Chapter 4

DEVELOPMENT OF AGRICULTURE AND ALLIED SECTORS

INTRODUCTION

Punjab has entered the new millennium with problems in the agriculture sector. During the mid-nineteen-sixties, the green revolution transformed the states agriculture and contributed significantly in making the country self-reliant in food. The increase in production and productivity of wheat and rice in the state is legendary in the history of agriculture in India. These achievements presented a rosy picture of agriculture in Punjab until recently, as the achievements of the state in agriculture have run out of steam. Growth rates in agricultural production and productivity are stagnating and profitability in farming progressively getting reduced. Sustainability in agricultural production and the natural resource base are under threat, as warnings have been sounded on over-exploitation of land and water resources, and degradation of the environment and ecology. The technology base, which led to the green revolution, is not expanding any more. Alternative growth paths need to be explored to expand the growth potential of the state.

Punjab is endowed with abundant resources and an enthusiastic farming community, which has resulted in increase in grain-production from 73 lakh tonne in 1970-71 to 253 lakh tonne in 1999-2000. The state contributed in 1999-2000, around 50 per cent to the Central Pool Stock of wheat and rice. Cropping intensity in Punjab is currently more than 185 as against 133 in the country as a whole, and consumption of fertilizer (NPK) is 184 kilogramme per hectare as compared to the Indian average of 70 kilogramme per hectare. About 18 per cent of the total tractors in India are in Punjab. Production is supported by about 94 per cent irrigation coverage with 9,35,000 tube wells. Some of the selected indicators of development in agriculture are given in Table 1.

The fast-track adoption of production-augmenting technologies has led to several growth-related problems on the economic, social and environmental fronts in Punjab agriculture, so much so that the sustainability of wheat-paddy rotation is being doubted and debated.

Today, Punjab is at the crossroads, as the existing production pattern and marketing systems are out of tune with the immediate and long-term supply and demand situation in both national and international markets. A package of dynamic, pro-active and responsive policies and action programmes are required to revive Punjab agriculture, so as to meet the oncoming pressures of free trade, liberalization and globalization.

IMPLICATION OF CHANGES IN AGRARIAN STRUCTURE

Since the introduction of the green revolution technology, the agrarian structure of Punjab has witnessed interesting changes. In the first phase covering upto 1980-81, the number of marginal and small holdings declined sharply, while those in the higher-size categories showed a modest increase. These changes occurred primarily due to three reasons. First, with the onset of the green revolution technology, crop production activities became economically attractive, which created an active land-market for

leasing and selling land. Secondly, progress of agriculture under the green revolution technology created additional employment opportunities in the non-farm sector. These encouraged many marginal farmers either to sell their land or lease it, to earn higher incomes from non-farming jobs. Finally, the new technology turned out to be more attractive to the large farmers, mainly because the mechanical inputs associated with it were indivisible, and thus uneconomic for use in smaller-size farms.

Table 1
Some Selected Indicators of Growth of Punjab Agriculture

Indicator	1970-71	1980-81	1990-91	1999-2000(p)	2000-01(p)
Wheat production (MT)	5.1	7.7	11.7	15.9	15.5
Wheat yield (kg./ha.)	2238	2730	3715	4696	4563
Rice production (MT)	0.7	3.2	6.7	8.7	9.2
Rice yield (kg./ha.)	1765	2733	3229	3347	3506
Total foodgrains (MT)	7.3	11.9	20.0	25.2	25.3
Total foodgrains yield (kg./ha.)	1860	2456	3391	4032	4033
All commodities production index (triennium ended 1969-70=100)	109.76	170.23	269.55	321.72	332.59
Cropped area irrigated (%)	71	81	94	94	94
Nutrient (NPK) use (kg./ha.)	38	113	163	184	179
Total tube wells (`000)	192	600	800	925	935
Total tractors (`000)	30	119	265	365	-
Gross cropped area (m./ha)	5.7	6.8	7.5	7.8	7.9
Net cropped area sown (m./ha)	4.0	4.2	4.2	4.2	4.3
Cropping intensity (%)	140	161	178	185	186
Total cultivators (`000)	1665	1767	1917	-	-
Total agricultural labourers (`000)	787	1105	1452	-	-
Share in total main workers (%)	20.11	22.83	23.82	-	-

Source: *Statistical Abstracts, Punjab, various issues.*
Note : (P) - Indicates provisional estimates

In the second phase beginning from 1980-81, when profitability in farming started falling and growth of employment opportunities in the non-farm sector became limited, the absolute number of holdings in the state increased, even with a significant decline in the total operated area. Consequently, the average holding size in the state fell sharply from 4.07 hectare in 1980-81 to 3.61 hectare in 1990-91 (Table2). All except the small farmers registered a decline in average land-holding size. The number of marginal farmers increased steeply from 1,97,000 in 1980-81 to 2,96,000 in 1990-91 (an increase of more than 50%), while their operating land base, during the same period, increased from a total of 1,26,000 hectare to around 1,64,000 hectare (i.e., an increase of about 30%). Small farms too increased but marginally, with more than a proportionate increase in their total operated area, primarily due to progressive subdivision of medium and large farms under the law of inheritance.

Table 2
Comparative Statement of Operational Holdings in Punjab

	1980-81			1990-91			1995-96		
Size class	No. of holdings (000)	Area operated (000)	Area size of holding	No. of holdings (000)	Area operational (000)	Area size of holding	Size class	No. of holdings (000)	Area operated (000)
Marginal (< 1ra)	197 (19.22)	126 (3.02)	0.64	296 (26.50)	164 (4.07)	0.55	204 (18.66)	122 (2.94)	0.60
Small (1-2 ra)	199 (19.41)	291 (6.98)	1.46	204 (18.26)	328 (8.13)	1.61	183 (16.74)	240 (5.79)	1.31
Medium (2-4 ra)	287 (28.00)	841 (20.16)	2.93	289 (25.87)	841 (20.86)	2.91	320 (29.28)	833 (20.08)	2.60
Large (4-10 ra)	269 (26.25)	1672 (40.09)	6.22	261 (23.37)	1622 (40.23)	6.21	306 (28.00)	1754 (42.30)	5.73
Extra Large (> 10 ra)	73 (712)	1241 (29.75)	17.00	67 (6.00)	1077 (26.71)	16.07	80 (7.32)	1198 (28.89)	14.98
Total	1025 (100.00)	4171 (100.00)	4.07	1117 (100.00)	4032 (100.00)	3.61	1093 (100.00)	4147 (100.00)	3.79

Source: *Statistical Abstracts*, Punjab, various issues.
1995-96 data are obtained from Department of Agriculture, Punjab Government
Note: Number in parenthesis is percentage to the total

These negative developments in Punjab agriculture appear to have been slightly arrested now. Data from the 1995-96-agriculture census indicated that the average holding size in the state had improved to nearly 3.80 hectare, though it still remained considerably below the level attained in 1980-81. However, except marginal and small farms, all other categories of farms have considerably increased. As a result, the average operating land base for all categories of farms has declined, except for the marginal ones. Apparently, the serious unemployment situation in the state has had a telling effect on its agrarian structure.

