14069343**	**15375744 (9.29)**	**16591033 (7.90)**	**17954650 (8.22)**
1.Gross State Value Added	**25377429**	**30832906**	**32877935**	**35436101**	**38584113**
2.Product Taxes	**2192500**	**3326918**	**3689719**	**4766685**	**5746715**
3.Product Subsidies	**907100**	**945130**	**1057472**	**961735**	**964813**
Gross State Domestic Product (At market prices) (1+2+3)	**26662829**	**33214694**	**35510182 (6.91)**	**39241051 (10.51)**	**43366015 (10.51**

Source: Statistical Abstract, Punjab; Figures in parenthesis are percent change over the previous year
Note: P (Provisional), Q (Quick estimates) R (Revised)

The share of crops in GSVA at constant prices (2011-12), which was 19.73 percent during 2011-12 declined to 15.81 percent during 2016-17. During the same period, the share of overall primary sector including livestock, forestry, fishing and mining activities along with crops declined from 30.81 percent to 26.16 percent (Table 1.5). On the other hand, during this period while the share of secondary sector in GSVA declined marginally from 25.40 per cent to 24.70 percent; that of tertiary sector increased from 43.79 percent to 49.14 percent. Thus, in Punjab state the tertiary sector is playing the leading role in contribution towards GSDP followed by secondary and primary sectors.

Table 1.7: Percentage distribution of Gross State Value Added by sectors in Punjab at current prices

Sector	2011-12	2013-14	2014-15(R)	2015-16(P)	2016-17(Q)
Agriculture, forestry and fishing	30.80	29.52	28.86	28.66	29.29
Crops	19.73	18.68	17.38	16.80	17.23
Livestock	8.02	8.08	8.53	9.06	9.34
Forestry and logging	2.82	2.46	2.62	2.47	2.33
Fishing	0.23	0.30	0.33	0.33	0.36
Mining and quarrying	0.01	0.03	0.03	0.01	0.01
Sub-total : Primary	**30.81**	**29.55**	**28.89**	**28.67**	**29.27**
Manufacturing	14.78	14.39	13.56	13.88	13.84
Electricity, Gas & water supply and other utility services	2.82	3.11	3.76	4.06	4.17
Construction	7.80	7.32	7.02	6.57	6.19
Sub-total : Secondary	**25.40**	**24.82**	**24.34**	**24.51**	**24.20**
Trade, Hotel & restaurants	9.98	10.92	11.10	10.78	10.57
Trade and repair services	9.35	10.29	10.47	10.14	9.91
Hotel & restaurants	0.63	0.63	0.63	0.64	0.66
Transport, storage & communication related to broadcasting	5.21	5.39	5.52	5.70	5.87
Railways	0.75	0.70	0.73	0.75	0.74
Road transport	2.46	2.55	2.57	2.54	2.55
Water transport	0.0	0.0	0.00	0.00	0.00
Air Transport	0.01	0.01	0.02	0.03	0.04
Services incidental to transport	0.13	0.13	0.13	0.13	0.15
Storage	0.19	0.07	0.07	0.07	0.06
Communication & services related to broadcasting	1.67	1.93	2.00	2.18	2.33
Financial services	5.77	5.54	5.16	5.24	5.01
Real estate, ownership of dwelling & business services	8.96	9.35	9.57	9.47	9.33
Public administration	5.00	4.99	5.33	5.14	5.02
Other services	8.87	9.44	10.09	10.49	10.73
Sub-total : Tertiary	43.79	45.63	46.77	46.82	46.53
Gross State Value Added	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: Statistical Abstract, Punjab,
Note: P (Provisional), Q (Quick estimates) , R (Revised)

The Per capita income is an indicator of standard of living of the population. At current prices the per capita income in Punjab state has increased from Rs. 49380 in 2007-08 to Rs. 131112 in 2016-17 (Table 1.8, figure I). Though in absolute terms the state per capita figures sound to be higher than that of national level (Rs. 74380 at current prices in 2013-14);

performance of state among different states of country had slipped down from its first rank in early 2000s to 10th rank in recent times.

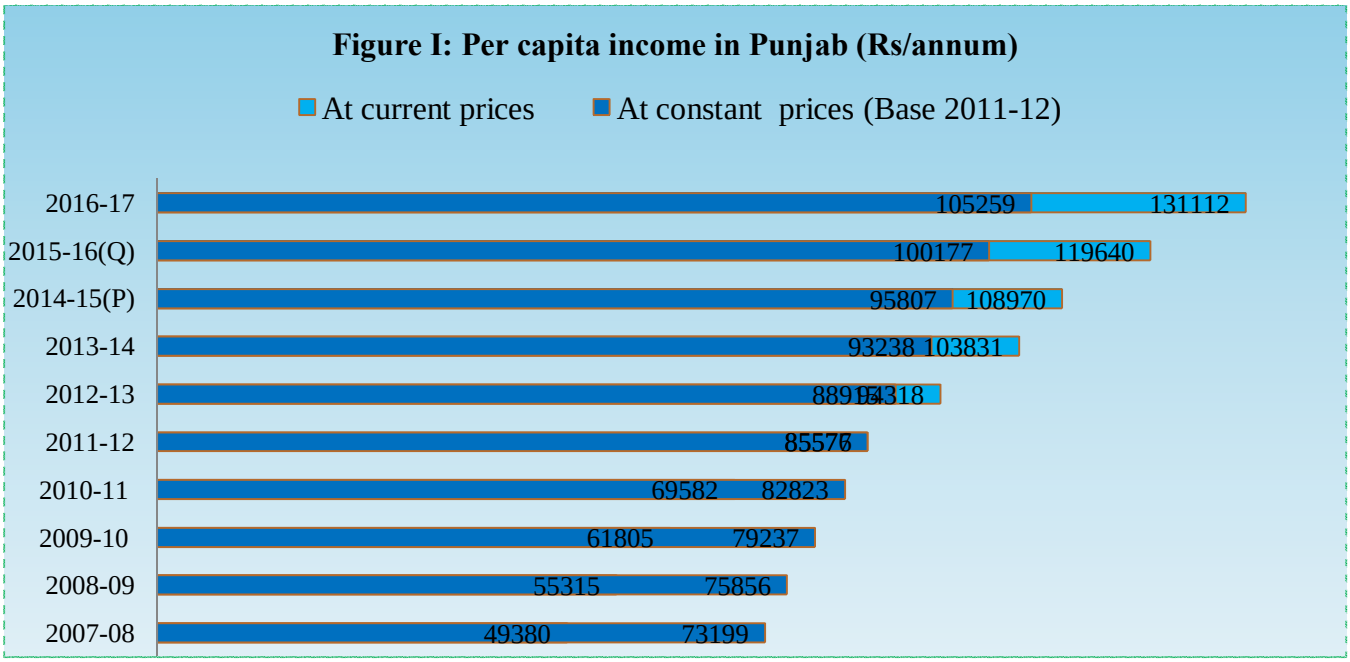
At constant prices (base 2011-12) the per capita income of state had shown an increase of about 44 per cent viz. from Rs. 73199 in 2007-08 to Rs. 105259 in 2016-17.

Table 1.8: Per capita income in Punjab

(Rs/annum)

Year	At current prices	At constant prices (Base 2011-12)
2007-08	49380	73199
2008-09	55315	75856
2009-10	61805	79237
2010-11	69582	82823
2011-12	85577	85576
2012-13	94318	88915
2013-14	103831	93238
2014-15(P)	108970	95807
2015-16(Q)	119640	100177
2016-17	131112	105259

Source: Statistical Abstract, Punjab
Note:, P-Provisional, Q-Quick estimates



Chapter 2

STRUCTURE AND PERFORMANCE OF PUNJAB AGRICULTURE

In the wake of new technology, Punjab agriculture made a rapid progress since mid sixties. This progress has been made possible by speedy adoption of improved seeds, irrigation and increased use of non-conventional inputs like fertilizers, machinery and pesticides supported by the natural resource base of the state. The progress was spectacular in early phase due to rising agricultural productivity and expansion in gross cropped area. However, of late the progress in agricultural production has slowed down and signs of stagnation are visible. The changes in agrarian structure and agricultural growth performance of state are being presented in this chapter.

2.1 Agrarian structure

Distribution of operational holdings, cropping patterns and proportionate share of each sub-sector in primary sectorôs contribution towards Gross State Domestic Product (GSDP) determines the agrarian structure. The agrarian structure of Punjab state revealed by above said factors is discussed in this section as follows:

2.1.1 Operational holdings

The information on distribution of operational holdings in state of Punjab at two points of time viz. 2005-06 and 2010-11 is depicted in Table 2.1. The figure shows that the total operational holdings in state during the last six years period increased by 50 thousands from 10.03 lakh to 10.53 lakh. Point worth noting is the marginalization of holdings with proportionate increase in marginal and small farmers. The proportion of marginal and small holdings which was 13.36 percent and 18.25 percent in 2005-06 increased to 15.57 percent and 18.82 percent in 2010-11, respectively. On the other hand, the proportion of holdings in all other categories viz. semi-medium, medium and large had been declined during this period. Over this period the average holding size in state also went down from 3.95 hectares to 3.77 hectares.

Table 2.1: Distribution of operational holdings in Punjab

Size category	2005-06			2010-11		
	Number (000)	Area (000,ha)	Average size of holding	Number (000)	Area (000,ha)	Average size of holding
Marginal (Below 1 ha)	134 (13.36)	83 (2.09)	0.62	164 (15.57)	101 (2.55)	0.61
Small (1-2 ha)	183 (18.25)	258 (6.51)	1.41	195 (18.82)	269 (6.78)	1.38
Semi-medium (2-4 ha)	319 (31.80)	855 (21.57)	2.68	325 (30.86)	855 (21.55)	2.64
Medium (4-10 ha)	296 (29.51)	1701 (42.91)	5.75	299 (28.40)	1713 (43.18)	5.75
Large (10 ha and above)	71 (7.08)	1067 (26.92)	15.03	70 (6.65)	1029 (25.94)	14.75
All holdings	1003 (100.00)	3964 (100.00)	3.95	1053 (100.00)	3967 (100.00)	3.77

Note: P-Provisional
Figures in parentheses indicate percentage of total holdings
Source: Agriculture at a Glance, Directorate of Agriculture, Punjab

2.1.2 Cropping pattern

Cropping pattern refers to the proportionate area under different crops during a crop year. Kharif and rabi are two main cropping seasons in the state. In the post green revolution era, the state of Punjab has witnessed a considerable change in its cropping pattern. Traditionally, Punjab has been predominantly a wheat growing area. Rice stormed in the cropping pattern since mid 1970ôs as a commercial crop and made a major impact on the Punjab agriculture. The area under wheat has increased two and a half times since 70ôs. During, 1970-71, about 40.49 percent of the gross cropped area (GCA) was under wheat which increased to 44.33 percent in 2016-17 (Table 2.2). The increase in wheat cultivation has been at the cost of gram, rapeseed and mustard. The area under paddy has increased ten folds during last five decades by replacing crops like cotton, kharif pulses, maize, jowar, Bajra and kharif oilseeds. The area under rice which occupied only 6.87 percent of gross cropped area during 1970-71 jumped up to 33.15 percent in 2007-08, and then rose further to around 38.77 percent in 2016-17. The state has extreme specialization of paddy-wheat cropping system which may be attributed to effective implementation of agricultural price policy with minimum support price (MSP) and relative

profitability of these crops as compared to other crops. As a result at present about 83 percent of the gross cropped area of the state has been encroached by paddy and wheat.

Cotton is ranked third in the cropping pattern of the state. The area under this crop in 1970-71 was about 7 percent of gross cropped area, increased to 9.34 percent in 1990-91. After mid -1990s the area under cotton had adversely affected due to inclement weather and pest attack and its share in GCA went down to 5.97 percent in 2000-01. With the introduction of Bt varieties area under cotton again rose to 7.69 percent in 2007-08. But during 2016-17 it accounted for only 3.64 percent of the GCA in state. The proportionate area under maize kept on declining since 1970-71 from 9.77 percent to 1.51 percent in 2016-17. Area under sugarcane and potato has not remained stable over time and accounted for 1.11 per cent and 1.18 per cent of GCA during 2016-17 respectively. Respective share of pulses and oilseeds in GCA has recorded a sharp decline from 7.29 and 5.20 percent in 1970-71 to 0.26 and 0.54 percent in 2016-17. It can be concluded that imbalance in favour of two main cereals viz. rice and wheat in the cropping pattern has further sharpened despite all efforts of diversification in the state agriculture.

Table 2.2: Shift in cropping pattern in Punjab (1970-71 to 2016-17)

(Percent to Gross cropped area)

	1970-71	1980-81	1990-91	2000-01	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
	40.49	41.58	43.63	42.92	44.31	44.57	44.72	44.53	44.63	44.69	44.72	44.61	44.5
	6.87	17.49	26.86	32.89	33.15	34.57	35.58	35.85	35.61	36.20	36.30	36.85	37.7
	6.99	9.60	9.34	5.97	7.69	6.66	6.49	6.13	6.52	6.11	6.13	5.27	4.2
	9.77	5.65	2.51	2.08	1.96	1.91	1.76	1.69	1.65	1.66	1.67	1.60	1.6
	0.30	0.59	0.31	0.75	1.14	1.04	1.05	0.81	0.89	1.02	1.01	1.13	1.1
	2.25	1.05	1.35	1.52	1.37	1.02	0.76	0.89	1.01	1.04	1.13	1.23	1.1
	7.29	5.04	1.91	0.68	0.34	0.28	0.24	0.25	0.25	0.25	0.24	0.17	0.2
	69.18	68.82	75.55	79.05	80.03	81.58	82.52	82.52	82.35	83.01	83.10	83.35	84.2
	5.20	3.52	1.32	1.01	0.76	0.76	0.79	0.71	0.66	0.65	0.60	0.59	0.6
	20.84	15.48	12.77	12.18	9.28	9.19	8.61	9.14	8.78	8.37	8.2	8.55	8.7

Source: Statistical Abstract, Punjab

2.1.3 Relative share of different agricultural activities in primary sector

Sub-sectoral distribution of GSVA from primary sector of state at constant prices (2011-12) and current prices along with percent contribution of each component from year 2011-12 onwards has been presented through Tables 2.3 and 2.4. Table 2.3 revealed that during 2011-12, at constant prices, out of total share of primary sector in GSVA at Rs 7820507 lakhs, crops, livestock, forestry & lodging and fishing accounted for about Rs 5007937, Rs 2034580, Rs 715707 and Rs 58601 lakhs, respectively. During 2016-17, out of total primary sectorôs contribution to GSVA at Rs 8475553 lakhs, the respective contribution of above sub-sectors was at Rs 5122402, Rs 2548046, Rs 721119 and Rs 79650 lakhs.