More recent changes in the structure of ownership and operational distribution of land-holdings, apart from the land-lease market, etc., has been reported in a PAU study published in 2001[*]. It reveals:

- Farmers with small and medium-size holdings leased in more area to make gainful use of their farm resources.
- The employment of adult male members of farming families in off-farm jobs were on the increase, with 1.37 per cent supplementing their income through off-farm labour, 3.98 per cent in other business, 13 per cent by service in public and private enterprises and 20 per cent in other occupations.
- The modal land rent worked out to Rs. 17,500 per hectare. The lease contracts were mainly verbal, in cash and for one year. The land-lease market did not conform to the provisions of existing legislation, but it was observed to be working more or less to the satisfaction of both leasers and leasees.
- Land sale was more by the small and marginal farmers, mostly because of distress due to their inability to support their farms.
- The average price of land increased from Rs. 41,675 per hectare in 1985 to Rs. 3,04,775 per hectare in 1999. When deflated with the price index, the price of land was still increasing, showing thereby that the land market has been inflationary.
- The practice of mortgaging land among farmers is on the decline. Only about one per cent of the total operational area was under mortgage.

[*] Joginder Singh, "Changing Structure of Land Market in Agrarian State of Indian Punjab", *Productivity*, 2001, National Productivity Council, New Delhi.

The distribution of land in three sub-regions of the state revealed that during 1991, the average size of holdings in the sub-mountain region was 2.53 hectare, 3.70 hectare in the central region and 3.79 hectare in the southwest region (Table 3). The size-class distribution of holdings in various districts revealed that concentration of small and marginal farmers was the highest in the sub-mountain region, while concentration of large and medium farmers was the highest in the southwest region. Central districts were at the top in concentration of semi-medium holdings.

Table 3
District-wise Trends in Number and Size of Operational Holdings in Punjab, 1971-1991

Region/District	Total holdings ('000)			Average size (Ha)		
	1971	1981	1991	1971	1981	1991
Sub-Mountain Region						
Rupnagar	65	49	54	1.84	2.61	2.09
Hoshiarpur	148	94	98	1.65	2.69	2.64
Gurdaspur	123	100	113	2.11	2.60	2.64
Sub-total	336	243	265	1.85	2.63	2.53
Central region						
Patiala	84	79	96	4.63	4.95	4.05
Ludhiana	91	74	83	3.46	4.44	3.91
Jalandhar	116	75	86	2.44	3.99	3.41
Kapurthala	53	35	39	2.49	4.19	3.63
Amritsar	187	115	124	2.08	3.64	3.52
Sub-total	531	378	428	2.84	4.19	3.70
South West region						
Sangrur	108	90	102	4.16	5.13	4.49
Bhatinda	107	91	102	4.79	5.53	4.80
Faridkot	136	114	107	3.67	4.60	4.83
Ferozepur	158	111	112	2.94	4.46	4.51
Sub-total	508	406	424	3.78	4.89	4.66
Punjab	1375	1027	1117	2.95	4.10	3.79

Source: *Statistical Abstract of Punjab*, various Issues

The present state of agrarian structure points to the fact that marginal and small-size farming, though the largest in numbers, are fast becoming unviable. With increasing pressure on land for more production per-unit area through adoption of modern technologies and use of capital inputs, marginal and small farmers are unable to keep pace with the rapid technological advances in crop production. The scarcity of employment opportunities in the non-farm sector and increasing indebtedness due to increase in cost of inputs, have made the survival of small and marginal farmers difficult. With growing market demand for quality produce, suitable technical and credit support needs to be given to marginal and small farmers, to upgrade their skills for the production of quality goods. Given the preponderance of a large number of marginal and small farms in the state, the strategy for agricultural production should give more attention to meet their specific requirements. Extension services should re-orient the target approach so as to cater to the ever increasing numbers of marginal and small farmers. Besides, appropriate policies have to be designed to generate more off-farm employment opportunities.

PROBLEMS OF CONCENTRATION IN CROP PRODUCTION PATTERN

Wheat-rice rotation implications: The strategy for increasing agricultural production followed in Punjab was based on putting large cultivated areas under wheat and rice; use of high yielding seeds, water and fertilizers; and efforts to improve input-use efficiency for reducing the cost of production. The centre encouraged to pursue this strategy, to enhance foodgrains production, particularly wheat and rice, for meeting the emergent food situation in the country, especially during the seventies and eighties. Consequently, the production of foodgrains in Punjab rose more than seven times, from 3.16 million tonne in 1964-65 to 25.30 million tonne in 2000-01. Besides, high yielding seed varieties, consolidation of land-holdings, expansion of irrigation facilities especially lifting the ground water through tube wells and pump sets, higher use of chemical fertilizers, farm mechanization, development of produce markets, power and road infrastructure, easy availability of credit, strong research and extension support, favourable inputs and output prices -- all contributed to raising agriculture production significantly. However, over time, the wheat-rice rotation, now covering over 60 per cent gross of sown area, has created problems of serious consequences, some of which are:

- Both the crops are water-intensive, thus leading to large-scale depletion of groundwater in many areas.
- Both crops are heavy consumers of macro- and micro-nutrients, thus degrading the soil.
- The wheat-rice rotation adversely affects physical characteristics of the soil as, due to puddling for paddy, an impervious layer is formed in the soil, which does not allow root-penetration to deeper layers, thus restricting nutrient use.
- The wheat-rice rotation consumes heavy doses of fertilizers, pesticides and weedicides, which create ecological problems of environmental pollution, fauna and flora imbalances, and builds up residual toxicity in soil, water and air.
- The spread of monoculture of wheat and paddy has rendered these crops vulnerable to pest and weed attacks, thus making them more susceptible to pests and diseases.

The widespread practices of wheat and paddy crop rotation has caused considerable harm to the natural reserves and need to be altered quickly, lest the damages become irreversible.