Table 2.3: Share of different primary sub-sectors in total primary sector at constant (2011-12), Punjab

Note: P-Provisional, Q-Quick estimates

Sector	2011-12	2013-14	2014-15(R)	2015-16(P)	2016-17(Q)
Agriculture, forestry and fishing	7816825 (99.95)	8147237 (99.90)	7866141 (99.90)	7976491 (99.96)	8471216 (99.95)
Crops	5007937 (64.03)	5173765 (63.44)	4824441 (61.27)	4795355 (60.09)	5122402 (60.44)
Livestock	2034580 (26.02)	2220929 (27.23)	2286234 (29.03)	2403993 (30.13)	2548046 (30.66)
Forestry and logging	715707 (9.15)	690100 (8.46)	686562 (8.72)	705080 (8.84)	721119 (8.51)
Fishing	58601 (0.75)	62444 (0.77)	68903 (0.88)	72063 (0.90)	79650 (0.94)
Mining and quarrying	3682 (0.05)	7759 (0.10)	8158 (0.10)	3298 (0.04)	4337 (0.05)
Primary	**7820507 (100.00)**	**8154996 (100.00)**	**7874299 (100.00)**	**7979788 (100.00)**	**8475553 (100.00)**

Note: P-Provisional, Q-Quick estimates
Figures in parentheses indicates percent share in total primary sector
Source: Statistical Abstract, Punjab

The collective percent share of agriculture, forestry and fishing sub-sector in GSVA from primary sector at constant prices (2011-12), which was 99.95 percent during 2011-12, remained at same level during 2016-17. While, during this period the contribution of crops in primary sector declined from 64.04 to 60.44 percent, the contribution of livestock increased from 26.02 to 30.66 percent. Over this period, the respective share of forestry sub-sector in overall primary sector of state declined marginally from 9.15 to 8.51 percent. On the other hand, during this time period the share of fishing had increased marginally from 0.75 percent to 0.94 per cent. Thus,

within agriculture sector there were only marginal changes in respective share of different components over this time period.

Table 2.4: Share of different primary sub-sectors in total primary sector at current prices, Punjab

(Rs. Lakh))

Sector	2011-12	2013-14	2014-15(R)	2015-16(P)	2016-17(Q)
Agriculture, forestry and fishing	7816825 (99.95)	9101469 (99.90)	9488170 (99.90)	10155548 (99.96)	11290641 (99.97)
Crops	5007937 (64.04)	5760170 (63.23)	5715593 (60.18)	5952648 (58.59)	6648936 (58.87)
Livestock	2034580 (26.02)	2490291 (27.33)	2804686 (29.53)	3210558 (31.60)	3603612 (31.91)
Forestry and logging	715707 (9.15)	758790 (8.33)	860233 (9.06)	873723 (8.60)	900216 (7.97)
Fishing	58601 (0.75)	92217 (1.01)	107657 (1.13)	118619 (1.17)	137878 (1.22)
Mining and quarrying	3682 (0.05)	8830 (0.10)	9285 (0.10)	3633 (0.04)	3910 (0.03)
Primary	**7820507 (100.00)**	**9110299 (100.00)**	**9497455 (100.00)**	**10159182 (100.00)**	**11294551 (100.0)**

Note: P-Provisional, Q-Quick estimates
Figures in parentheses indicates percent share in total primary sector
Source: Statistical Abstract, Punjab

2.2 Growth performance of Punjab agriculture

The progress made by agriculture in Punjab state is unparalleled in the history of the world agriculture. The state which was deficit in food at the time of independence has made rapid strides in agricultural development and contribution to the central pool towards strengthening Indiaôs self sufficiency. Dominating agrarian structure, consolidation of holdings, development of irrigation infrastructure and hard working peasantry led to the early progress. With adoption of new agricultural technology in mid sixties backed with adequate agricultural policies, the state turned surplus in food grains and became a model of Indiaôs successful green revolution strategy. Selected agricultural growth indicators of the state have been presented in Table 2.5 and 2.6. Overtime, the production of wheat in the state significantly grew at the CAGR of 2.61 percent per annum from 5.62 million tones in 1971-72 to 17.64 million tones in 2016-17.

Table 2.5: Area, production and yield of different crops and milk production, 1971-72 to 2016-17, Punjab

Crop		1971-72	1981-82	1991-92	2001-02	2010-11	2012-13	2013-14	2014-15	2015-16	2016-17
Wheat	A	2336	2914	3237	3420	3510	3517	3510	3505	3506	3495
	P	5618	8544	12309	15499	16472	16614	17610	15086	16068	17636
	Y	2405	2932	3803	4532	4693	4724	5017	4304	4583	5046
Rice	A	450	1269	2069	2487	2830	2849	2849	2895	2970	3046
	P	920	3750	6739	8816	10833	11390	11259	11111	11803	12638
	Y	2044	2955	3257	3545	3828	3998	3952	3838	3974	4149
Maize	A	548	340	176	165	138	131	131	126	127	116
	P	857	625	345	449	497	482	510	460	474	445
	Y	1564	1838	1962	2722	3707	3679	3898	3652	3735	3835
Cotton	A	475	686	719	606	483	481	445	421	335	278
	P	1030	1275	2505	1305	1822	1627	1491	1342	389	1243
	Y	369	316	592	366	641	575	570	542	197	760
Sugar cane	A	103	104	109	142	70	82	89	97	92	88
	P	403	601	693	925	417	483	552	600	638	675
	Y	3913	5779	6358	6514	5952	5890	6197	6186	6930	7670
Potato	A	17	33	31	57	64.4	80	79	89	92	92
	P	222	635	617	1147	1609	2001	1980	2230	2365	1650
	Y	13430	19419	19981	20054	24988	25013	25062	25056	25706	17934
Pulses	A	384	325	90	49	20	20	19	13	20	20
	P	302	161	75	30	17	12	17	12	10	12
	Y	786	495	833	612	850	600	895	923	500	600
Total food Grains	A	3915	4999	5638	6152	6504	6533	6522	6549	6635	6651
	P	7925	13156	19632	23878	27846	28551	29443	26708	28393	30763
	Y	2024	2632	3482	3881	4281	4370	4514	4078	4279	4625
Total oilseed	A	319	225	141	83	56	51	47	46	48	42
	P	272	173	127	84	73	70	60	58	52	58
	Y	853	769	901	1012	1304	1373	1276	1261	1083	1381
Milk (Lakh tones)	P	21.04	34.94	53.82	79.30	94.23	97.24	100.13	103.51	107.74	112.82

A: Area in 000ðha, P: production in 000 metric tones and Y: Yield in kg/ha

Note: Production of sugarcane is in terms of gur

Cotton production is cleaned cotton and is in terms of thousand bales of 170 kgs each, Yield (lint kg/ha)

Oilseeds does not include figure relating to non-edible oil seed e.g. Castor seeds

Source: Statistical Abstract, Punjab

Table 2.6: Compound Annual Growth Rates (CAGR) of major crops and milk production in Punjab

(Percent/annum)

Crop	1971-72 to1980-81			1981-82 to1990-91			1991-92 to 2000-01			2001-02 to 2016-17		
	A	P	Y	A	P	Y	A	P	Y	A	P	Y
Wheat	2.55***	5.02***	2.41***	0.97***	3.70***	2.71***	0.41*	2.54***	2.12***	0.19***	1.15***	0.95
Rice	12.98***	17.70***	4.17***	4.85***	5.61***	0.73ns	2.72***	2.84***	0.12ns	1.19***	1.84**	0.64
Maize	-4.60***	-4.00***	0.62ns	-5.72***	-7.08***	-1.41ns	-1.79**	1.57ns	3.42*	-1.96***	1.22*	3.56
Cotton	3.43***	1.62**	-1.74***	1.18ns	9.81**	8.53***	-3.58*	-11.17***	-7.86**	-2.91*	-3.51ns	-0.6
Sugar-cane	-3.33*	-0.65ns	2.78**	0.91ns	0.76ns	-0.14ns	2.29ns	2.14ns	-0.16ns	-2.75*	-1.84ns	0.9
Potato	11.75***	17.59***	5.11***	-2.77ns	-2.24ns	0.49ns	14.14***	13.93***	-0.01ns	2.22***	3.82***	1.5
Pulses	-1.64ns	-3.73ns	-2.13ns	-7.16***	-4.40ns	2.97ns	-5.67***	-7.97***	-2.44**	-6.34***	-7.22***	-1.3
Total food-grains	2.39***	6.04***	3.57***	1.23***	3.88***	2.61***	1.11***	2.57***	1.44***	0.44***	1.35***	0.90
Total oilseeds	-5.78***	-6.38***	-0.64ns	-6.27**	-4.57ns	1.81ns	-6.02*	-6.56ns	-0.57ns	-5.32***	-3.66***	1.7
Milk	-	4.25***	-	-	4.52***	-	-	4.40***	-	-	2.00***	

Source: Statistical Abstract, Punjab, A: Area, P: Production and Y: Yield

***, ** and * Significant at one, five and ten percent level of probability, respectively

Similarly, the production of rice another major crop of state, during this period increased by about twelve times from 0.92 million tones to 12.63 million tones i.e at CAGR 5.11 per cent. Total food grain production over this period increased by 3.7 times. Wheat and rice productivity increased remarkably in State from 2405 Kg/ha and 2044 kg/ha during 1971-72 to 5046 kg/ha and 4149 kg/ha respectively during 2016-17. Besides, production of cotton, potato and milk during this period has been gone up by 1.45, 9.86 and 4.76 times, respectively. On the other hand, the production of pulses and oilseeds went down drastically over this period and that of sugarcane with some variations remained almost same. The reason of decline of production of these crops was the drastic decline of area under these crops due to encroachment by paddy and wheat. However, except pulses yields of these crops increased significantly during this time period (Table 2.6).

2.3 Drivers of agricultural growth

Punjab state has made a remarkable progress in agriculture through taking a big leap forward in terms of irrigation facilities, use of chemical fertilizer, pesticide, high yielding varieties, mechanization etc. Backed with effective agricultural policies, the farmers of state tended their crops according to the advice of experts through well established agricultural extension network and achieved the record productivity levels. Major drivers of agricultural growth in the state are provided through Table 2.7. The irrigated area, as percent to the net area sown in 1970-71was 71 per cent and it has been increased to a level of about 99.6 percent by the year 2016-17. The number of tube wells has gone up from 1.92 lakh in 1970-71 to 14.19 lakh in 2016-17. The proportion of area under HYVs to gross cropped area has increased tremendously. Hundred percent of the area of wheat and rice is under HYVs and that of maize is nearly 98 percent. The adoption of HYVs in Punjab has tremendously raised the consumption of chemical fertilizers and plant protection materials. The per hectare consumption of chemical fertilizers (NPK) which was merely 37.50 kg in 1970-71 has gone up to 232 kg in 2016-17. Total consumption of chemical fertilizers (nutrient) in state which was only 213 thousand tons in 1970-71 has reached to 1917 thousand tons in 2016-17. Consumption of Insecticides (Technical Grade) has increased from 3200 MT in 1980-81 to 5843 MT in 2016-17.

The rapid adoption of the green revolution technology in Punjab has led to the sharp increase in farm mechanization. The number of tractors in state was only 5281 in 1970-71

Table 2.7: Growth drivers in Punjab agriculture

Indicators/Period	1970-71	1980-81	1990-91	2000-01	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Tractors (Number) *	5281	118845	289064	410000	425200	434000	NA	476835	488504	472179	-	4.72
Number of tractors per 000ô ha	1.3	28	70	96	102	104	-	115	118	115	-	-
No. of tube wells (Lakh)	1.92	6.00	8.00	10.73	13.76	13.82	13.83	13.85	14.05	14.06	14.19	14.19
Number of tube wells per 000ô ha	47.37	143.06	189.66	252.47	330.93	332.37	334.54	333.74	348.61	342.93	343.25	343.58
Cropping intensity (%)	140.09	161.37	177.86	186.07	189.69	190	191	190	189	189	191	189
Consumption of chemical fertilizers (000' nutrient tone)	213	762	1222	1313	1866	1911	1918	1972	1713	1677	1943	1917 (P)
Consumption of chemical fertilizers (kg/ha)	38	113	163	168	237	243	243	239	251	247	257	232 (E)
Consumption of insecticides/pesticides (technical grade M.T)	-	3200	6500	6970	5745	5600	5690	5725	5720	5699	5721	5843
Gross cropped area (000ôha)	5678	6763	7502	7941	7876	7882	7902	7870	7848	7857	7872	7823
% of net irrigated area to net area sown	71	81	93	95	97.9	97.9	98.8	99.2	99.9	99.9	99.9	99.6
No. of Regulated markets	88	120	143	144	146	146	149	149	151	152	153	153
Area under HYVs in 000'ha (figures in parentheses are percent of total area under crop)												
Rice	130 (33.33)	1095 (92.56)	1906 (94.59)	2506 (95.94)	2802 100.00	2830 100.00	2814 (100.00)	2849 (100.00)	2849 (100.00)	2895 (100.00)	2970 (100.00)	3046 (100.00)
Maize	49 (8.83)	127 (41.78)	160 (85.11)	154 (93.33)	140 (100.00)	129 (93.48)	126 (96.92)	124 (94.65)	125 (96.15)	126 (100.00)	111 (87.48)	114 (98.28)
Wheat	1589 (69.12)	2757 (98.04)	3271 (99.94)	3408 (100.00)	3522 (100.00)	3510 (100.00)	3527 (100.00)	3517 (100.00)	3512 (100.00)	3505 (100.00)	3506 (100.00)	3495 (100.00)
Minimum support price (Rs./qtl)												
Paddy	51	105	205	540	980	1030	1110	1280	1345	1400	1525	1700
Wheat	76	117	215	580	1100	1170	1285	1350	1400	1450	1450	1625
Cotton	-	304	620	1625	2500-3000	2500-3000	2800-3300	3600-3900	3700-4000	3750-4050	3860-4100	3860-4160
Market arrival of major food crops in 000, tones (figures in parentheses are percent of total production)												
Paddy	637 (62.03)	4432 (91.38)	7882 (81.17)	11057 (80.50)	14237 (84.90)	13136 (81.35)	11926 (75.80)	13395 (117.77)	13192 (117.09)	11841 (106.61)	14333 (121.23)	17915 (141.76)
Wheat	2375 (46.16)	4270 (55.62)	7109 (58.47)	9698 (62.36)	10994 (72.48)	10278 (62.40)	11094 (61.70)	12834 (77.34)	11097 (62.98)	11932 (79.08)	10506 (65.49)	11834 (66.35)

Source: Statistical Abstract, Punjab, * 2000-01 onwards as per Agriculture at a glance, Directorate of Agriculture, Punjab

had gone to 4.72 lakh during 2016-17. Punjab state is one of the leading states for number of tractors tillers in terms of density per 1000 hectare of net sown area. Development of irrigation infrastructure along with large scale mechanization of state agriculture helped in increasing the gross copped area from 5678 thousand hectares in 1970-71 to 7823 thousand hectares in 2016-17. Consequently, over this period the intensity of cropping jumped from 140 percent to 189 percent. Effective price policy through significant increase in Minimum Support Prices (MSP), assured procurement and development of market infrastructure particularly for wheat and paddy coupled with relatively better production technology available has driven the state agriculture at remarkable rate and resulted into the emergence of paddy and wheat crops as the most secure and profitable ones in the state.

Thus, rapid dissemination and adoption of new technologies and modern inputs viz. HYVs, fertilizers and pesticides, irrigation, agricultural credit, development of necessary infrastructure and setting up of institutional mechanisms for the supply of agricultural inputs and procurement of agricultural produce created an enabling environment for enhancing the agricultural production in the state.

2.4 Marketing and warehouse facilities

Besides the advancement in farm technology the agricultural development also depends upon the improvement in market infrastructure to ensure better returns to the farmers. Under Agricultural Produce Markets Act, 1961 the market charges in Punjab have been regularized and transactions are conducted by open auction in the regulated markets. Under this act at the market level there is a market committee represented by farmers, traders, labourers and officials of agriculture and cooperative departments. The weights and measurement act provides for standardization of weights and measures used in the markets.

To facilitate the efficient marketing of farm produce and agricultural input delivery system in the state, Punjab Mandi Board the coordinating body for market committees played a lead role in developing the village approach roads and market yards on priority. Indicators of marketing infrastructure presented in Table 2.8 reflected that the number of regulated market in Punjab has increased from 88 in 1970-71 to 153 in the year 2016-17. Likewise, during the same period the number of sub-yards attached with these regulated markets has increased from 154 to 282. Over this period, the geographical area and average number of villages served per regulated market in Punjab decreased from 573 to 329 sq. km and from 139 to 81, respectively.

Table 2.8: Market and warehouse infrastructure in Punjab

Particulars	1970-71	1985-86	2000-01	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
No. of regulated markets	88	130	144	145	145	146	146	149	149	151	152	153
No. of sub yards attached	154	516	519	294	294	294	294	294	294	275	275	283
Average no. of villages served per regulated market	139	94	86	85	85	85	84	82	82	81	80	81
Average area served per regulated market (Sq. Km)	573	387	350	347	347	347	345	338	338	334	331	336
No. of focal points	NA	362	597	597	596	596	596	596	596	600	1144	396
Marketed surplus of foodgrains and non foodgrains handled (Lakh tones)	NA	132.40	270.56	311.44	325.93	332.06	326.96	289.59	304.86	299.64	316.94	316.23
Percent of villages linked with metalled roads	NA	97.59	99.24	99.90	100.00	100.00	100.00	100.00	100.00	99.4	99.4	99.4
State owned storage capacity (Lakh tones)	NA	117.63	251.59	176.39	203.50	209.55	226.33	234.04	146.16	245.84	220.95	232.84
Storage capacity as % to procurement of Paddy and Wheat	NA	88.11	121.22	56.23	85.44	83.05	99.66	101.67	89.85	101.21	92.94	93.74

Note: NA ï Not available.
Source: Statistical Abstract, Punjab

The Punjab Mandi Board provided all weather metalled roads to all the villages so that the farmers could sell their output throughout the year. It is very encouraging that hundred percent villages of Punjab are linked with the all weather metalled roads which helped in efficient marketing of farm output in the state.

With large scale state procurement of food grains which takes time to be dispatched to the deficit states; state owned storage capacity remained a major issue. In the recent years many steps have been taken in this regard and the total state owned storage capacity increased from 203.50 lakh tons in 2008-09 to 246.29 lakh tones in 2016-17 (Table 2.9). During 2016-17, Food Corporation of India (FCI) owned the maximum storage capacity to the tune of 45.80 percent followed by Food Supply Department (18.88%), Punjab State Civil Supply Corporation (11.95%), and Punjab Agro Industries Corporation (7.66%).

Table 2.9: Agency-wise state owned storage capacity in Punjab (Lakh tones)

Agency/Year	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
FCI	63.18 (31.05)	76.30 (36.41)	83.22 (36.77)	83.96 (35.87)	103.20 (43.62)	117.04 (47.61)	111.80 (50.60)	109.53 (47.05)	112.79 (45.80)
Markfed	30.15 (14.82)	41.52 (19.81)	44.34 (19.59)	43.30 (18.50)	41.03 (17.34)	29.18 (11.87)	0.88 (0.40)	0.74 (0.32)	13.61 (5.53)
Punjab state civil supply corporation	23.02 (11.31)	31.59 (15.08)	32.37 (14.30)	33.36 (14.25)	33.26 (14.06)	31.56 (12.84)	30.79 (13.94)	29.44 (12.64)	29.44 (11.95)
Punjab agro industries corporation	15.20 (7.47)	19.50 (9.31)	29.92 (13.22)	29.92 (12.78)	20.39 (8.62)	23.31 (9.48)	20.25 (9.16)	18.86 (8.10)	18.86 (7.66)
Food supply department	11.79 (5.79)	18.70 (8.92)	18.38 (8.12)	23.36 (9.98)	18.38 (7.77)	25.66 (10.44)	29.32 (13.27)	46.50 (19.97)	46.50 (18.88)
State warehousing corporation	52.74 (25.92)	19.54 (9.32)	16.57 (7.32)	19.24 (8.22)	19.75 (8.35)	18.93 (7.70)	20.80 (9.41)	20.64 (8.86)	17.57 (7.13)
Central warehousing corporation	7.09 (3.48)	2.28 (1.09)	1.29 (0.57)	0.68 (0.29)	0.35 (0.15)	0.09 (0.04)	7.03 (3.18)	7.06 (3.03)	7.03 (2.85)
Marketing board	0.33 (0.16)	0.12 (0.06)	0.24 (0.11)	0.22 (0.09)	0.21 (0.09)	0.07 (0.03)	0.08 (0.04)	0.07 (0.03)	0.49 (0.20)
Total state owned storage capacity	203.50 (100.00)	209.55 (100.00)	226.33 (100.00)	234.04 (100.00)	236.57 (100.00)	245.84 (100.00)	220.95 (100.00)	232.84 (100.00)	246.29 (100.00)

Figures in parentheses are percentages to total, Storage capacity includes hired and open storage capacity.
Information relates to 31st March.
Source: Statistical Abstract, Punjab

2.5 Emerging demand-supply mechanics

To meet the increasing demand of food grains, the country is heavily dependent on the availability of adequate local supplies particularly from the Punjab state. To maintain the tempo of food grains production, the production incentive oriented procurement prices to the farmers are provided by the government. As a result of the assured market at remunerative prices coupled with market infrastructure and available production technology, the Punjab farmer countered countryôs demand for foodgrains through pushing up the wheat and paddy production

remarkably, and thus strengthened the foodgrain self sufficiency of the nation. Currently, about 83 percent of the gross cropped area in state is under these two crops. The market arrival of these two crops in the state has been depicted through Table 2.10. During 2016-17, market arrival of paddy and wheat has been observed at 179.15 lakh tones and 118.34 lakh tones, respectively. Due to decentralization of procurement, although the share of state in central pool of food grains has been declining from last few years; still Punjab is the largest contributor. During 2016-17, state contributed about 29.00 per cent of rice and 46.40 per cent of wheat towards central pool (Table 2.11).

Table 2.10: Market arrivals of major crops in Punjab

(000, tones)

Year	Paddy	Wheat
2007-08	12802	7911
2008-09	13234	10584
2009-10	14237	10994
2010-11	13136	10278
2011-12	11926	11094
2012-13	13395	12834
2013-14	13192	11097
2014-15	11841	11932
2015-16	14333	10506
2016-17(P)	17915	11834

Source: Statistical Abstract, Punjab, P: Provisional

Table 2.11: Contribution of Punjab towards the central pool of food grains

(Lakh tones)

Year	Rice	Wheat
2007-08	79.8 (27.80)	67.8 (60.90)
2008-09	85.5 (25.10)	99.4 (43.80)
2009-10	92.8 (28.90)	107.3 (42.20)
2010-11	86.3 (25.30)	102.1 (45.40)
2011-12	77.3 (22.10)	109.6 (38.70)
2012-13	85.6(25.10)	128.3(33.60)
2013-14	81.06(25.46)	108.97(43.40)
2014-15	77.86(24.20)	116.41(41.54)
2015-16	93.50(27.30)	103.44(36.80)
2016-17(P)	110.52(29.00)	106.49(46.40)

Information of wheat pertains to marketing year whereas that of rice pertains to crop year
Figures in parentheses are percentage contribution in central pool, P: Provisional
Source: Statistical Abstract, Punjab

Observing the agency-wise procurement, it can be seen from Table 2.12 that since 2008-09 the role of government agencies in procurement has been increased in a major way which pushed the private traders nearly out of paddy and wheat trade in the state. During 2016-17, the government agencies procured 98.16 percent of the total market arrivals of wheat in the state. Similarly, a giant share (97.91%) of market arrivals of paddy during 2016-17 has been procured by the government agencies. As the government is the major player in rice and wheat trade in the state, private traders are reluctant to enter the market for the same. For cotton, the third most important crop of state, demand mainly comes from private mills and traders. However in some years significant quantities were also purchased by state owned Cotton Corporation of India (Table 2.13).

Table 2.12: Procurement of paddy and wheat by different agencies in Punjab, (000, tones)

Agency	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16(P)
Paddy								
State government/ Pungarain	3627 (27.41)	4155 (29.18)	4073 (31.01)	3375 (28.30)	3796 (28.34)	3696 (31.21)	4516 (31.51)	6011 (33.55)
FCI	205 (1.55)	671 (4.71)	517 (3.94)	182 (1.53)	579 (4.32)	288 (2.43)	654 (4.56)	359 (2.00)
Markfed	2775 (20.97)	2864 (20.12)	2707 (20.61)	2597 (21.78)	2906 (21.69)	2689 (22.71)	3133 (21.86)	3900 (21.77)
PUNSUP	2714 (20.51)	3171 (22.27)	3021 (23.00)	2837 (23.79)	2909 (21.72)	2607 (22.02)	2992 (20.87)	3827 (21.36)
PSWC	1502 (11.350	1687 (1.85)	1488 (11.33)	1303 (10.93)	1268 (9.47)	1122 (9.48)	1324 (9.24)	1734 (9.68)
Traders	1133 (8.56)	371 (2.61)	209 (1.59)	483 (4.05)	623 (4.65)	222 (1.87)	381 (2.66)	329 (1.84)
Punjab Agro Industries Corporation (PAIC)	127 (89.66)	1318 (9.26)	1121 (8.53)	1149 (9.63)	1314 (9.81)	1217 (10.28)	1333 (9.30)	1755 (9.80)
Total	13234 (100.00)	14237 (100.00)	13136 (100.00)	11926 (100.00)	13395 (100.00)	11841 (100.00)	14333 (100.00)	17915 (100.00)
Wheat								
State government	1847 (17.45)	1682 (15.30)	1707 (16.61)	1760 (15.86)	2213 (17.24)	2292 (19.21)	2083 (19.83)	2651 (22.40)
FCI	1074 (10.15)	1716 (15.61)	1654 (16.09)	1664 (15.00)	1933 (15.06)	1838 (15.40)	1849 (17.60)	1460 (12.34)
Markfed	2481 (23.44)	2557 (23.26)	2382 (23.18)	2623 (23.64)	2841 (22.14)	2556 (21.42)	2094 (19.93)	2424 (20.48)
PUNSUP	2369 (22.38)	2392 (21.76)	2301 (22.39)	2492 (22.46)	2921 (22.76)	2450 (20.53)	2056 (19.57)	2231 (18.85)
PSWC	1279 (12.08)	1403 (12.76)	1122 (10.92)	1284 (11.57)	1465 (11.41)	1334 (11.18)	1251 (11.91)	1796 (15.18)
Traders	334 (3.16)	22 (0.20)	61 (0.59)	37 (0.33)	-	290 (2.43)	161 (1.53)	247 (2.09)
Punjab Agro Industries Corporation	1200 (11.34)	1222 (11.12)	1051 (10.23)	1234 (11.12)	1461 (11.38)	1172 (9.82)	1012 (9.63)	1025 (8.66)

(PAIC)								
Total	7911 (100.00)	10584 (100.00)	10994 (100.00)	10278 (100.00)	11094 (100.00)	12834 (100.00)	11932 (100.00)	11834 (100.00)

Note:P-Provisional, Procurement by Pungrain for the year 2015-16
Figures in parentheses are percentage to the total, Source: Statistical Abstract, Punjab

Table 2.13: Purchase of cotton by Cotton Corporation of India (CCI) in Punjab

(000ôbales of 170 kg each)

Year	At MSP	Commercial	Total
2007-08	0	78.98 (100.00)	78.98
2008-09	1043.81 (99.85)	1.60 (0.15)	1045.42
2009-10	86.60 (89.90)	9.73 (10.10)	96.33
2010-11	0	100.78 (100.00)	100.78
2011-12	0	11.76 (100.00)	11.76
2012-13	0	18.44 (100.00)	18.44
2013-14	0	70.27 (100.00)	70.27
2014-15	127.72 (100.00)	0	127.72
2015-16 (as on December 2016)	0	0	0

Figures in parenthesis are percentage to total
Source: Agricultural Statistics at a Glance

Under contract farming scheme, some companies have entered to the Punjab market to buy the farm output. For this, these companies make the contract with farmers to purchase the specific quantity of specific quality produce at some pre decided price. Basmati, maize, hyola and malting barley were the main crops grown under this scheme (Table 2.14). However, area under contract farming in state went down drastically over time from 95312 hectares in 2007-08 to only 827 hectares during 2016-17. It was only malting barley which had been grown under contract farming scheme during 2016-17. Thus, there is need to explore and address the poor performance of contract farming initiative in state.

Table 2.14: Area of different crops under contract farming scheme in Punjab

(Hectares)

Year	Hyola	Durum Wheat	Malting Barley	Basmati Pure	Maize	Green Pea	Potato Seed	Total
2007-08	13273	-	3020	33614	45405	-	-	95312
2008-09	14130	-	2488	33606	43012	448	-	93684
2009-10	7326	-	3277	29966	33028	449	1625	75670
2010-11	-	600	3051	28322	-	254	1671	33899
2011-12	-	-	4784	-	-	-	-	4784
2012-13	-	-	5941	-	-	-	-	5941
2013-14	-	-	2792	-	-	-	-	2792
2014-15	-	-	2354	-	-	-	-	2354
2015-16	-	-	955.2	-	-	-	-	955.2
2016-17	-	-	826.8	-	-	-	-	826.8

Source: Statistical Abstract, Punjab

Chapter 3

NATURAL RESOURCE MANAGEMENT

To match the increasing demands for food by the fast growing population of the country, the main emphasis in Punjab state remained on increasing the food grain production with little attention on managing its natural resource base. There has been continuous increase in the net sown area in the state and currently the proportion of net sown area to total geographical area is the highest in the country. Punjab state has recorded remarkable growth in agriculture sector as almost 100 percent of the cultivated area is under assured irrigation which is the major reason for higher productivity and input use in agriculture. The intensive agriculture, particularly monoculture of wheat and paddy is now imposing intense pressure on the available natural resources which requires new vision and holistic approach for their management. Now there is need to promote the optimum management of soil and water resources so as to conserve these to improve the almost stagnant productivity. The government policies, availability of resources, appropriate agro-technologies, social and economic factors influence the way in which vital resources are used and managed. Present land use scenario and management of soil and water is discussed in this chapter.