Changes in cropping pattern: The green revolution brought significant changes in the cropping pattern of Punjab. In 1970-71, about 41 per cent of the gross cropped area was under wheat, which increased to nearly 44 per cent in 1990-91, and hovered around 42-43 per cent thereafter. Similarly rice, which occupied around 6.8 per cent of the gross cropped area in 1970-71, increased to over 25 per cent in 1990-91, and then rose further to around 33 per cent in 2000-01. The increase in wheat cultivation has been at the cost of gram, rapeseed and mustard, while that of rice has been obtained by shifting the area from maize, groundnut and millets. Areas under legumes and forage crops too have declined considerably. Areas under such crops as sugarcane, sunflower, potato, etc., have not remained stable (Table 4). Area under cotton has been adversely affected due to inclement weather and pest attack. It is, however, encouraging to note that productivity of most crops have been increasing over the years except for bajra (Table 5).

Table 4
Shift in Cropping Pattern in Punjab (Area in' 000 ha.)

Crop	1970-71	1980-81	1990-91	1999-2000	2000-01
Rice	390 (6.87)	1183 (17.49)	2015 (26.86)	2604 (33.18)	2612 (32.92)
Maize	555 (9.77)	304 (4.50)	183 (2.44)	163 (2.08)	164 (2.07)
Bajra & Jowar	212 (3.73)	70 (1.03)	12 (0.16)	5 (0.06)	6 (0.08)
Groundnut	174 (3.06)	83 (7.23)	11 (0.15)	5 (0.06)	4 (0.05)
Cotton (American)	212 (3.73)	502 (7.42)	637 (8.49)	381 (4.86)	358 (4.51)
Sesamum	15 (0.26)	17 (0.25)	18 (0.24)	145 (1.85)	19 (0.24)
Sugarcane	128 (2.25)	71 (1.05)	101 (1.35)	108 (1.38)	121 (1.52)
Kharif pulses	33 (0.58)	58 (0.86)	73 (0.97)	51 (0.65)	42 (0.53)
Wheat	2299 (40.49)	2812 (41.58)	3273 (43.63)	3388 (43.18)	3408 (42.95)
Barley	57 (1.00)	65 (0.96)	37 (0.49)	51 (0.65)	32 (0.40)
Gram	358 (6.30)	258 (3.81)	60 (0.80)	6 (0.08)	8 (0.10)
Rapeseed & Mustard	103 (1.81)	136 (2.01)	69 (0.92)	56 (0.71)	55 (0.69)
Potato	17 (0.30)	40 (0.59)	23 (0.31)	76.0 (1.00)	64 (0.81)
Other vegetable	23 (0.41)	24 (0.36)	31 (0.41)	47 (0.60)	46 (0.58)
Fruits	50 (0.88)	29 (0.43)	69 (0.92)	30 (0.38)	34 (0.43)
Net Sown Area	**4053**	**4191**	**4218**	**4243**	**4264**
Total Cropped Area	**5678**	**6763**	**7502**	**7847**	**7935**
Cropping Intensity	**140**	**161**	**178**	**185**	**186**

Source: *Statistical Abstract, Punjab*, 1971, 1981, 1991, 2000 and 2001
Note: Figures in parentheses indicate area under crops as percentage share to total cropped area

Area under pulses has recorded a sharp decline. Gram, which used to be the most important pulse crop in the state during the sixties, declined from a level of nearly 3,60,000 hectare in 1970-71 to less than 10,000 hectare in 2001. Yield of gram, which stagnated till 1990-91, has started improving, though it has not yet become attractive enough to arrest the decline in its area and production.

Table 5
Yield (kg./ha.) of Principal Crops in Punjab

Crop	1970-71	1980-81	1990-91	1999-2000
Wheat	2238	2730	3715	4696
Rice	1765	2733	3229	3347
Maize	1555	1602	1786	2577
Barley	1022	1640	2754	3521
Gram	797	582	744	974
Bajra	1176	1244	1107	703
Sugarcane (Gur)	4117	5526	5941	6265
Cotton (American)	399	329	481	337
Cotton (Desi)*	338	241	285	352
Rapeseed & Mustard	553	567	1003	1117
Groundnut	970	1249	816	969

Source: *Statistical Abstract, Punjab*, 1971,1981,1991 and 2001.
Note: ***** In term of lint

An examination of district-wise data reveals an interesting pattern in the variabilities in crop yield levels (Table 6). Crops, which have now become important in the state, such as wheat, rice, cotton and sugarcane, have generally lower inter-district variability in their respective crop yields than those, which have been marginalized, such as oilseeds, pulses, bajra and maize. For instance, wheat yield ranges from a low of 3,500 kg per hectare in Hoshiarpur district to a high of nearly 5,150 kg per hectare in Fatehgarh Sahib district. Similarly, rice yield varies from around 2,800 kg per hectare in Gurdaspur district to a high of nearly 3,700 kg per hectare in Fatehgarh Sahib district. In the cotton-growing districts, yield has been fluctuating in a narrow range around an average of 340 kg per hectare. However, the yield of oilseeds, cultivation of which has been marginalized in the state, has recorded wide variations, from as low as 738 kg per hectare in Gurdaspur district to as high as 1,388 kg per hectare in Fatehgarh Sahib. Yield level of pulses, bajra and maize crops, which have too been marginalized in the state, has recorded wide inter-district variations.

Table 6
District-wise Productivity of Crops (1999-2000) (Kg per hectare)

Region/District	Wheat	Rice	Cotton	Oil Seeds	Sugar Cane	Pulses	Bajra	Maize
Majha								
Gurdaspur	4362	2831	-	738	68450	560	-	2042
Amritsar	4885	3108	274	932	65870	338	703	2407
Doaba								
Kapurthala	4710	3489	-	1190	55040	500	-	3357
Jalandhar	4925	3487	-	1326	58720	625	-	2949
Nawanshar	4597	3481	-	1216	58060	667	703	2550
Hoshiarpur	3591	2920	-	1030	62010	600	-	2680
Malwa								
Ropar	4022	3112	-	909	54540	592	-	2426
Ludhiana	5064	3611	-	1250	70510	716	-	3122
Firozepur	4648	3509	335	1103	70630	649	703	-
Faridkot	4662	3388	353	1090	60740	425	-	-
Muktsar	4725	3208	344	898	66360	658	703	2577
Moga	4928	3355	280	1187	-	655	703	-
Bathinda	4614	3453	302	1051	-	617	572	-
Mansa	4582	3202	374	1000	66560	765	719	-
Sangrur	4828	3562	346	1050	69720	695	753	2577
Patiala	4800	3248	-	1120	59840	706	-	3050
Fatehgarh Sahib	5148	3679	-	1388	62380	1060	-	2759
Punjab	**4696**	**3347**	**337**	**1065**	**62650**	**665**	**703**	**2577**

Source: *Statistical Abstract,* Punjab, 2001

While the state has attained high yields in some important crops, considerable scope exists for improving crop yields by furthering full use of technology available, within and outside the country. For instance, wheat yield in Punjab is 4,332 kg per hectare whereas it is 8,031 kg per hectare in Ireland (Table 7). Similarly, Punjab produces rice with the yield level at 3,152 kg per hectare whereas Australia has an yield of 10,269 kg per hectare. Sugarcane yield in Punjab is 59.5 tonne per hectare while in Switzerland it is 136.5 tonne per hectare. Again among fruits, for example, while the yield of citrus in Israel is now over 5,407 kg per hectare, it is only around 180 in Punjab. Efforts should be made to improve the yield per unit-area through exploitation of genetic potential via bio-technological tools and intensive research and development. For accelerating the productivity of different crops, advances made by different countries should be utilized to obtain scientific and technological knowhow for adaptation to suit our conditions.