3.1 Land use pattern

The Punjab state lies between the 29°33'-32°3'N latitude and 73°53'- 76°55'E longitude and is bounded on the, west by Pakistan, on the north by Jammu and Kashmir, on the north -east by Himachal Pradesh and on the south by Haryana and Rajasthan. The land use classification of state for period 2007-08 to 2016-17 is presented in Table 3.1. The total geographical area, of the state is 50.36 lakh hectares. During 2016-17, about 82 percent of the area in state was already under cultivation. This is the highest in country and the state is virtually comparable to a farmstead where most of the area is under the cultivation leaving little land for other activities. Further, there is virtually no land left to bring under cultivation, due to recent spurt in urbanization the net sown area declined from 41.58 lakh hectare in 2009-10 to 41.30 lakh hectare in 2016-17. However, during this period the cropping intensity remained almost same i.e 189 percent had arrested any fall in gross cropped area in state from 78.76 lakh hectare to 78.23 lakh hectare. The forest wealth of state is very poor with only 5.08 percent area under forest cover. The area under permanent barren and un-culturable land which has 23-25 thousand hectares in state during 2009-10 to 2011-12 surprisingly doubled in 2012-13 to 51 thousand hectares and itôs

52 thousand hectare during 2016-17. The state has virtually reached the saturation point in the matter of addition to the physical area horizontally; the vertical expansion of area has become increasingly limited due to already achieved higher levels of cropping intensity and some topographical and irrigational constraints in some pockets of the state. Therefore, sustainability in the growth of production per unit of land area has to come through raising the input use efficiency or upward shift in the use of technology.

Table 3.1: Land use pattern in Punjab

(000 hectares)

Area/Period	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17(P)**
Geographical area	5036	5036	5036	5036	5033	5036	5036	5036
Forests	295	294	294	262	258	256	256	256
Barren and un-culturable land	25	25	24	51	51	58	52	52
Land put to non-agricultural use	503	503	508	486	498	430	475	475
Culturable waste	2	2	4	5	6	7	16	16
Permanent pastures &other grazing land	4	4	4	5	5	5	5	5
Land under tree crops & groves not included in net area sown	5	4	4	9	8	8	9	9
Current fallow	37	33	45	58	55	55	77	77
Fallow land other than current fallow	4	4	(a)	6	6	6	6	6
Net area sown	4158	4158	4134	4150	4145	4119	4137	4130
Net area sown as percentage to total area	83	83	82	82	82	82	82	82
Area sown more than once	3718	3724	3767	3720	3703	3738	3734	3699
Gross cropped area	7876	7882	7902	7870	7848	7857	7872	7823
Cropping intensity	189.69	190	191	190	189	189	191	189

Source: Statistical Abstract, Punjab, (P) Provisional

(a) Below 500 hectares, R: Revised

3.2 Soil management

Most of the soils of Punjab are alluvial and deep, varying from sandy to silty clay. The soils of Punjab, having developed on alluvium are at initial to medium stage of profile development. They are generally very deep porous sandy loam in texture, and show weak to moderately developed soil structures with good soil-air-water relationship. The soils have great potential for agricultural production in view of their high reserves of weather able minerals. With present state of intensive agriculture surface crusts, sub-soil compaction, soil erosion, development of hard pan, development of fine textured sodic soils, water logging, free percolation in coarse soils and poor permeability in fine textured soils, salinity/sodicity and pollution from agro-chemicals, sewerage and industrial effluent, depletion of organic matter, multi-nutrient deficiencies, nutrient imbalance, decline in quality and quantity of soil biomass, low-biological oxidation and slow rate of decomposition of crop residues are the major problems being faced by the Punjab soils**.**

In some parts of the state due to fluctuating ground water table, use of poor quality irrigation water, improper soil and water management practices and lower topographic positions resulted into accumulation of salts in the upper soils and turning these into saline and sodic. The sodic soil can be brought under cultivation by application of gypsum and following rice-wheat cropping system. Total land reclaimed through gypsum application in state so far stand at 5.91 lakh hectare (Table 3.2).

Table 3.2: Land reclaimed through gypsum application, Punjab

Year	Gypsum distributed (000ô tones)	Subsidy Utilized (Rs in Lakh)	Area reclaimed (000 ha)	
			Yearly	**Cumulative**
2007-08	62	297	12	572.34
2008-09	-	-	-	-
2009-10	15	184	3.10	575.34
2010-11	20	268.4	4	591.34
2011-12	-	-	-	-
2012-13	-	-	-	-
2013-14	-	-	-	-
2014-15	-	-	-	-
2015-16(T)	15	-	-	-

Source: Agriculture at a Glance, Directorate of Agriculture, Punjab, T-Target

Water erosion is the major problem in Kandi area located in the shivalik foot-hills. The south-western parts of the state face the problem of wind erosion in the months of May and June. During the last decades considerable efforts have been made to reduce the wind eroded areas by

following land-development (leveling and or clearing of sand dunes) and crop management practices and by bringing more areas under irrigated agriculture. The problem of water logging is particularly acute in south-western districts (Ferozepur, Fazilika, Muktsar and Faridkot) of the state occupying lower topographic positions. Introduction of salt resistant crops and good drainage system may overcome this problem to some extent.

As per expert views, the high nutritional requirement of paddy and wheat has exhausted the Punjab soils of vital nutrients. Thus, higher and higher doses of major nutrients, especially nitrogen, have to be applied for sustaining adequate production levels. Low fertility status obviously implies that the amount of plant nutrient that the soil itself is capable of making available to the growing crop is far less than that needed for getting high yields. Most of the state soils test low to medium in available nitrogen and available phosphorus. The soils in general are medium to high in available potassium. Micronutrient deficiencies in large areas have also been noticed adversely affecting the crop yield. The soils contain sufficient calcium and magnesium. However, their deficiencies can be observed in local pockets supporting sodic soils. Recently sulphur deficiency has been recorded in some soils, especially in coarse-textured soils, receiving high-analysis fertilizers. In recent years, widespread deficiency of one or more micro-nutrients has been observed, resulting in significant decrease in crop yield especially of high-yielding varieties. Deficiency of zinc is of widespread occurrence, particularly in the central and south-western districts. Deficiencies of iron and manganese have been observed in coarse-textured soils recently brought under rice-wheat cropping system.

Thus, it is more important to preserve existing cultivated areas in the state from degradation due to water logging, soil salinity and sodicity, besides soil erosion due to intensive cropping and its attended manifestations. Repeated paddy cultivation in the long run will make the soils fine textured, impervious and unfit for cultivation. Corrective measures through intensive R & D have to be undertaken to conserve soil resources. Speedy soil-testing facilities, followed by appropriate advice about fertilizers use, can effectively help to save the soils from exhaustion.

3.3 Cropping Intensity

Cropping intensity is a measure of the extent of multiple cropping. In Punjab state there has been progressive increase in intensity of cropping over the years and now intensive copping i.e. getting two crops from the same field is a common feature. Statistics on cropping intensity of

the state for recent years have been presented in Table 3.3. The data reflected that cropping intensity in state increased marginally from 188 percent in 2007-08 to 191 per cent in 2011-12 and again in 2015-16, but at 189 percent in 2013-14. This, already higher level of cropping intensity indicates that in Punjab state the vertical expansion of area in future has become increasingly limited.

Table 3.3: Cropping Intensity in Punjab State

Year	Percent
2007-08	187.96
2008-09	189.69
2009-10	189.00
2010-11	190.00
2011-12	191.00
2012-13	190.00
2013-14	189.00
2014-15	189.00
2015-16	191.00
2016-17	189.00

Source: Statistical Abstract, Punjab

3.4 Land ceiling limit

In state the ceiling on land is as per the Punjab Land Reforms Act, 1972. Subject to the provisions of section 5 of this act, no person shall own or hold as landowner or mortgagee with the possession or tenant or partly in one capacity and partly in another in excess of the permissible area. Limits of the permissible area are described in Table 3.4.

Table 3.4: Permissible land ceiling limit under Punjab land reforms act, 1972

S No	Particulars	Permissible area (ha)
1	Land under assured irrigation and capable of yielding at least two crops in a year (in this Act referred to as the first quality land)	7
2	Land under assured irrigation for only one crop in a year	11
3	Barani land	20.5
4	Land of other classes including banjar land, and area is to be determined accordingly to the prescribed scale with reference to the intensity of irrigation, productivity and soil classification of such classes having regard to the respective valuation and the permissible area of the classes of land mentioned at (1), (2) and (3) Provided that: a) Where land consists of two or more classes, the permissible area shall be determined on the basis of relative valuation of sub class of land, subject to the condition that it does not exceed 21.8 hectares b) Where the number of member of a family exceeds five, the permissible area shall be increased by one-fifth of the permissible area for each	< 21.8

	member in excess of five, subject to the condition that additional land shall be allowed for not more than three such members.	

Source: Agricultural Statistics at a Glance

3.5 Water management

In Punjab about 99 percent of the net sown area is irrigated. The state has excellent surface and groundwater irrigation infrastructure. Surface irrigation distribution network comprises of 1, 45,000 kilometers of canals including branch canals and minor distributaries, and one lakh kilometers of field channels or water courses. The canal irrigation system irrigated 1186 thousand hectare in 2016-17 accounting for 28.74 per cent of the net irrigated area in state (Table 3.5). While canal irrigation has been almost stable over the years with some variations, tube well irrigation, particularly in the central and northern region of Punjab has been on the increase and during 2016-17, there were about 14.19 lakh tube wells providing irrigation to about 2940 thousand hectares of land accounting for 71.25 per cent of the net irrigated area in state.

Table 3.5: Source-wise net area irrigated in Punjab

(000, ha)

Year	Govt. canals	Private canals	Tube well & wells	Other sources	Total	% of net irrigated area to net area sown
2007-08	1142	-	2922	4	4068	97.2
2008-09	1110	3	2950	1	4064	97.4
2009-10	1111	3	2955	2	4071	97.9
2010-11	1113	3	2954	-	4070	97.9
2011-12	1113	3	2970	4	4086	98.8
2012-13	1133	-	2982	-	4115	99.2
2013-14	1160	-	2981	-	4141	99.9
2014-15	1175	-	2943	-	4118	99.9
2015-16	1201	-	2936	-	4137	99.9
2016-17(P)	1186	-	2940	-	4126	99.9

Source: Statistical Abstract, Punjab, Data for 2012-13 has been collected from Agriculture at a Glance, Directorate of Agriculture, Punjab

According to estimates the total annual demand for irrigation water in the state is 4.76 million hectare meters (mhm) against a total annual supply of 3.48 mhm from both canal and ground-water resources. This excessive demand leaves an annual net deficit of 1.28 mhm (Jain, A K) which is met from over-exploitation of groundwater reserves through tube wells. In many areas, excessive exploitation has pushed the groundwater table below the critical depth of 10

meters. Deep tube wells are being used even in the southern region, where the underground water is brackish. Existing cropping pattern, cheap credit and free supply of electricity are the main factors behind steep increase in the use of tube wells for irrigation in the state. The data on pre-monsoon and post-monsoon water table in state for recent years is presented in Table 3.6.

Extensive use of groundwater through tube wells have led to lowering of the ground-water table in most parts of the state. The water table in the central districts of Punjab has been going down whereas in south western parts it is going up resulting into the problem of water logging. Most of the centrifugal pumps have been replaced by the submersible pumps leading to additional expenditure along with tremendous increase in energy consumption.

Table 3.6: Pre and post monsoon ground water level in Punjab

Period	Season	Level	Meters
June 2008	Pre monsoon	Minimum	5.92
		Max	23.53
October 2008	Post monsoon	Minimum	6.93
		Max	22.92
June 2009	Pre monsoon	Minimum	5.52
		Max	22.59
October 2009	Post monsoon	Minimum	5.41
		Max	22.28
June 2010	Pre monsoon	Minimum	6.23
		Max	23.57
October 2010	Post monsoon	Minimum	5.53
		Max	23.01
June 2011	Pre monsoon	Minimum	6.07
		Max	23.03
October 2011	Post monsoon	Minimum	5.53
		Max	23.17
June 2012	Pre monsoon	Minimum	6.57
		Max	23.61
October 2012	Post monsoon	Minimum	6.39
		Max	24.07`
June 2013	Pre monsoon	Minimum	7.06
		Max	23.04
October 2013	Post monsoon	Minimum	6.45
		Max	23.02
June 2014	Pre monsoon	Minimum	6.74
		Max	23.37

October 2014	Post monsoon	Minimum	6.69
		Max	23.71
June 2015	Pre monsoon	Minimum	138.3
		Max	469.3
October 2015	Post monsoon	Minimum	144.42
		Max	475.45
June 2016	Pre monsoon	Minimum	7.98
		Max	24
October 2016	Post monsoon	Minimum	7.61
		Max	24.19
June 2017	Pre monsoon	Minimum	8.57
		Max	22.25
October 2017	Post monsoon	Minimum	7.34
		Max	23.92

Source: Statistical Abstract, Punjab

The distribution of blocks in different categories on the basis of underground water resources in past decade is given in Table 3.7. During 2015, out of 140 blocks of state 107 blocks were over exploited where exploitation was more than 100 percent of annual net recharge of water, 4 blocks were in critical category (exploitation above 85 percent) and 7 blocks felled in semi critical-category (exploitation of 65-85 percent). Thus there were only 22 blocks which were considered safe. In other words ground water in 76 percent of the total geographical area of state has been over exploited, with another 7.86 percent in critical or semi-critical category. Part of about 16 percent geographical area which is considered to be safe for ground water development falls in kandi area where as rest of it falls in south-western parts of state where ground water is brackish and unfit for irrigation use.

Table 3.7: Distribution of blocks in different categories on basis of underground water resources in Punjab

Category	**2000**	**2005**	**2010**	**2015**
Over-exploited (Dark)	73 (52.90)	103 (75.18)	110 (79.71)	107 (76.42)
Critical	11 (7.97)	5 (3.65)	3 (2.17)	4 (2.86)
Semi critical	16 (11.59)	4 (2.92)	2 (1.45)	7 (5.00)
Safe	38 (27.54)	25 (18.25)	23 (16.67)	22 (15.72)

Source: Jain A K, Department of Soil & Water Engineering, PAU, Ludhiana

Various steps have taken to work out methods for optimum water-use efficiency for different crops in different regions. Implementation of Punjab preservation of sub-soil water act, 2009 is a major breakthrough in managing dwindling ground water resources of the state.

THE PUNJAB PRESERVATION OF SUBSOIL WATER ACT, 2009

(Punjab Act No. 6 of 2009)AN ACT to provide for prohibition of sowing nursery of paddy and transplanting paddy before the notified dates, and for the matters connected therewith or incidental thereto

BE it enacted by the Legislature of the State of Punjab in the Sixtieth Year of the Republic of India as follows:-

1.(1) This Act may be called Punjab Preservation of Subsoil Water Act, 2009

(2) It shall come into force at once.

***2.** In this Act, unless the context otherwise requires,-*

(a) "authorised officer" means an officer, authorised by State Government by notification in the Official Gazette;

(b) "Collector" shall have the meaning, as has been assigned to it in the Punjab Land Revenue Act, 1887, and includes any other officer, as may be appointed under this Act by the State Government by notification in the Official Gazette to exercise the powers of Collector;

(c) "farmer" means any person, cultivating land either as an owner or as tenant or as a share cropper for the purpose of agriculture, horticulture, agro forestry and the like;

(d) "notified date" means the date as notified under sub-sections (1) and (2) of section 3; and

(e) "State Government" means the Government of the State of Punjab.

***3.** (1) No farmer shall sow nursery of paddy before 10th Day of May of the agricultural year or such other date as may be notified by the State Government by notification in the Official Gazette for any local area. Explanation – For the purpose of this section, ,,agricultural year" means the year commencing on the 16th day of June or on such other date, as may be appointed by the State Government by notification in the Official Gazette for any local area.*

(2) No farmer shall transplant paddy before such date, as may be notified in this regard by the State Government by notification in the Official Gazette.