Table 7
Yields of Crops in Punjab, India and in Selected Countries (kg/ha) 1998-99

Crop	Yield in Punjab	Yield in India	Highest Yield in India		Highest Yield in World
Wheat	4332	2583	--	8767	Ireland
Rice	3152	1928	2443 (Tamil Nadu)	7539	Ukaraine
Maize	2286	1755	3328 (A.P)	9401	Chile
Pulses	788	620	830 (U.P)	5368	France
Oilseeds – Groundnut	774	1210	1630 (Tamil Nadu)	6302	Israel
Sun flower	1718	602	--	2794	Switzerland
Sugarcane	59520	72560	110156 (Tamil Nadu)	118706	Peru
Citrus	180	N.A	--	5407	Israel
Fruits					
a) Kinnow	10000	N.A	N.A	65000	Israel
b) Orange	15000	N.A	N.A	43000	Israel
c) Mango	7000	N.A	N.A	17000	Israel*
d) Lemon	5000	N.A	N.A	50000	Israel*
e) Plum	4000	N.A	N.A	10000	Israel*
Vegetables					
a) Potato	17000	17886	22629 (U.P)	49000	Belgium
b) Tomato	24000	15068	N.A	466667	Netherlands
c) Cauliflower	24000	15000	N.A	50000	Armenia
d) Onion	19330	10106	N.A	81504	Korea

Source: Directorate of Horticulture, Government of Punjab
Directorate of Agriculture, Government of Punjab
FAO Bulletin of Statistics, 2002 (Vol.2*)*
Israel Agriculture, Govt. of Israel, 1986
Note: * - These figures pertain to 1996

Monoculture: The wheat crop has, from the very beginning, dominated the cropping pattern of the state and its importance has steadily increased. The area and productivity of wheat made a substantial jump during the mid-sixties when new dwarf varieties were introduced. In 1960-61, 29 per cent of the gross sown area of the state was under wheat, which increased to 40.5 per cent in 1970-71 and then to 43 per cent in around 2000-01.

In contrast, the area under rice, which had been only 4.8 per cent in 1960-61 and 6.8 per cent in 1970-71, increased to a level of 33 per cent in around 2000-01. This significant development in the crop production pattern of the state occurred after the introduction of dwarf IRRI rice varieties in the early seventies. Within the cereal group, wheat and rice became the most dominant crops and the area under these two crops together increased from 34 per cent in 1960-61 to over 75 per cent around 2000-01. Unfortunately, however, the seeds used for the cultivation of these two crops have remained limited to a select few. For instance, surveys conducted by the Department of Economics and Sociology, Punjab Agricultural University, have found that more than 80 per cent of the area under wheat is currently using a single variety, namely, PBW 343.

Table 8
Average Yield of Rice, Wheat and Cotton Crops in Punjab (kg/ha)

Period	Wheat	Rice	Cotton American (in lint)
1967-68 to 1969-70	2095	1392	374
1971-72 to 1973-74	2279	2113	415
1974-75 to 1976-77	2400	2410	400
1977-78 to 1979-80	2683	2818	368
1981-82 to 1983-84	2985	3055	280
1985-86 to 1987-88	3346	3230	505
1990-91 to 1992-93	3762	3292	S569
1993-94 to 1995-96	3995	3341	481
1996-97 to 1998-99	4134	3337	280
Annual Rate of Growth (%)			
1967-68 to 1981-82	2.47	6.01	- 0.89 NS
1981-82 to 1998-99	2.14	0.59 NS	- 0.38 NS

Source: *Statistical Abstract of Punjab, v*arious issues
Note: NS implies statistically not significant

The increasing popularity of the wheat-rice crops rotation practised in the state, however, has been moderated by a slow-down in their respective crop yields. The wheat-yield growth rate declined from the pre-1980 level of 2.47 per cent per annum to 2.14 per cent per annum over the following two decades. The decline in the rice-yield growth rate was more dramatic; it sharply declined from the pre-1980 level of 6.01 per cent per annum to a statistical insignificant level of 0.59 per cent per annum. Rice yield in the state is now fluctuating between three to 3.5 tonne per hectare. Another problem of practising monoculture is the resurgence of pests and diseases, which has adversely affected crop production in most of the districts. The wheat-rice crop rotation has also caused emergence of new and uncontrollable weeds. Monoculture all over the world is considered harmful to natural reserves, and is a risky proposition, which should not be practised over a longer period.

SOIL AND WATER MANAGEMENT

Soil management: Most of the soils of Punjab are alluvial and deep, varying from sandy to silty clay. Due to intensive cultivation, the organic carbon of the soil has come down from 0.5 per cent in 1960 to 0.2 per cent in 1990. Loss in organic carbon means wasteful extra application of chemical fertilizers, loss in soil biological activity and poor soil moisture retention. The high nutritional requirement of paddy and wheat have

exhausted the soils of vital nutrients. Thus, higher and higher doses of major nutrients, especially nitrogen, has to be applied for sustaining adequate production levels. Micro-nutrient deficiencies in large areas have also been noticed adversely affecting crop yield. The following are some of the important soil related problems that are adversely affecting agricultural production in Punjab:

- *Physical*: Surface crusts; sub-soil compaction; soil erosion; poor air-water relationship; development of hard pan; development of fine textured sodic soils.
- *Hydrologic*: Shallow water table; negative water balance; water logging; flood hazards; free percolation in coarse soils and poor permeability in fine textured soils.
- *Chemical*: Depletion of organic matter; multi-nutrient deficiencies; nutrient imbalance; salinity/sodicity and pollution from agro-chemicals, sewerage and industrial effluent.
- *Biological*: Decline in quality and quantity of soil biomass; low-biological oxidation and slow rate of decomposition of crop residues.