(3) Notwithstanding anything contained in sub-sections (1) and (2), the provisions of this section, shall not be applicable to-

(a) any research project of the Punjab Agricultural University, Ludhiana;

(b) any other Research Institute, as may be declared by the State Government by notification in the Official Gazette;

(c) any water logged area, as may be declared by the State Government by notification in the Official Gazette;

Explanation – For the purpose of this clause, the term ,,water logged area" means an area, having depth to water table less than one metre below the ground level; and

(d) any other method of paddy crop, as may be declared by the State Government by notification in the Official Gazette.

***4.** The authorised officer or his subordinate, servant or workman shall have the power to enter into the estate of any farmer for the purpose of surveying the area to assess the violation of the provisions of this Act.*

Explanation- The term ,,estate" shall have the same meaning as has been assigned to it under the Punjab Land Revenue Act, 1887.

***5.** The authorised officer, either suo motto or on the information brought to his notice regarding the violation of any provision of this Act, shall be competent to issue directions to the farmer, who has violated any provision of this Act to destroy the nursery of paddy or sown or transplanted before the notified date.*

***6**. In case, a farmer does not act as per the directions of the authorised officer given under the section 5, the authorised shall cause such nursery of paddy, or sown or transplanted paddy, as the case may be, to be destroyed at the expenses of such farmer.*

***7.** (1) Any farmer, who contravenes the provision the provisions of this Act, shall be liable of penalty of rupees ten thousand for every month or part thereof, per hectare of the land till the period, such contravention continues.*

(2) The penalty referred to in sub-section (1), shall be in addition to the recovery of the expenses, incurred for destroying the nursery of paddy, or sown or transplanted paddy before the notified date.

(3) Before passing an order for imposing any penalty under sub section (1), the authorised officer shall make such enquiry, as he may deem necessary and shall give an opportunity of being heard to the concerned farmer.

***8.** Any farmer, aggrieved by an order of the authorised officer, passed under sub section (3) of section 7, may prefer an appeal to the Collector within a period of thirty days from the date of passing the order.*

***9.** The penalty and the expenses referred to in section 7, shall be recoverable as arrears of land revenue.*

***10.** No suit, prosecution or legal proceedings shall lie against the State Government or its officer or employee for anything, which is done or intended to be done in good faith under this Act.*

***11.** No Civil court shall have jurisdiction to entertain any suit or proceeding in respect of any matter arising under or connected with this Act.*

***12.** Notwithstanding anything to the contrary contained in any other law, enacted by the Punjab State Legislature for the time being in force, the provisions of this Act shall have effect.*

Promotion of adoption of tensiometers, laser leveling of fields, ridge planting and emphasis on growing water saving crops are some of the other steps taken in this regard. Time has come to use rainwater harvesting technologies for conserving water and for recharging the underground water, both in rural and urban areas.

3.6 Weather and climate

The land use pattern and crop production depends on the climate to a much greater extent than any other factor of production. The effects of weather on agriculture are far reaching, affecting the crop plants right from germination till maturity. The effects of weather continue to affect the agricultural output in the markets and during storage. Important factors that make environment are the temperature, moisture/rainfall, solar radiation and wind. Plants do best under certain inter-related conditions of these factors and there are also extremes beyond which significant losses to vegetation occurs. The climate of Punjab is mainly influenced by the Himalayas in the North and the 'thar' desert of Rajasthan in the south and south west. The mean annual rainfall varies from less than 300 mm to about 1400 mm. A major portion of the rainfall (70%) is received during monsoon season (July to September). The information on average annual rainfall from year 2007 onwards is presented in Table 3.8.

Table: 3.8 Average annual rainfall in Punjab

Year	Rainfall (Millimeters)
2007	438.0
2008	529.2
2009	384.9
2010	472.1
2011	489.0
2012	345.0
2013	619.7
2014	384.9
2015	546.9
2016	426.7

Source: Statistical Abstract, Punjab.

In Punjab state the Mean Annual Temperature (MAT) varies from 23.3°C (Pathankot) to 25.8° C (Abohar). The mean monthly minimum temperature (January) is as low as 4.7°C and the mean monthly maximum temperature in June is as high as 42° C. Information on agro-eco sub regions of state along with important environmental/climatic characteristics is provided in Table 3.9.

Table 3.9: Important characteristics of agro-eco sub-regions of Punjab

Characteristics	Agro-eco-sub regions				
	Sub-mountain (Siwalik hills)	**North-eastern undulating subrigion**	**Piedmont and alluvial plain**	**Central alluvial plain**	**South-western alluvial plain**
Major criteria for subdivision	Topography	Topography and climate	Length of growing period and landform	Length of growing period and climate	Length of growing period
Percent area of Punjab covered by sub regions	2.37	8.38	29.36	38.17	21.72
Districts (partly /whole) covered by sub regions	Gurdaspur, Hoshiarpur, Nawan Shahar, Rupnagar	Gurdaspur, Hoshiarpur, Nawan Shahar, Rupnagar, S.A.S nagar	Gurdaspur, Amritsar, Taran taran, Kapurthala, Hoshiarpur, Jalandhar, Nawan Shahar, Rupnagar, Mohali, Ludhiana, Fatehgarh sahib, Patiala	Amritsar, Taran taran, Kapurthala, Jalandhar, Moga, Faridkot, Ferozepur, Ludhiana, Sangrur, Barnala, Patiala	Ferozepur, Mukatsar, Faridkot, Bathinda, Mansa
Topography	Siwalik hills	Foothills and Undulating piedmont plain	Piedmont plain and alluvial plain	Old alluvial plain	Alluvial plain
Length of growing period*- days	150-170	150-170	120-150	90-120	60-90
Rainfall-mm	950-1300	850-1200	700-1000	550-800	300-550
Soil moisture regime	Udic-Ustic	Udic-Ustic	Ustic	Ustic	Aridic
***Temperature (^{o}C)**					
-Maximum	25-34	25-36	24-35	25-35	26-37
-Minimum	8-22	8-22	10-23	10-24	10-24
-Mean	16-28	17-29	17-29	18-30	18-31
Temperature regime	Hyperthermic	Hyperthermic	Hyperthermic	Hyperthermic	Hyperthermic
Potential evapo-transpiration	800-1000	1000-1300	1500-1800	1700-1800	1800-1900
Major soil orders	Entisols	Entisols, Inceptisols	Inceptisols, Alfisols	Inceptisols, Entisols	Aridisols, Entisols

*Normal/ long term average , Source: Department of Soils, Punjab Agricultural University, Ludhiana

Chapter 4

FARM INPUT MANAGEMENT

The remarkable progress of Punjab agriculture is credited to the use of inputs like fertilizers, improved seeds, irrigation, plant protection chemicals, machinery, credit and technology back up. In state the use of fertilizer (nutrients) increased from 37 kg/ha in 1970-71 to 232 kg/ha in 2016-17. During this period net irrigated area as proportion to net cultivated area increased from 71 percent to about 99 percent. Almost hundred percent area under major crops is covered by the high yielding verities. The farm credit market in Punjab is very extensive and about 90 percent farmers use credit to finance the farm production operations (Shergill, 2011). Punjab is a leading state in ensuring the timely availability and efficient delivery system of these vital inputs required for agriculture. The present chapter deals with the recent trends in use/requirement of important farm inputs and their prices in Punjab.

4.1.1 Seeds

Good quality seed of high yielding varieties has played the most important role in increasing agricultural production in Punjab. Foundation seed of HYVs is supplied by the Agricultural Universities for its further multiplication. Various Seed Corporations, Punjab Agricultural University and State Department of Agriculture distribute the certified seeds to the farmers. Without realizing the yield losses, many farmers are tempted to keep their own seeds particularly of cereals in which the seed rate is quite high and the crops are self pollinating. The government has made the efforts to increase the agricultural production through total replacement of seed of the self pollinated crops by the interval every three years and that of hybrids it should be replaced every subsequent year. Extension campaigns, subsidies and ensuring timely supply of seeds are some of the steps taken in this direction. Due to sincere efforts of concerned Departments of State and Punjab Agricultural University (PAU), the state farmers did not face the shortage of seed of principal crops in the state during the recent years.

The total seed requirement in Punjab for the major rabi and kharif crops worked out at recommended seed rate per hectare and area under the crop is presented in Table 4.1. For wheat and paddy crops the total seed requirement in the state during 2014-15 was estimated at 350500 tones and 57880 tones, respectively. Seed prices of important crops of state are provided in Table 4.2.

Table 4.1: Use of seed for major crops in Punjab

Crop	Seed require-ment/ hectare (Kg)	Total seed requirement*(Tones)								
		2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Wheat	100	352600	352200	351000	352700	351700	351000	350500	350600	349500
Gram	40	120	120	120	80	80	80	72	76	64
Sarson	3.8	109	116	120	114	110.2	114	106.4	120.08	120.46
Moong	20	178	140	168	212	240	186	126	210	96
Sunflower	5	100	110	75	69	75	41.5	35	57.5	52.5
Paddy	20	54700	56040	56520	56280	56980	56980	57900	59400	60920
Maize	20	3020	2780	2660	2600	2620	2620	2520	2540	2320
Sugarcane	8750	708750	525000	612500	700000	717500	778750	848750	805000	770000
Cotton	1.5	789	766	724	772.5	721.5	655.5	621	501	427.5

* Calculated by multiplying per hectare requirement (recommended) of seed with area under respective crops
E- Based on final estimate of crop area by Directorate of Agriculture, Punjab

Table 4.2: Seed prices of important crops in Punjab

(Rs/kg)

Crop	2009	2010	2011	2012	2013	2014	2015	2016	2017
Wheat	17.50	17.50	20	22.5	24	27.50	30	30	30
Gram	50	50	50	80	80	80	90	90	90
Sarson	46.67	66.67	66.67	80	60	80	120	120	120
Moong	60	60	100	100	100	110	110	160	120
Sunflower	200	200	200	300	300	300	300	300	300
Paddy	18.75	18.75	25	25	31.25	37.50	37.50	37.50	37.50
Maize	50	70	70	150	150	175	175	180	180
Sugarcane	1.75	1.80	2.50	2.75	2.75	2.95	3.54	3.60	3.72
Cotton	2000	2000	2000	2000	2000	2000	2222	1778	1778

Source: Department of Economics & Sociology, Punjab Agricultural University, Ludhiana

4.2 Fertilizers and manures

Intensive agriculture, with high use of synthetic fertilizers was introduced in India in 1960s as a part of the Green Revolution. The quick adoption of synthetic fertilizers and fertilizer responsive varieties along with irrigation did help in a remarkable increase in agricultural

production of Punjab state. Statistics on fertilizer consumption in state is presented in Table 4.3. Total consumption of Nitrogen (N), Phosphorus (P) and Potash (K) nutrients in state during 2007-08 was 16.98 lakh tons which increased by about 12.9 percent i.e to 19.17 lakh tons in 2016-17. During 2016-17, use of N, P and K was 14.58, 4.11 and 0.48 lakh tons, respectively.Estimate of per hectare use of fertilizers in State during 2016-17 was 232 kg. Nitrogen fertilizers are most important for the growth of plants and hence are used in highest proportions which are leading to nutrient imbalances. In spite of the fact that Punjab is one of the most agriculturally progressive states, the ratio of N, P, and K in Punjab is one of the most lop sided one in the country with the maximum emphasis on nitrogen and very little attention has been given to balanced nutrient application.

Table 4.3: Consumption of Fertilizers in Punjab

(000, nutrient tones)

Year	Nitrogenous (N)	Phosphatic (P)	Potassic (K)	Total (NPK)	Consumption per hectare (kg/ha)
2007-08	1316	344	38	1698	213
2008-09	1332	379	57	1768	223
2009-10	1358	434	74	1866	237
2010-11	1403	435	73	1911	243
2011-12	1416	448	54	1918	243
2012-13	1486	462	24	1972	251
2013-14	1364	325	24	1713	218
2014-15	1321	326	30	1677	213
2015-16	1447	418	78	1943	247
2016-17	1458	411	48	1917	232

Source: Statistical Abstract, Punjab

Table 4.4: Fertilizer prices in Punjab

Name of Fertilizer	Year								
	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
DAP (Rs/qtl)	935	995	996	1820	2420	2250	2400	2030	2400
Urea 46% (Rs/qtl)	478	530	530	540	540	544	544	570	590
Muriate of Potash(Rs/qtl)	445	520	520	1200	1680	1680	1680	1100	1240

Zinc sulphate (Rs/qtl)	2500	2500	2800	4000	4000	3000	3000	3000	3000
FYM (Rs/tone)	100	100	100	120	130	140	150	200	225

Source: Department of Economics & Sociology, Punjab Agricultural University, Ludhiana

It can be seen from the Table 4.4 that before 2010-111, fertilizer prices remained almost unchanged for many years. Price of urea is still controlled by the Government and hence increased from Rs 530/qtl in 2010-11 to Rs 590/qtl in 2016-17. However after partial decontrol, prices of phosphate fertilizers particularly Di-ammonia phosphate (DAP) increased tremendously from Rs 996/qtl in 2010-11 to Rs 2400/qtl. in 2014-15. During the same period the price of muriate of potash (MOP) has also gone up from Rs 520/qtl to Rs 1240/qtl. However, price of zinc sulphate which peaked to Rs 4000/qtl during 2011-12 declined subsequently to Rs 3000/qtl in 2016-17.

4.3 Pesticides/weedicides

In yield potential exploitation and stability in state agricultural production, the use of insecticides and weedicides have played a crucial role. The pest problem accentuated with the introduction of high yielding varieties of crops, intensive use of inputs and development of new cropping patterns. Crops like cotton, sugarcane, paddy, oilseeds and vegetables have shown greater reliance on pesticides. Problem of weeds also increased with increase in cropping intensity and fertilizer use particularly in irrigated areas like Punjab. This resulted into tremendous increase in demand for pesticides and weedicides over time. Consumption of insecticides/pesticides for recent years is given in Table 4.5.

Table 4.5: Consumption pesticides/insecticides in Punjab

Year	Consumption in technical grade (Metric Tonnes)
2007-08	5900
2008-09	5760
2009-10	5745
2010-11	5600
2011-12	5690
2012-13	5725
2013-14	5720
2014-15	5699
2015-16	5721

2016-17	5843
2017-18(T)	6374

Source: Agriculture at a Glance, Directorate of Agriculture, Punjab, (T) Target

The total consumption of plant protection agro-chemicals including insecticides, weedicides, fungicides and rodenticides in Punjab was at 5900 MT (technical grade) in 2007-08 which declined to 5600 MT (technical grade) in 2010-11. The decline may be attributed to the large scale adoption of insect-pest and decease resistant crop varieties. The consumption of pesticides again increased and was estimated to be 5843 MT (technical grade) in 2016-17. Certain harmful effects of extensive use of these chemicals being observed includes chemical residue in agricultural output, development of strains of resistance, undesirable side effects on non target flora and fauna and resurgence of certain insect and weed species along with appearance of secondary pests/weeds. Regular monitoring and surveillance of these problems in state is need of the hour. Table 4.6 depicted the continuous general increase in prices of the agro-chemicals (insecticides, weedicides, fungicides) with some variations.

Table 4.6: Prices of important insecticides/weedicides/fungicides in Punjab

(Rs.)

Name of Chemical/Year	**Year**								
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Weedicide									
Arelon (per 500 gm)	150	160	170	210	210	230	250	250	245
Leader (per 13 gm)	340	320	325	400	400	400	400	400	300
Topik (per 160 gm)	-	350	350	400	400	450	350	350	280
2,4 D (per 500 gm)	300	200	220	220	220	175	150	150	115
Atrazine (per 500 gm)	150	150	150	150	160	185	185	185	200
Butachlor (per Litre)	200	180	180	180	200	250	250	275	345
Insecticide									
Chlorpyriphos (per Litre)	250	220	220	250	250	300	210	210	250
Malathion 50EC (per Litre)	180	250	240	240	250	300	350	300	270
Rogor 30EC (per Litre)	240	350	290	300	300	350	335	335	370

Confidor (per Litre)	1500	1600	1800	1800	2100	2000	1900	2400	2450
Dithane M-45 (per 500 gm)	200	170	180	250	250	250	350	350	182.5
Indofil M-45 (per 500 gm)	145	170	180	250	250	225	200	225	170
Stomp (per Litre)	390	450	450	450	450	450	480	450	495
Fungicide									
Blitox (per kg)	200	250	280	360	500	520	550	520	600
Streptocycline (per 6 gm)	32	30	35	40	40	45	45	45	45
Emisan-6 (per 100 gm)	50	60	55	65	65	100	100	100	100

Source: Department of Economics & Sociology, Punjab Agricultural University, Ludhiana

4.4 Farm machinery and equipments

Mechanization has contributed significantly in the increasing agricultural production of the state. It helps in achieving the timeliness of various farm operations like seedbed preparation, sowing, spraying, harvesting and threshing and makes efficient use of resources. Further, it offsets the challenges of labour shortages and drudgery involved in farm work. Farm mechanization, no doubt, has been beneficial for the intensive use of land and has helped considerably in overcoming the risk of unfavorable effects of weather on maturing crops. In Punjab with crop intensification, agriculture has become highly machinery dependent.

Table 4.7: Agricultural machinery and implements in Punjab

(Number)

Machinery	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2012-13**	**2013-14**	**2014-15**
Tractor	420000	425200	425200	434000	476835	488504	472179
Disc Harrow	220000	224000	224300	210000	191689	NA	167173
Seed-cum fertilizer drill	178000	183000	183400	166489	175362	159430	153439
Knapsac spray pump	655000	665000	655000	600000	610964	NA	-
Vertical conveyer reaper	5518	5522	-	-	-	NA	-
Tractor operated combine	6570	6670	6270	6056	4949	4455	4030
Self propelled combine	7600	8400	8400	8130	8069	7613	7308
Thresher	910400	822000	802000	740000	623942	561650	370000
Straw reaper	21848	32666	32900	33678	38684	36692	36990
Maize sheller/thresher	1890	1893	1850	1832	1804	1644	1663
Potato planter	5160	5330	5250	5228	5647	5901	6638

Tubewell electrical/diesel run	1246000	1276200	1375517	1381606	1384885	1404232	1406632
Sugarcane cutter planter	340	290	290	NA	NA	NA	-
Strip till drill	215	195	NA	NA	NA	NA	-
Zero till drill	9083	10141	10300	10465	11517	13142	14151
Rotavator	3309	6419	6720	8691	12346	22004	29600
Laser land leveller	NA	NA	NA	4500	-	5034	5617

Source: Agriculture at a Glance, Directorate of Agriculture, Punjab, Chandigarh, NA: Not available

Different types of farm machinery utilized in Punjab agriculture and their number are presented in Table 4.7. As being indicated by marginal increase in number of various machines during the recent years, the mechanization of state agricultural has now almost reached at a saturation point. As per estimates of Punjab State Farmers Commission, the state has double the number of tractors than it requires. The average use of tractors per annum in the state is barely 450 hours, which is much below the prescribed efficient usage of 1000 hours, in agriculture.

The over capitalization in form of mechanization coupled with its under utilization pattern leads to disproportionate hike in cost of production or lowers the net returns to the farmers and makes farming an unviable venture.

Along with under utilization of the farm machinery the increase in their prices is also another factor behind increase in cost of production. As, Table 4.8 reflected that since 2007-08 the price of tractor (35 HP) has jumped from 3.70 lakh in 2007-08 to Rs. 5.00 lakh in 2014-15, during the same period the price of electrical motor has gone up from Rs. 23000 to Rs. 34000.

Table 4.8: Prices of selected agricultural machinery in Punjab

(Rs/ unit)

Machinery	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2012-13***	**2013-14***	**2014-15***
Tractor (35 HP)	370000	375000	450000	480000	490000[@]	495000[@]	500000[@]
Electrical motor	23000	23000	23500	28500	32500[#]	33000[#]	34000[#]

Prices are approximate only. Source: Department of Economics & Sociology, Punjab Agricultural University, Ludhiana

* Information collected through personal correspondence with dealers; ** Price of Mahindra 265 Model; *** Price of submersible EM of 10 HP

4.5 Irrigation

Agriculture in Punjab has a heavy requirement of water for irrigation and there is an excellent network of surface and ground irrigation facilities serving this purpose. Almost 100 percent of net sown area in state is irrigated (Table 4.9). Punjab has an organised irrigation distribution set up through canals, branch canals and minor distributaries and field channels or

water courses. The cultivation of high water demanding crops particularly paddy is an important factor accountable for decline in underground water levels in Punjab. Annual availability of surface and ground water in state is 3.48 million hectare meters (mhm). However, the annual demand for state agriculture is 4.76 mhm (Table 4.10). The annual deficit to the tune of 1.28 mhm every year is met through the overexploitation of underground water by tube wells leading to serious problem of deteriorating underground water resources. Overtime, tube well irrigation has been increased and about 73 percent of the total irrigated area is irrigated by underground water pumped out by about 14.19 lakh tube wells in the state. This is mainly due to availability of cheap credit and free supply of electricity in the state. As, for the last many years, the Punjab farmers are getting free electricity supply for the use of tube wells as well as canal water irrigation.

Table 4.9: Gross cropped and irrigated area in Punjab

(000' ha)

Year	Gross cropped area	Irrigated area	% of gross irrigated area to gross cropped area
2007-08	7870.0	7689.3	97.7
2008-09	7912.0	7723.6	97.6
2009-10	7876.0	7714.2	97.9
2010-11	7882.0	7723.8	98.0
2011-12	7902.0	7770.6	98.3
2012-13	7870.0	7744.0	98.4
2013-14	7848.0	7728.0	98.5
2014-15	7857.0	7757.0	95.7
2015-16	7872.0	7765.0	98.6
2016-17	7823.0	7795.0	99.6

Source: Statistical Abstract, Punjab

Table 4.10: Status of water resources in Punjab

Annual canal water available at H/w	1.79 M ha-m
Annual canal water available at outlets	1.45 M ha-m
Annual canal water available	2.03 M ha-m
Total annual available water resources	3.48 M ha-m
Annual water demand	4.76 M ha-m
Annual water deficit	1.28 M ha-m

Source: Jain A K, Department of Soil & Water Engineering, PAU, Ludhiana

Wheat and paddy being the major crops of the state, maximum area irrigated is under these two crops. Table 4.11 shows that during 2016-17, wheat and paddy accounted for 44.90 per cent and 39.26 per cent of the gross irrigated area in Punjab State.

Table 4.11: Crop wise gross irrigated area in Punjab (000' ha)

Crop/Year	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2015-16	2016-17
Rice	2721.8 (35.24)	2783.5 (36.08)	2814.2 (36.44)	2802.4 (36.06)	2838.5 (36.42)	2838.5 (36.73)	2961.7 (38.14)	3032.7 (39.26)
Jowar	0.1 (0.00)	0.1 (0.00)	(a)	-	-	-	-	-
Bajra	4.9 (0.06)	3.4 (0.04)	2.5 (0.03)	2.8 (0.04)	2.2 (0.03)	2.0 (0.03)	2.0 (0.3)	3 (0.04)
Wheat	3474.8 (44.99)	3474 (45.03)	3466.9 (44.89)	3488.8 (44.90)	3478.4 (44.63)	3474 (44.95)	3472.2 (44.72)	3467.7 (44.90)
Barley	16.0 (0.21)	13.7 (0.18)	11.7 (0.15)	12.6 (0.16)	12.9 (0.17)	9.3 (0.12)	11.5 (0.15)	8.3 (0.11)
Maize	98.0 (1.27)	99.9 (1.30)	94.1 (1.22)	98.0 (1.26)	99.3 (1.27)	99.8 (1.29)	97.1 (1.25)	94 (1.22)
Gram	2.2 (0.03)	2.3 (0.03)	2.2 (0.03)	1.7 (0.02)	2.2 (0.03)	1.5 (0.02)	1.6 (0.02)	0.6 (0.01)
Other pulses	16.1 (0.21)	16.3 (0.21)	14.7 (0.19)	16.7 (0.21)	16.2 (0.21)	14.7 (0.19)	15.5 (0.20)	1.6 (0.02)
Sugarcane	75.2 (0.97)	58.3 (0.76)	67.6 (0.88)	76.8 (0.99)	78.4 (1.01)	83.2 (1.08)	89.2 (1.15)	86.9 (1.13)
Other food crops (including condiments & spices	178.1 (2.31)	165.8 (2.15)	174.3 (2.26)	103.6 (1.33)	146.0 (1.87)	148.8 (1.93)	189.7 (2.44)	201.2 (2.60)
Cotton	527.3 (6.83)	508.8 (6.60)	482.8 (6.25)	514.8 (6.62)	481.4 (6.18)	444.9 (5.76)	334.7 (4.32)	281.8 (3.65)
Other non-food crops	609.1 (7.89)	588.1 (7.62)	592.8 (7.67)	652.4 (8.40)	588.2 (7.55)	611.0 (7.91)	589.1 (7.59)	526.8 (6.82)
Total	7723.6 (100.00)	7714.2 (100.00)	7723.8 (100.00)	7770.6 (100.00)	7743.7 (100.00)	7728.2 (100.00)	7764.7 (100.00)	7723.7 (100.00)

Figures in parentheses are percentages to total
(a): less than 500 hectares
Source: Statistical Abstract, Punjab

4.6 Labour and agricultural wages

Punjab State is predominantly an agricultural state with two-third of its population directly or indirectly dependent on agriculture. With the introduction of new agricultural technology in mid sixties, crop rotations experienced significant changes along with the increase in cropping intensity, which resulted in increased aggregate labour employment in the agriculture sector. However, due to fast pace of agriculture mechanization during eighties, the complementary relationship between the agricultural development, mechanization and demand for labour has

weakened. During nineties, the Punjab agriculture reached a stage where increased mechanization particularly for harvesting of wheat and paddy and use of labour substituting inputs like weedicides and herbicides started competing with labour force and resulted in substantial labour displacement. The recent stagnation in productivity of major crops along with imperceptible movement of labour out of agriculture sector raised concern about its potential to increase the income and labour productivity. There is a clear evidence that overtime the capacity of agriculture sector to absorb labour has been declining significantly. The employment elasticity with respect to aggregate output come down from 0.54 during 1970's to 0.36 during 1980's and presently even less than 0.20 (Sidhu, 2002). In addition, the experience of the last decade brings out that, the growth in agricultural sector has been generating more casualization of employment. There is an increase in casualization of labour as overtime the proportions of family labour and permanent hired labour is declining (Deshapande *et al,* 2007).

The slow growth of agriculture employment in recent years could be largely attributed to imbalanced growth of mechanization that substitutes the machine labour for human and animal labour. The level of mechanization is already higher in Punjab, where man days employed in production of crops are low as compared to other parts of the country and a negative growth in agricultural employment was experienced against a positive growth rate of real agricultural output in the nineties (Haque and Sharma, 2004). In a labour surplus economy like ours, the primary concern still centers on human labour employment. As the siphoning off mechanism of agricultural labour to other sectors has remained rather ineffective in Punjab state, the solution to problems of rural unemployment and under employment depends upon the potential of crop production sector to absorb the labour.

The per hectare labour use in cultivation of wheat, paddy and cotton which collectively account for more than 85 percent of the gross cropped area in Punjab state is presented in Table 4.12. During 2013-14, per hectare labour use in cultivation of wheat, paddy and cotton was 136.48, 353.46 and 682.78 man hours, respectively. Wages are an important indicator for the importance of a particular sector along with socio-economic status of the people employed in it. Table 4.13 highlighted the wage rate of major agricultural operations in Punjab. It was observed that the wage rate for various agricultural operations in the state have increased by nearly three times during the period from 2009 to 2016-17. On the other hand, in case of skilled labour the

wage rate during this period has increased at lesser rate i.e two times. This clearly points towards shortage of labour for agricultural sector in past few years.

Table 4.12: Labour use (per ha) for major crops in Punjab

(Man Hours/ ha)

Crop/Year	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Wheat	188.01	184.87	177.94	160.83	161.99	133.08	136.48	123.78
Rice	402.54	417.19	439.46	390.95	385.97	380.80	353.46	345.50
Cotton	803.30	717.78	714.82	703.12	707.51	731.21	682.78	639.61

Source: Estimates of cost of cultivation scheme

Table: 4.13 Wages paid to agricultural and skilled labour in Punjab

(Rs/ man day)

Crop/Year	2009	2010	2011	2012	2013	2014	2014	2015	2016 (P)	2017 (P)
Agricultural labour: for										
Ploughing	143.92	151.82	205.50	280	285	302	302	347	391	407
Sowing	141.18	145.80	204.50	282	287	309	309	340	370	385
Weeding	129.75	149.47	197.25	281	287	293	293	224	352	363
Harvesting	186.00	189.61	203.00	271	290	310	359	359	393	400
Picking cotton*	-	141.88	190.00	241	262	278	359	359	414	429
Other agricultural operations	144.25	144.43	215.00	307	309	313	335	335	366	380
Black smith	224.65	226.88	270.00	336	340	354	428	428	469	473
Car penter	227.37	230.54	267.00	341	344	356	438	438	472	484

*For female labour; P-Provisional
Source: Statistical Abstract, Punjab

4.7 Credit

Credit is an important input which has played a significant role in the development of Punjab agriculture. The formal credit institutions such as Cooperative Credit Institutions, Regional Rural Banks and Commercial Banks are supposed to meet the agricultural credit requirement in the state. Besides institutional credit, informal sources particularly the commission agents/arthytias provide a significant amount of credit to the farmers. About 2095 rural/semi-urban branches of all Commercial Banks and 4755 retail outlets of Cooperative Credit set-up are operating in the farm credit market. Out of total retail outlets of Cooperative Credit

set-up 3990 are Primary Agricultural Cooperative Societies, Primary Agricultural Cooperative Banks and 676 rural/semi-urban branches of Central Cooperative Banks (Shergill, 2011). The extent of formal credit to agriculture in the state is depicted in Table 4.14. During 2015-16, against the target of Rs 92135 crore under agriculture and allied sector, banks had disbursed Rs 90012 crore, thus achieving 98 percent of the target.