Punjab has about 4.2 million hectare of land area under cultivation. In addition, another two million hectare of degraded land is available (Table 9). Part of this degraded land can be recovered for cultivation provided adequate research is undertaken for its reclamation. On the other hand, it is more important to preserve existing cultivated areas 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 save the soils from exhaustion.

Table 9
Extent of Degraded Land in Punjab

Waste-land/soil degradation	Area (lakh ha)
Water erosion	
(i) Severe (gullies, ravenous)	1.70
(ii) Slight & moderate (with/without scrubs)	3.40
Water-logged—rising water table	1.22
Marshy-submerged	2.28
Salt-affected (varying degrees of deterioration)	
(i) Canal command areas	3.93
(ii) Outside canal command areas	1.27
Degraded forest/pasture lands	2.00
Coarse/very light textured (loss of nutrients with deep percolation and leaching, poor in fertility)	6.20

Source: Director, Punjab Remote Sensing Centre, Ludhiana

Water management: Punjab has an irrigation distribution network of 1,45,000 kilometres of canals including branch canals and minor distributaries, and one lakh kilometres of field channels or water courses. The canal irrigation system irrigated 12,92,000 hectare land in 1970-71 while only 10,02,000 hectare was irrigated in 2000-01 (Table 10). There has been a significant reduction in canal irrigated area since 1990-91. At present only around 40 per cent of the water that enters the canal system irrigates the crops, whereas the optimum efficiency should be above 60 per cent. Management of the canal irrigation system needs revamping, so that the water thus saved can be used for the remaining unirrigated areas of the state.

Table 10
Net Irrigated Area (`000 ha.) by Different Sources in Punjab

Source	1970-71	1980-81	1990-91	1999-2000*	2000-2001*
Canals	1292	1430	1669	1051	1002
Tube wells	1591	1939	2233	2938	3017
Other sources	5	13	7	12	2
Total	2888	3382	3909	4001	4021
Share of area irrigated to the gross area sown (%)	71	81	93	94	94

Source: *Statistical Abstract*, Punjab 1971, 1981, 1991, 2000 and 2001
Note: *** -** Indicates provisional estimates

There are 9,35,000 tube wells to lift underground water for irrigation. The total demand for irrigation water in the state is estimated at 4.381 million hectare metres (mhm) against a total supply of 3.130 mhm from both canal and ground-water resources, leaving a net deficit of 1.251 mhm (Sondhi and Khepar, 1995). The deficit 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 metres.

Irrigation coverage, which was around 71 per cent of the total cropped area in 1970-71, increased to 94 per cent in 2000-01. While canal irrigation has been declining over the years, tube well irrigation, particularly in the central and northern region of Punjab has been on the increase. Over six per cent of the total tube wells in India are in Punjab. Deep tube wells are being used even in the southern region, where the underground water is brackish.

Due to cheap credit and free supply of electricity, the use of tube wells for irrigation has increased steeply in the state. The number of electrically operated tube wells has increased from 6.0 lakh in 1990-91 to 7.7 lakh in 1999-2000. Extensive use of canal irrigation and reckless use of groundwater through tube wells have caused water logging problems in some areas and lowering of the ground-water table in other areas. The water table in the central districts of Punjab has been going down at an average rate of 0.23 metres per year (Table 11). It is estimated that in the next 15 years about two lakh submersible pumps would be needed to replace the present pump sets, at an estimated cost of Rs. 2,000 crore, or an additional expenditure of Rs. 5,000 per hectare, in addition to a two-fold increase in energy consumption.

Table 11
Rise and Fall in Underground Water Table in Different Districts of Punjab, 1973 through 1994

District	Fall in water table (m)			Rise in water table (m)		
	Blocks	1973-83	1984-94	Saline/ semi-saline blocks	1973-83	1984-94
Sub-mountainous Zone						
Gurdaspur	All	+0.2-0.6	-0.7-1.2	--	--	--
Ropar	All	+0.04	-1.8	--	--	--
Hoshiarpur	All	-0.9	-0.9	--	--	--
Central Plains						
Amritsar	All	-0.9	-2.3	--	--	--
Kapurthala	All	-0.7	-1.8	--	--	--
Jalandhar	All	-1.5	-2.5	--	--	--
Ludhiana	All	-0.9	-1.9	--	--	--
Patiala	All	-1.7	-9.8	--	--	
Fatehgarh Sahib	All	-1.3	-2.7	--	--	--
Sangrur	All	-5.1	-5.1	--	--	
Southwest Zone						
Mansa	All	-1.6	-1.4	--	--	--
Bathinda	0.5	+3.5	-1.9	0.5	7.3	4.2
Faridkot	0.5	-1.15	-4.5	0.33	9.0	5.0
Ferozepur	0.75	+0.1	-4.5	0.25	7.7	3.0

Source: Directorate of Water Resources, Punjab**.**

Currently, 90 blocks out of a total of 118 show a decline in water-table depth ranging from zero to three metres (24% area), three to five metres (23% area) and above five metres (29% area). According to a PAU estimate, there is over-exploitation of more than 100 per cent of annual net recharge of water in 63 blocks, whereas in seven blocks it is above 85 per cent. Out of the remaining 38 blocks, 15 fall in the grey category with 65-85 per cent of net annual recharge to groundwater, thus leaving only 23 blocks in the white category (Table 12). This over-exploitation of underground water is due to increase in the number of tube wells, free supply of electricity, cultivation of such high water-consuming crops paddy, potato, wheat, sugarcane, etc., and scant attention to efficiency in water use. Extensive research is needed to work out methods for optimum water-use efficiency for different crops in different regions. Time has come to use increasingly rain-water harvesting technologies for conserving water and for recharging the underground water, both in rural and urban areas.

Table 12
Distribution of Blocks into Dark, Grey and White on Basis of Underground Water Resources in Punjab, 1994

District	Dark	Grey	White	
			Total	Technically exploitable
Gurdaspur	5	3	5	1
Hoshiarpur	1	4	6	0
Ropar	1	1	4	0
Sub-mountainous Zone	**7**	**8**	**15**	**1**
Amritsar	12	3	0	0
Kapurthala	4	0	0	0
Jalandhar	12	0	0	0
Ludhiana	9	1		0
Patiala	8	1	0	0
Sangrur	10	0	0	0
Central Plains	**55**	**5**	**0**	**0**
Mansa	0	0	3	1
Bathinda	1	0	5	2
Faridkot	4	0	6	0
Ferozepur	3	2	4	2
Southwest Zone	**8**	**2**	**18**	**5**

Source: Directorate of Water Resources, Punjab, Chandigarh.