Table 4.14: Disbursement of institutional loans under agricultural and allied activities in Punjab

(Rs in Crore)

Year	Targets	Achievements	% Target achieved
2010-11	30471	30106	99
2011-12	41832	40753	97
2012-13	49411	51282	104
2013-14	63513	67178	106
2014-15	79564	81924	103
2015-16	92135	90012	98

Source: Agenda papers, various meetings of State Level Bankersô Committee (Punjab)

With aiming at increasing the efficiency of formal credit delivery system, the Central Government launched the scheme of Kisan Credit Cards (KCC) in 1998-99. This scheme offers more flexibility in withdrawing money as per farmersô requirements with fixed borrowing limit. The number of KCCs, amount sectioned and distributed in this scheme is illustrated in Table 4.15. On cumulative basis, there were about 19.63 lakh outstanding KCCs in Punjab State amounting to Rs 111689.91 crore as on 31st March, 2016. Out of this commercial banks and cooperative banks had about 10.14 lakh and 9.48 lakh outstanding KCCs amounting to Rs 104459.93 and Rs 7217.86 crore respectively (Agenda papers of 136th Meeting Of SLBC-Punjab) .

Table 4.15: Number of kisan credit cards and amount sanctioned, distributed under KCC scheme

(Rs Crore)

Period	**Sanctioned**		**Disbursed**		**Outstanding**	
	No. of KCC	Amount	No. of KCC	Amount	No. of KCC	Amount
Commercial banks						
2006-07	127378	1922.72	126600	1991.76	125885	1968.40
2007-08	132795	2740.04	132217	2705.51	130283	2610.29
2008-09	165774	3717.19	165218	3601.61	164644	3536.68
2009-10	148942	3660.91	147827	3572.18	147453	3562.37
2010-11	208279	5286.39	196436	5162.14	168840	2477.68
2011-12	238586	8347.89	237801	8138.17	235003	7930.88
2012-13	284701	11276.01	284076	10819.74	212615	8747.40
2013-14	333958	18662.62	333186	18489.25	293747	14203.93
2014-15	288364	20649.10	288250	19795.64	362032	18218.58
2015-16	2982709	102155.18	2905132	99420.22	1014405	104459.93
Since inception up to March-2017	3246537	116995.10	3168033	114575.81	1207471	5593622
Cooperative banks						
2006-07	33937	205.78	33937	205.78	33937	205.78
2007-08	35494	601.51	35494	601.51	35494	601.51
2008-09	18570	157.57	18111	139.62	18111	139.61
2009-10	16216	749.47	16216	749.47	16216	749.47
2010-11	22417	332.44	22415	282.78	14241	175.27
2011-12	8095	149.25	8077	148.87	8075	148.02
2012-13	17521	239.31	17521	239.31	17521	239.31
2013-14	15804	192.45	15804	192.45	15804	192.45
2014-15	13840	128.08	13840	128.08	13840	128.07
2015-16	998118	7813.96	998098	7763.92	948932	7217.86
Since inception up to March-2017	1004579	7891.32	1004579	7841.23	944416	7243.91
Total since inception	4251116	124886.42	4172590	122417.04	2151887	6318013

Source: Agenda papers, 136th meeting of State Level Bankersô Committee (Punjab)

Chapter 5

AGRICULTURAL RESEARCH, EDUCATION AND EXTENSION

Agricultural research and technological improvements are prerequisites for growth of agricultural productivity and income of the rural workforce. This in turn helps to alleviate poverty, which is a primary rural phenomenon. Indian Council of Agricultural Research (ICAR) being an apex scientific organization at national level, at the state level Punjab has an excellent infrastructure for agricultural research and education at Punjab Agricultural University (PAU). Established in 1962 at Ludhiana on the pattern of land grant colleges of USA with integrated teaching research and extension programme, PAU is committed to continue improvement in the productivity and profitability of agriculture and allied sectors. It played a crucial role in promoting and accelerating the use of science and technology programmes relating to agricultural research and education. It also provides assistance and support in demonstrating the use of new technologies in agriculture. PAU did a commendable job in adapting/developing wheat and rice varieties to suit the regional conditions leading to manifold increase in productivity. It has also made notable contributions in increasing livestock and poultry production. In 2006 the College of Veterinary Science of PAU, Ludhiana was upgraded to become Guru Angad Dev Veterinary and Animal Science University (GADVASU) which is now looking after the research, teaching and extension regarding livestock and veterinary sciences.

PAU is engaged in carrying out research in Agriculture, Agricultural Engineering, Basic Sciences and Home Science. Since its inception, PAU has evolved a strong crop improvement programme and released 833 crop varieties and hybrids till August, 2017 (Table 5.1). Among these several have gained national and international acceptability.

Table 5.1: List of crop varieties/hybrids released by Punjab Agricultural University (Up to August, 2017)

S. No.	Name of crop	Number of varieties
1	Wheat	64
2	Barley	8
3	Rice	42
4	Maize	41
5	Cotton	54
6	Pulses	56
7	Soybean	11
8	Oilseeds	63
9	Pearl millet	13
10	Fodder	49
11	Sugarcane	22
12	Vegetables	188
13	Horticulture	146
14	Flowers	46
15	Mushrooms	9
16	Forest crops	14
17	New crops	4
18	Green manuring crops	3
Total		**833**

Source: Directorate of Research, Punjab Agricultural University, Ludhiana

PAU introduced cultivation of many new crops and developed/recommended resource conservation/crop production technologies. Important one are as following:

- Zero tillage/minimum tillage
- Bed planting/ridge planting
- Leaf colour charts (LCC)
- Direct seeding of paddy (DSR)
- Laser leveling of fields
- Tensiometer (for optimum irrigation)
- Crop residue management
- Technology for reclamation of problem soils (saline and water logged)
- Timely sowing/transplantation of crops
- Net-house cultivation of vegetables
- Integrated nutrient management
- Soil testing based fertilizer application

PAU also worked out on crop disease/fungus management and integrated pest management/insect resistance management technologies. Besides, it has strong machinery development and testing programme. Italian honeybee was introduced in Punjab and technologies in honey production, extraction and processing were developed.

The State Department of Agriculture as well as extension services of PAU and GADVASU play a lead role in dissemination of research findings and recommendations among the farming community of Punjab, who quickly respond through adoption of the same. The State Department of Agriculture has district level training centers which are instrumental in imparting training to the farmers and farm-women in day to day agricultural technological developments with regards to crop production and allied activities. District level camps are organized both in Kharif and Rabi season by the department where experts/scientists educate the field staff as well as progressive farmers about the latest scientific crop production/management technologies. Field staff of the department has been organizing farmers training camps at block and village level. Extension wings of the PAU and GADVASU are the vital links between scientists and different state departments, other development agencies and farmers. Directorate of Agricultural Extension, PAU provides agricultural extension services through farm advisory services, Krishi Vigyan Kendraôs (KVKs) and farm communication wing. Besides expert TV talks, PAU also demonstrate latest technologies to farmers at Kisan Melas at University Campus as well as at various Regional Research Stations which attracts large number of farmers. List of major agricultural extension activities of PAU is given in Table 5.2.

Since inception PAU is operating an elaborative programme of undergraduate and post graduate studies in agricultural and allied fields. Besides four year programme in B Sc agriculture, with aim to induct more students from the rural areas a six year programme of B Sc agriculture was started in 2008-09. Certificate courses for farmers to train in application of recent agricultural technologies are also being conducted in the University. With a view to meet the emerging challenges in agricultural economy these programmes are regularly updated. Besides, in recent years a number of private colleges and universities in state have also started graduate programmes in agriculture.

Table 5.2: Major agricultural extension activities by Punjab Agricultural University

Activity	No. of activities performed/participants							
	2009-10	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
Kisan melas	10	11	14	14	14	14	14	14
Workshops	6	7	5	8	9	5	5	5
Adaptive research trainings	745	1053	433	846	1800	933	814	713
Demonstrations	1560	2197	2801	5636	4916	5673	3924	3568
Field days								
No.	174	134	285	207	155	175	232	230
Participants	41700	31400	52600	41400	31000	59205	25602	59609
Exhibitions	350	420	941	801	898	629	740	782
Training courses								
No.	1582	1780	1885	1908	1788	1688	1151	1464
Participants	36600	28249	37427	31430	35007	31632	30399	30796
Training camps								
No.	370	670	656	491	780	755	157	736
Participants	80000	108000	105200	78560	124800	145500	135000	-
Technical guidance								
Office	12171	14932	18861	10973	6760	15888	75014	59609
Field	71000	75500	81300	43915	39363	43317	30588	-
Plant clinic								
Farmers guided	13982	9538	7699	6720	5117	7352	3945	3103
Samples diagnosed	3542	3397	2617	2289	1893	1893	866	473
Telephone queries addressed	3495	2033	1488	741	981	870	931	731

Source: Directorate of Extension, Punjab Agricultural University, Ludhiana

Chapter 6

ANIMAL HUSBANDRY, DAIRYING AND FISHRIES

In Punjab, animal husbandry is closely interwoven with agriculture and plays an important role in rural economy. But it received relatively less attention in comparison to crop production till recently. After achieving self sufficiency in food grain production, government initiated various steps to usher the white revolution in the country. Livestock is one of the important components of the state economy. During 2016-17, this sector accounted for 7.86percent of the Gross State Value Added (GSVA) and about 30.66 percent share in primary sector.

Most of the farm families in Punjab maintain milk animals to produce milk major part of which is consumed at home. During 2016-17, the per capita availability of milk in Punjab was 1075 grams per day, which was quite higher than the national average. The yield of milch animals, though higher than national average, is not in consonance with the levels attained in developed countries. The dairy sector in the state is facing problems due to less productivity of animals, higher cost of production and marketing of the produce. About 5.98 lakh hectare area in the state is under fodder cultivation, which comes out to be about 7 percent of gross cropped area of the state. The fodder crops occupied about 2.91 lakh hectare area in the rabi season, about 2.82 lakh hectare during kharif season and about 0.15 lakh hectare area cultivated during summer season. However, daily fodder availability in the state comes to be 10-12 kg per animal, which is quite low as compared to the optimum requirement of 40 to 50 kg per animal. Hence, the milch animals are under nourished and it affects their productivity level (Grover and Kumar, 2011).

The data on livestock population patterns in Punjab from 2003 to 2012 is presented in Table 6.1. The figures revealed that livestock population in state during declined from 86.07 lakh heads in 2003 to 73.31 lakh heads during 2007 and then increased to 81.17 lakh heads in 2012. Thus, livestock population in Punjab which had been declined by about 15 per cent during period 2003 to 2007 had been compensated through increase in the same by about 11 per cent during the following period from 2007 to 2012. Clearly, the losing interest of state people in livestock during early 2000s has been observed to be revived during the recent times. The number has decreased for all the livestock animals from 2003 to 2007. The decline of the number of buffaloes, donkeys, mules, sheep and camels during overall period (2003 to 2012) points toward

the declining relative importance of these animals in the state livestock sector. Contrary to this, overtime (2003 to 2012) increase in number of cattle, horses, goats and pigs in state indicates the increasing importance of these animals during recent times. Despite recent trend of increase in number of cattle in state, due to consumersô preference towards buffalo milk, Punjab has been traditionally dominated by buffalo population. While at national level cattle outnumber the buffaloes, in Punjab buffaloes outnumber the cattle. Although the buffalo population showed decline in number from 59.94 lakh heads in 2003 to 51.60 lakh heads in 2012, still its share in total livestock population of state was found out to be the highest at about 64 percent during 2012. During this period, the cattle population in state had increased from about 20.38 lakh heads to 24.28 lakh heads and it accounted for about 30 per cent of the total livestock population of state during the later year. While the population of sheep in state reduced from 2.20 lakh heads in 2003 to 1.28 lakh heads in 2012, the goat population increased from 2.78 lakh heads to 3.27 lakh heads during the same time period. The respective share of sheep and goat in total livestock population of state during 2012 was 1.58 and 4.03 percent respectively.

Table 6.1: Number of livestock, Punjab, 2003 - 2012

(000 head)

Particulars	**2003**	**2007**	**2012(P)**	**Percentage Change (2003 to 2007)**	**Percentage Change (2007 2012)**	**Percentage Change (2003 2012)**
Cattle	2038.54 (23.68)	1761.57 (24.03)	2427.71 (29.91)	-13.59	37.82	19.09
Buffaloes	5994.54 (69.64)	5001.80 (68.23)	5159.73 (63.57)	-16.56	3.16	-13.93
Horses and ponies	29.30 (0.34)	29.60 (0.40)	32.86 (0.40)	1.02	10.98	12.12
Donkeys	9.20 (0.11)	4.60 (0.06)	2.90 (0.04)	-50.00	-36.96	- 64.68
Mules	5.30 (0.06)	9.50 (0.13)	5.16 (0.06)	79.25	-45.68	-2.64
Sheep	220.10 (2.56)	210.70 (2.87)	128.53 (1.58)	-4.27	-39.00	-41.60
Goat	278.20 (3.23)	286.30 (3.91)	327.27 (4.03)	2.91	14.31	17.64
Camels	3.40 (0.04)	2.10 (0.03)	0.69 (0.01)	-38.24	-67.14	-79.71
Pigs	29.00 (0.34)	25.10 (0.34)	32.22 (0.40)	-13.45	28.37	11.10
Total livestock	**8607.50 (100.00)**	**7331.27 (100.00)**	**8117.06 (100.00)**	-14.83	10.72	-5.70

Source: Statistical Abstract, Punjab; Note: P-Provisional; Figures in parentheses show the percent to total in each column.

The data on production of important livestock products in state is given in Table 6.2. During 2015-16, the milk production in the state was observed to be about 169.34 lakh tones. Although the per capita availability of milk in the Punjab state is the highest in the state, still the dairy sector in the state is facing problems due to less productivity of animals, higher cost of production and marketing of the produce. Production of eggs the second most important livestock product in state which was at 37.91 billion in 2007-08 rose to 44.22 billion during 2014-15. Meat production during this period went up from 109 thousand tones to 250 thousand tones.

Table 6.2: Production of important livestock products in Punjab

Item	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Milk (000ô tones)	9282	9387	9389	9423	9551	9724	10011	10351	10774
Eggs (Lakh No.)	37914	36790	32828	35449	36030	37911	43376	42642	44218
Meat (000ô tones)	109	108	147	175	181	212	235	237	250
Wool (000ô kg)	435	451	485	506	532	558	558	461	473

Source: Agricultural Statistics at a Glance
Meat production is from commercial poultry has been included from 2009-10 onwards

After the green and white revolution, Punjab is now on the threshold of a blue revolution as the state has a great potential for diversification of agriculture in favour of fish farming. The farmers are already engaged in the intensive fish culture in ponds and tanks on modern scientific lines through composite fish culture of fast growing resources. Fishery resources of Punjab comprise 868 kilometers of rivers, 11,200 kilometers of canals, 5084 hectares of small water reservoirs and lakes. In addition to this, there are 7135 village ponds covering an area of 4378 hectares, which can be made suitable for fish culture after minor renovation. Another 5228 village ponds covering an area of 2668 hectares, which requires major renovation work, can also be made fit for fish culture (Grover and Kumar, 2011). The relevant statistics regarding fish culture and production in the state is presented in Table 6.3.