Watershed management: Soil erosion is rampant in the sub-mountain kandi region of the Shivalik range, due to excessive water-flow during the rainy season and absence of water for irrigation in the rest of the year. Water management is necessary in this area. A watershed development project was initiated in 1990 with the assistance of the World Bank in this region. Vegetative barriers and vegetative reinforcements have been established in 6,274 hectares, as a result of the development of watershed contours and rain-water conservation has been made possible for irrigating over 5,000 hectare of land. Watershed management has helped improve crop yield. Cropping intensity too has increased to 165. In the project area successful cultivation of crops, forests and grasses has become possible, while in non-project areas conditions continue to be favourable for growing crops. Participation of the local people and government agencies have demonstrated that infertile and degraded areas can be conveniently converted into fertile and cultivable areas with collective effort and effective use of technology. Extension of watershed management programmes in the remaining areas is necessary for increasing crop productivity. Besides, watersheds can meet the growing demand for irrigation in lean periods.

MECHANIZATION AND CHEMICALIZATION OF AGRICULTURE

Mechanization: Intensive agriculture requires farm mechanization, besides modern inputs of seeds, water and such chemicals as fertilizers and pesticides. The rapid adoption of the green revolution technology in Punjab has led to a sharp increase in farm mechanization. In 1960-61, there were seven tractors per thousand hectare of land, which shot up to 96 in 1998-99. On an average, there is now one tractor for every eight hectare of net cultivated land, and in some districts the area operated by a tractor is even lower. In contrast, at the all-India level, the area operated by a tractor is above 66 hectare. Table 13 provides a comparative picture of the stock of agricultural machinery and implements in Punjab and the country as a whole. Clearly, Punjab agriculture is relatively more heavily mechanized.

Table 13

Agricultural Machinery and Implements in Punjab and India (in '000)

Implements and Machinery	Punjab	India
	1996	1992
Tractor/Trailer	330	12218
Tiller/cultivators	228	
Disc harrows (T. drawn)	248	
Seed-cum-fertilizer drills	135	
Spray pumps	510	
Tractor-drawn combines	4.6	
Self-propelled combines	2.3	
Threshers	305	
Cane crushers (bullock operated	--	5861
Cane crushers (power operated)	35	
Tubewells	875	109809
Wooden ploughs	--	395815
Iron ploughs	--	
Carts	--	133860

Source: *Statistical Abstract*, Punjab, 1997, Chandigarh
Statistical Abstract, India, 2000

There are numerous farmers in Punjab with little land, owning a tractor, while many large farmers have more than one tractor. The available stock of tractors in the state is not fully utilized. In addition, lack of facilities for the service and maintenance of farm equipment near the villages results in raising the cost of production.

Excessive farm tractorization has caused damage to physico-chemical characteristics of soils, particularly where puddling is done for rice cultivation. With the loss of soil characteristics, biological activities are also impaired and in the long run, such soils are likely to become unproductive. Use of harvester-combines for wheat and paddy has been on the increase. Their use leaves uncut straw and stubbles in the fields, which are often burnt, causing smoke pollution. Approximately 10,000 tonne of straw are thus lost every year, which could otherwise have been used as feed for cattle or ploughed back into the soil to improve some of its characteristics.

The high level of mechanization used in sowing, irrigation and harvesting has considerably displaced human and bullock labour from Punjab agriculture. Upto 1977, bullock-operated ploughs, wells, carts and cane-crushers dominated the agricultural scene. By 1996 these implements had virtually disappeared. Farm mechanization, no doubt, has been beneficial for the intensive use of land and has helped considerably in

overcoming the risk of unfavourable effects of weather on maturing crops. In turn, there has been a decline in the use of agricultural labour, which has created serious social and economic problems, as alternative avenues for employment of displaced labour are few. The level of efficiency of farm implements, in terms of time and energy-consumption, needs to be improved through extensive research. Besides, there is also need to develop more innovative and inexpensive instruments, which could be used as time-saving devices and also for additional operations of cleaning, grading, packing, etc.

Chemicalization: Extensive use of agro-chemicals became an important component for increase in crop production during the initial years of the green revolution, and their use has since continued to increase. Among the agro-chemicals, chemical fertilizers dominate the scene, followed by pesticides including weedicides. Punjab has the highest consumption of chemical fertilizer per hectare in the country. It consumed 167 kg of chemical fertilizers per hectare during 1997-98 as compared to the all-India average of 74 kg. Growth of chemical fertilizers consumption was the highest during 1970-71 to 1980-81, with the consumption of all types of chemical fertilizers (NPK) increasing by 250 per cent. By 1998-99 it declined to 80 per cent (Table 14). While productivity of crops increased during the first two decades, on account of increasing nutrient-use efficiency, it began to decline thereafter on account of imbalances in the use of N, P and K, along with the deficiencies of micro-nutrients. The fertility level of 67 per cent blocks in the state was reported to be low in N, while in the remaining 33 percent, it was medium (Table 15). Further, micro-nutrient deficiency of zinc, iron and magnesium has become pronounced in several areas of the state. Deficiency of sulphur and copper too has been reported from several areas. To enhance fertilizer-use efficiency under different cropping systems, continuous technological inputs are needed to make them cost-effective. Integrated use of balanced chemical fertilizers in conjunction with organic manures (compost and green manure), rotation of cereals with legumes and use of bio-fertilizers and vermiculture have to be undertaken to maintain the health of the soil.

Table 14
Consumption of Chemical Fertilizers in Punjab ('000 metric tonne)

Year	Nitrogenous (N)	Phosphates ($P_2O_{5)}$	Potassic (K_2O)	Total NPK
1970-71	175	31	7	213
1980-81	526	207	29	762
1990-91	877	328	15	1220
1998-99	1081	275	19	1375

Source: *Statistical Abstract of Punjab,* 1999

Table 15
Per cent Distribution of Blocks According to Fertility Status of Soils in Punjab (on the basis of per cent deficient samples)

Fertility Status	1970-77			1981-90		
	N	P	K	N	P	K
Low	52	16	13	67	44	--
Medium	48	65	58	33	55	43
High	--	19	29	--	1	57

Source: Brar and Chhibba, 1994, Brar, 1979

Use of pesticides including weedicides has also contributed to increasing crop production. Currently, about one kg technical grade pesticides per hectare is being used in wheat, paddy, cotton, sugarcane, fruits and vegetables cultivation in Punjab against the all-India average of 350 gm per hectare. The spectrum of use of pesticides has been

changing over the years in response to emerging pests- and weed-problems due to intensive cultivation.

Excessive and indiscriminate use of pesticides and weedicides has led to several new problems, such as development of pest resistance, pest resurgence and outbreaks, and adverse effects on such non-target organisms as predators, pollinators and honey bees. Development of resistance in the American boll worm, because of abuse and misuse of pesticides, accounts for the inability to control cotton pests in Bathinda district. (See the CRRID report on Problems of Cotton Growers in Punjab). Even contingency strategies have failed to cope with the situation causing enormous losses to cotton growers during the last five years. Similarly, abuse and misuse of pesticides is rampant on fruit and vegetable crops, which pose great health hazards to consumers.

The strategy for effective management of pests- and weed-problem lies in the use of integrated pest management technology (IPM), wherein agronomic practices, inter-cropping and forecasting of pests and diseases are essential components, besides use of pesticides. Unfortunately, IPM technology for important crops has not reached the farmers, due to lack of effective extension efforts. On the other hand, the pesticides available in the market, particularly at the village level, are usually unbranded, often adulterated or date-expired, and the advice on how to use pesticides is given by relatively ignorant pesticide sellers or commission agents. This inadequacy in the use of pesticides is not only wasteful but also dangerous, as it contributes heavily to the pollution of air, water and soil, in addition to health hazards. Appropriate information has to be made available to the stakeholders so that the ill effects of agro-chemicals are reduced. Suitable technologies should be developed to promote safe and efficient use of pesticides. Use of bio-pesticides should be encouraged so that health hazards are minimized.

The disquieting aspect of the excessive use of chemical fertilizers and pesticides is their adverse affects on the eco-system, as it causes soil pollution as well as underground-water pollution, plus changes in ecology of weed and soil organisms. Overuse of pesticides is becoming a threat to both human and cattle populations, besides disturbing the flora and fauna of the state. It is on account of these ill effects of agro-chemicals that the green lobby for growing and using organic foods is picking up in the West. Punjab, being agro-technically progressive, should venture into developing technologies for growing organic crops for domestic and international markets.

AGRICULTURAL CREDIT

Sources of institutional and non-institutional credit: Credit is an important enabling input, which has significantly contributed to the success of the green revolution in Punjab. The credit delivery mechanism, cost of credit, etc., are intimately linked with the sources of supply of credit to agriculturists. Formal credit institutions, such as co-operative societies, co-operative banks, land mortgage banks, regional rural banks and commercial banks are supposed to meet the credit requirements of most agriculturists in Punjab. The extent and spread of formal credit institutions in Punjab is given in Table16. Compared to other states, the spread of the co-operative credit network, as also of commercial and regional rural banks, is fairly well developed in Punjab. There are 50 bank branches per thousand square km in Punjab as compared to 20 for the whole country, 21 for Maharashtra, 18 for Andhra Pradesh and 19 for Gujarat.

Table 16
Extent of the Spread of Formal Credit Institutions in Punjab
(1998-99) (in Lakh Rs.)

S. No	Type of institution	Number	Loans advanced in 1998-99	Loans outstanding as on 31 March 99
A. Co-operatives				
1.	Primary Agricultural Credit Societies	4200	1716.13	1327.17
2.	Primary Non-credit Societies	882	200.99	133.28
3.	Primary Agricultural Development Banks	80	487.00	1240.00
4.	Punjab State Agricultural Development Banks	1	311.35	1183.96
5.	Punjab State Co-operative Bank	1	5958.60	1324.11
6.	Central Co-operative Bank	19	3334.42	1951.55
B. Banking Institutions				
1.	Number of branches including those of RRB's	2520	2007.50	2255.29

Source: *Statistical Abstract*, Punjab, 1999

Besides institutional credit, a substantial amount of credit flows to the farmers from non-formal channels, i.e., commission agents or arhtias. The Department of Co-operation, Government of Punjab, in one of their studies (1998), has pointed out that 63.85 per cent of farmers obtained credit from arhtias or commission agents, 51.25 per cent from co-operative institutions and 8.85 per cent from commercial and regional rural banks. About 55 per cent farmers borrowed money from more than one source, with the idea of revolving back the money for credit repayment. The study further reveals that small, medium and large farmers were more dependent on commission agents (arhtias) for short-term loans. The amount of credit per operated acre of land was the highest among small farmers (Rs. 4,536) and the lowest among large farmers (Rs. 2,488).

Small and medium farmers in the state have taken more long-term loans, during 1998-99, and that too for non-productive purposes in most cases. Non-productive long-term loans were mostly taken from private money- lenders. Commercial banks were the preferred agencies for long-term productive loans. According to the same study, Punjab farmers are under debt of Rs. 5,700 crore, out of which 46.32 per cent is to commission agents, 7.12 per cent on mortgages, 27.14 per cent to co-operative institutions and 19.42 per cent to commercial banks. However, the amount of debt per unit of operated area was higher among marginal, small and medium farmers than among large farmers. Increase in indebtedness, though officially attributed to the increasing cost of inputs, is high really because of unproductive spending habits of farmers; the relative ease with which credit is made available encourages farmers to spend it often on social ceremonies and excessively on domestic consumption.

The arhtia-farmer relationship is traditionally very old and bitter, because of the excessive interest they charge. On the other hand, no institutional credit can match the services the arhtias provide --speedy supply of credit on demand and on short notice. Sometime the artias manipulate the repayment, by giving more loans at a still higher interest rate, until the farmer is forced to sell a part or whole of his land, to meet the debt obligations.

Incidentally, formal credit, though most welcome for increasing agricultural production, has some inbuilt shortcomings. Hassles in obtaining credit from formal institutions is consumer unfriendly as it is time consuming; demands documentation based on land records, which does not include leased or mortgaged lands; and there are credit limits for specific operations and crops. Inefficiencies of the credit institutions, delays and uncertainties due to lack of manpower, unco-operative attitude of the officials, commission for processing loan applications through agents, and political and administrative interference are the reasons for the arhtias being more popular with the farmers. The flourishing business of the arhtias often depends on the credit they themselves obtain from the banks against land for advancing the money to the bank shy farmers. (Those who do not want to disclose their identity). All efforts in the past to overcome the shortcomings of the credit institutions and reduce the influence of arhtias and commission agents have failed to yield the desired results. Nevertheless, with the increasing opening up of the rural economy, a system of direct linkages should be encouraged through face to face contact of the producers with the investors or marketing and processing agencies. The role of the corporate sector in such a venture needs full policy and governmental support in order to minimize the role of commission agents and arhtias.

Kisan credit cards: Keeping in view the limitations and inefficiencies of the formal credit system, and heavy dependence of farmers on arthias, the Central Government introduced a scheme of Kisan Credit Cards (KCC) in 1998-99. It aims at adequate and timely support from the banking system to farmers for their agricultural needs, particularly for crop production and short-term loans. The KCC has a provision of flexibility in withdrawing money at any time according to the farmer's requirements, while the borrowing limit is fixed according to the net worth of the farmer, which is determined by district-level technical committees. The KCC scheme is like revolving cash credit and provides for any number of withdrawals and repayments within the limit. The number of KCCs in Punjab stood at 62,624 as in September 2000, with a sanctioned amount of Rs. 317.15 crore.