Table 6.3: Fisheries statistics in Punjab

Year	Area where fish stocked (hectare)	No. of fingerlings (000')	Fish seed and nurseries production (Lakh)	Fish production (000 tones)
2007-08	9941	142281	465.62	78.73
2008-09	10058	139486	527.94	104.77
2009-10	10247	153179	341.29	122.86
2010-11	10857	164474	532.17	97.04
2011-12	11287	151985	368.91	97.62
2012-13	11687	176441	402.94	99.13
2013-14	13039	204444	515.71	104.02
2014-15	14851	230659	514.76	110.44
2015-16	15393	257362	491.84	125.34
2016-17(P)	15636	3925498	-	-

Source: Statistical Abstract, Punjab and Agricultural Statistics at a Glance

The area where fish has been stocked in the state increased from 9941 hectare in 2007-08 to 15636 hectare in 2016-17. During this period the production of fish seed and nurseries increased from 465.62 lakh to 514.76 lakh in 2015-16, but declined to 491.84 in 2015.16Fish production observed at 78.73 thousand tones in 2007-08 increased to 114.77 thousand tones during 2014-15.

Growth in any sector or sub sector is not possible without back up of adequate infrastructure and related services. However, in Punjab the area served per institution and veterinarian has not been improved since 2007-08 (Table 6.4).

Table 6.4: Average no. of livestock units, area and units served per veterinary institution and per veterinarian in Punjab

Year	Unit No*	Livestock units per		Area served per sq. km.	
		Institution	Veterinarian	Institution	Veterinarian
2007-08	7052908	2473	5159	17.66	36.84
2008-09	7052908	2473	5159	17.66	36.84
2009-10	7052908	2473	5159	17.66	36.84
2010-11	7052908	2473	5159	17.66	36.84
2011-12	7052908	2452	5159	17.66	36.84
2012-13	7052908	2752	5159	17.66	36.84
2013-14	8117101	2852	5938	17.66	36.84
2014-15	7681100	2852	5619	17.66	36.84
2015-16	7681100	2852	5619	17.66	36.84
2016-17	7618100	2856	5619	17.63	36.84

Estimated on the growth rate of 1977 and 1990, 1990-1997 and 2003 livestock census by using modified geometric method

Note: Total livestock has been converted into livestock units-One livestock unit=one cattle=one buffalo=one horse/pony=one donkey=one camel=10 goats=10 sheep= 5pigs= 100 poultry

Source: Statistical Abstract, Punjab

Information on number of breed-wise frozen semen straw produced in semen banks reveals that in case of Sahiwal it increased from 67270 during 2008-09 to a record high at 420999 in 2016-17 (Table 6.5). However, during the same period, the production of Crossbred semen straw increased from 364169 to 561984, but of Jersey declined from 183211 to 103918 and 66189 respectively. Significant improvement was recorded in case of buffalo semen straw production which increased from 1001982 in 2008-09 to 1779822 in 2016-17.

Table 6.5: Livestock and artificial insemination development centers and frozen semen straw produced in Punjab (Number)

Livestock	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17(P)
Bull kept in A.I. centers/ semen banks									
Cow bulls	64	61	63	74	58	80	67	68	67
Buff bulls	53	56	60	113	81	108	112	122	140
Holstien Friesian	609839	918739	985902	1364049	1314079	1256228	1040852	1108742	1395938
Breed-wise frozen semen straw produced in semen banks									
Sahiwal	67270	65966	75142	193806	244342	157909	219045	375403	420999
Crossbred	364169	569857	554517	562347	654057	536616	362289	482926	561984
Jeracy	183211	213243	154032	93824	66189	69473	57893	63326	103918
Buffalo	1001982	1278691	1655417	1802547	1610096	1744660	1705859	1848540	1779822

Source: Statistical Abstract, Punjab

Chapter 7

POST HARVEST MANAGEMENT AND VALUE ADDITION

Agro based industry refers to the subset of manufacturing that processes raw materials obtained from agriculture and its allied sectors such as animal husbandry, forestry and logging and intermediate products derived from other industries such as semi processed hides and skins for manufacturing leather and leather products and edible oils for manufacturing hydrogenated oil. The value adding processes range from simple preservation like drying, grading and storage of output to production of high value products such as manufacturing of textiles, paper, rubber etc., through modern capital intensive methods (Chadha and Sahu, 2003). Developing countries have long promoted post harvest management and value added processing of agricultural output as a path of industrialization. With increase in per capita income and urbanization leading to increase in demand for high quality processed and packaged foods the process of value adding to agricultural production and fostering of farm non-farm linkages starts gathering momentum which in turn generates higher income and employment for the farm families, besides making agriculture a more effective contributor to industrial growth (Sarkar, 1997).

Punjab, despite being the leading producer of food grains is way behind in value addition industry to agricultural output. The state government has taken many steps to diversify the Punjab agriculture toward the production of high value crops. However, the high value crops like fruits and vegetables are highly perishable in nature and the farmers have to take the quick decision of disposal of the produce. Due to lack of adequate facilities (like grading and packing houses, cold storages etc.) for the post harvest handling of high value crops diversification initiatives in state met with limited success. The processing plants established in the area procure the produce from a few contract farmers only. Majority of the farmers have to depend upon the markets where the prices are highly volatile in nature whenever there is glut, and a slight delay in disposal may lead to serious post harvest losses to the produce. Both quantitative and qualitative losses of extremely variable magnitude occur at all stages in the post harvest system from harvesting, through handling, storage, processing and marketing to final delivery to the consumer. The principal causes of these losses are physiological deterioration due to high temperature, low atmospheric humidity and damage due to physical injury, diseases and pests.

Post harvest losses range between 15-35 percent for different types of agricultural produce. It is obvious that any reduction in post harvest losses will contribute to the net availability of food in the economy, which is of immeasurable worth and will help to increase the producer's returns and consumer's price (Grover and Kumar, 2011).

With the scale of production, the most prominent food grain processing activity in state is the milling of paddy. Rice milling is a primary processing activity under which the paddy grain is converted into polished rice. Rice forms the basic primary processed product obtained from paddy along with various secondary and tertiary products like husk and bran oil. Till nineties, the major portion of the paddy was milled through hullers usually with low milling capacity and no control on the polishing of rice, bran and a higher breakage of rice occurs. To overcome all these, rice mills have been established and became more popular as substitute for a huller mill. Over time number of improved/modern rice mills in the state increased remarkably to 3984 in the year 2012-13 (Table 7.1).

Table 7.1: Number of rice mills in Punjab

Year	Modernized rice mills
2009-10	3161
2010-11	3505
2011-12	3778
2012-13	3984

Source: Department of Food and Civil Supplies, Punjab, Chandigarh.

District-wise number of modern rice mills in state and installed capacity is presented in Table 7.2. Sangrur and Patiala district of the state are leading districts in terms of the number of modern rice mills in the state and occupying about 17 and 15 percent of the total number of mills in the state in the year 2012-13. Ludhiana, Barnala and Bathinda are the other important districts in terms of the number of modern rice mills in the state and occupying about 10, 9 and 7 percent of the total number of mills in the state, respectively. Presently, the milling capacity of paddy processing by the modern rice mills in the state was 9978 MT. Sangrur district of the state has the highest milling capacity of paddy accounting for about 15 percent of the total capacity in the state. Ludhiana, Moga and Patiala are the other important districts in terms of milling capacity of paddy processing by the modern rice mills in the state which was about 14, 11 and 10 percent, respectively.

Sugar mills are also among the largest agro industries in the state with daily crushing capacity of 76.90 lakh tones during 2016-17 (Table 7.3). Due to declined interest of farmers in sugarcane cultivation the cane supply continuously declined from 2007-08 to 2009-10, and thus the per cent capacity utilization of mills decreased over this period from about 61 per cent to about 23 percent. However with increased cane supply from 2010-11 onwards, the trend reversed and the percent capacity utilization in sugar industry increased to the tune of about 88 per cent during 2016-17.

Cotton is the first largest agro based manufacturing industry in India with value addition of at least 100 percent in successive stages of processing. Cotton after spinning to yarn is woven to fabrics, processed and converted to made ups or readymade garments. The value addition by converting cotton to readymade garments is impressive through export of cotton products (Chengappa, 2004). The number of spinning mills, composite mills, spindles, roster and looms installed in textile industry of Punjab is given in 8.4. Production of yarn, cloth in Cotton Textile Mills and production of traditional Khadi in Punjab is given in Table 8.5. The data shows that after facing the phase of stagnation, cotton textile sector in state had shown significant growth since 2011-12 in production of total yarn and of traditional khadi.

The state is one of the major milk producing states in India and per capita milk availability in Punjab is highest in country. During 2014-15, there were 66 milk plants in the state of which 11 were in cooperative sector (Milk fed), 3 in joint sector and 65 in the private sector (Table 8.6). Out of total milk processing capacity of 8514 thousand liters per day about 23 per cent falls with the Milkfed, about 6 per cent in joint sector and the rest about 71 per cent with the private sector.

Table 7.2: District wise number of rice mills, Punjab, 2012-13

District	Number	% share in total number	Capacity (tones)	% share in total capacity
Gurdaspur	110	2.76	375	3.76
Amritsar	50	1.26	141	1.41
Tarntaran	38	0.95	106.50	1.07
Kapurthala	80	2.01	302	3.03
Jalandhar	79	1.98	480	4.81
SBS Nagar	48	1.20	166.50	1.67
Hoshiarpur	45	1.13	136.50	1.37
Ropar	40	1.00	126.10	1.26
SAS Nagar	28	0.70	66.50	0.67
Ludhiana	407	10.22	1393.69	13.97
Ferozepur	175	4.39	526	5.27
Faridkot	30	0.75	385	3.86
Muktsar	187	4.69	351.51	3.52
Moga	278	6.98	1058	10.60
Bathinda	293	7.35	576	5.77
Mansa	217	5.45	317.50	3.18
Sangrur	686	17.22	1472.50	14.76
Barnala	343	8.61	702	7.04
Patiala	615	15.44	1018.25	10.20
Fatehgarh Sahib	137	3.44	273.50	2.74
Punjab	3984	100.00	9978.45	100.00

Source: Department of Food and Civil Supplies, Punjab, Chandigarh

Table 7.3: Cane crushed by sugar mills in Punjab

Year	Crushing capacity* (000' tones)	Cane crushed (000' tones)	% of capacity utilization
2007-08	9377.40	5760.5	61.42
2008-09	9377.40	2603.5	27.76
2009-10	9377.40	2112.0	22.52
2010-11	10502.40	3433.2	32.69
2011-12	10502.40	4270.5	40.66
2012-13	9864.90	4739.2	48.04
2013-14	9864.90	4972.5	50.41
2014-15	9864.90	5695.0	50.41
2015-16	9864.90	6671.0	67.62
2016-17	7689.90	6759.0	87.89

Source: Statistical Abstract, Punjab; * Number of working days of sugar mills assumed to be 150 in a year

Table 8.4: Cotton textile mills, spindles and looms in Punjab

(Number)

Particulars	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Spinning mills	119	119	127	128	133	138	140	140	142
Composite mills	4	4	6	8	9	9	9	9	9
Spindles installed(000)	2199	2353	3116	3113	3355	3498	3528	3674	3720
Roters installed	61024	61024	72996	78344	86192	93392	96528	100392	103640
Looms installed	1090	1090	1269	1359	1252	1162	1162	1162	1122

Source: Statistical Abstract, Punjab. Data includes small scale industries

Table 8.5: Production of yarn, cloth in cotton textile mills and production of traditional khadi in Punjab

Year	Total yarn (000 kg.)*	Total cloth/ M.sq.mtr	Production of traditional khadi (000' meter)**
2007-08	489617	206.51	913
2008-09	545482	220.30	740
2009-10	589516	221.29	627
2010-11	651065	239.56	296
2011-12	655582	149.76	933
2012-13	761117	221.77	940
2013-14	818424	226.04	1128
2014-15	843617	192.90	1410
2015-16	858978	163.49	2045
2016-17(P)	835151	166.27	2454

Total cloth includes cloth production by mill sector and exclusive weaving units;*Includes production of yarn by SSI units;** Includes khadi Sewa Sangh Jalandhar also, (P) provisional

Source: Statistical Abstract, Punjab

Table 8.6: Numbers of milk plants and milk processing capacity in Punjab

Particulars	Number of milk plant	Capacity (000 liter/day)
2009-10		
Milkfed	11 (14.86)	1525 (24.47)
Joint sector	3 (4.05)	500 (8.02)
Private sector	60 (81.08)	4206 (67.50)
Total	74 (100.00)	6231 (100.00)
2010-11		
Milkfed	11 (15.07)	1725 (21.23)
Joint sector	3 (4.11)	500 (6.15)
Private sector	59 (80.82)	5900 (72.62)
Total	73 (100.00)	8125 (100.00)
2011-12		
Milkfed	11 (13.92)	1700 (21.08)
Joint sector	3 (3.80)	500 (6.20)
Private sector	65 (82.28)	5864 (72.72)
Total	79 (100.00)	8064 (100.00)
2012-13		
Milkfed	11(13.92)	1700(20.62)
Joint sector	3(3.80)	500(6.07)
Private sector	65(82.28)	6044(73.31)
Total	79(100.00)	8244(100.00)
2013-14		
Milkfed	11(13.92)	1975(23.20)
Joint sector	3(3.80)	500(5.87)
Private sector	65(82.28)	6039(70.93)
Total	79(100.00)	8514(100.00)
2014-15		
Milkfed	11(16.67)	1775(22.83)
Joint sector	3(4.55)	500(6.43)
Private sector	52(78.78)	5501(70.74)
Total	66(100.00)	7776(100.00)
2015-16		
Milkfed	11(13.92)	1975(23.38)
Joint sector	3(3.80)	500(5.92)
Private sector	65(82.28)	5974(70.71)
Total	79(100.00)	8449(100.00)
2016-17		
Milkfed	11(13.92)	1975(23.20)
Joint sector	3(3.80)	500(5.87)
Private sector	65(82.28)	6039(70.93)
Total	79(100.00)	8514(100.00)

Figures in the parentheses are percentage to the total
Source: Statistical Abstract, Punjab

Processing of fruits and vegetables is very limited in Punjab. Specific processed products that are produced from horticulture sector in state include tomato paste, potato chips, juices, jams, chutney, pickles, murabbas, frozen vegetables, etc. Due to climatic conditions the fruits and vegetables production in state is characterized by short harvesting seasons and high productivity. Hence the viability of processing plants handling only one type of fruits/vegetables becomes limited and ultimately becomes uneconomical. Punjab Agro Juices Limited (PAJL) was established in 2006 with aim to add value to horticultural crops and provide opportunity to farmers for selling their produce at competitive basis. Two major plants (Hoshiarpur and Abohar) which can handle processing of various fruits and vegetables, commissioned by PAJL had started commercial production during 2008. These processing plants can handle pulp as well as store all the concentrates and single strength juices at the facility. In addition both of the plants are equipped with facilities of normal cold storage and deep freezer. Other notable high tech agro/food industries involved in value addition to agricultural production in state are Glaxo Smithkleim at Nabha (Patiala), Nestle at Moga, Nijjar Agro Foods at Jandiala and Pepsico agro Foods at Zahoora (Hoshiarpur).

Overall, despite being the leading agrarian state of the country, Punjab is way behind in food processing/value addition industry. The agro industry in state is limited to grain processing like rice milling, flour mills, oil mills and cotton ginning.

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