There was initial enthusiasm for over a year in obtaining the Kisan Credit Cards, but this has slowed down for various reasons. A farmer has to be literate and has to declare the total value of his assets before getting a credit card. He has several inhibitions about such disclosures. Only large farmers are taking advantage of KCC. The success of KCC would depend upon its wide acceptability and use by the small and medium farmers. This might be possible if the credit limit is linked only with the farmers' property value and repayment is made easier and at a lower interest rate.

AGRICULTURAL RESEARCH AND EXTENSION

Punjab Agricultural University (PAU), Ludhiana, was established in 1962 on the pattern of Land Grant Institutions of the USA. The university did a commendable job in adapting Mexican wheat varieties suitable to North Indian conditions and subsequently improving their quality. Similarly, rice varieties developed by the International Rice Research Institute (IRRI), the Philippines, were quickly modified to suit Indian conditions, thereby getting a quantum jump in yield over the previous existing varieties. Along with this, research in other areas, such as plant protection, agronomy, soil sciences, agricultural economics, etc., helped develop a full package practices. All combined to usher in the green revolution during the late 1960s, which became a role model for the entire country.

The State Department of Agriculture also contributed its mite by disseminating the findings of the university and arranging to produce the required seeds of high yielding varieties. Extension agencies of both the Agricultural University and the State Department of Agriculture reached the farming community with their packages, who, in turn quickly responded by adopting these for the production of wheat and paddy, which gave them good returns. Since then, PAU has been actively engaged in extending its teaching, research and extension activities, and bagged the award of the best Agricultural Research Institute from the Indian Council of Agricultural Research (ICAR) in 1995. The research activities of the State Department of Agriculture were transferred to PAU in 1962, while the extension work continued to remain with it*.

PAU has developed an excellent infrastructure for agricultural research in its five faculties: Agriculture, Agriculture Engineering, Basic Sciences and Humanities, Home Sciences and Veterinary Sciences. The ICAR has established five Centres of Advanced Studies and Training in the PAU, namely, Farm Power and Machinery; Genetics and Plant Breeding; Soil Sciences; Veterinary Gynaecology and Reproduction; and Veterinary Surgery and Radiology. More than 5,000 committed research workers, academics and field extension workers are on the rolls of the university.

Despite all attributes, which make PAU a great Institution, its present activities are not very promising. The biggest problem is of inbreeding, with more than 85 per cent of the staff stagnating in their knowledge and its dissemination. More than 75 per cent of the faculty received their Ph.D. degrees from PAU and this proportion will reach 90 per cent by the end of 2006. Nearly 34 per cent of the present faculty will retire by 2006, whereas the number of direct recruits with degrees from other universities is relatively very small. There is very little participation of the faculty in international exchange programmes,

* The State Department of Agriculture has 12 district-level farmers' training centres (STCs) to impart training to the farmers and farm-women. These training centres were established in the early sixties. The existing 12 STCs also cater to the training needs of the newly carved five districts of the state. These are also instrumental in imparting training to the farmers and farm-women in day-to-day agricultural technological developments with regard to crop production and other allied occupations. For this purpose training camps of farmers at the district level were organized, where scientists of PAU educated on the progressive farmers and field staff of the department of agriculture about the latest scientific techniques for crop production and marketing. These were organized both in Kharif and Rabi seasons at all the district headquarters. Later, the staff of the department of agriculture have been organizing farmers' training camps at block and village levels. Every year about three lakhs farmers are trained on scientific crop production.

The details of the training programmes undertaken both during Kharif and Rabi every year by these training centres are given below:-

Sr. No.	Name of Training Camp/Institutional	No. of Camps/Courses
1.	District level training camp	34
2.	Block level training camps	272
3.	Specialized institutional courses for farmers and farm-women	340
4.	Institutional courses for conveners	255
5.	Production-cum-demonstration camps	1700
6.	Demonstration camps for farm-women	170

training programmes or even international conferences and symposia. Lack of funds is said to be the reason for the neglect of this important training and skill upgradation activity. PAU is also saddled with problems of imbalance in staffing and declining quality of education. Staff deployment is unrelated to the importance and prioritization of programmes. PAU is ridden with inadequacies not only of research strategy and extension but also of basic maintenance, because of an unhealthy fiscal situation. Around 85 to 90 per cent of the total budget of PAU is spent on salaries alone.

Research and information hold the key to bringing about major breakthroughs in agricultural and livestock production. At present PAU's means of assessing, storing and retrieving information are very primitive. While Punjab agriculture needs a turn-around in its effort to meet global challenges, PAU is lagging behind and is unable to provide any leadership, for which it was once known as the premier institution at the time of the green revolution.

Extension activity, involving transfer of technology, had once been the most important work of the university. It used to provide a live and intimate link between scientists on the one hand and the field- level functionaries of different state departments, other development agencies and farmers on the other. The three services provided by the extension directorate have been: farm advisory service; farm communication service; and farm training programmes. Besides T & V programmes, these have been very successful and have attracted large numbers of farmers to the Campus Kisan Melas, held at the university and at district headquarters and Regional Research Stations. Currently, the extension activities of the university have considerably slackened and farmers are losing faith in these, as answers to their problems are not forthcoming.

PAU is equipped to meet effectively the challenges of agricultural research posed today by liberalization, privatization and globalization trends, as it has the necessary infrastructure and skills. However, there is need for focused prioritization in research and development strategies, as was the case at the time of the green revolution. Emerging challenges demand that the university should take a fresh look at all its resources, policies and programmes, in order to make a shift to a progressive, sustainable and long-lasting framework of activities. This requires not only adequate funding but also basic improvement in the quality of manpower. It will be necessary to develop a strategic partnership with the corporate sector and with other research institutions both in India and abroad, so as to make a shift from adaptive to original research. For this, excellence in teaching programmes through modern courses and well-equipped laboratories are a must. The disjointed projects for research have to make way for a systems approach to agricultural research. The green revolution made a quantum jump in the yield of wheat and paddy, but such increases in the yield of other crops were neither aimed at nor any breakthrough achieved. A complete range of packages, including technologies for efficient land- and water-management, agronomic practices like IPM, INMS, development of bio-fertilizers and bio-pesticides, etc., and post-harvest storage and marketing techniques and systems have to be developed. Such research, which cuts across different disciplines, requires a significant shift from the existing commodity-approach to an integrated and precision-programme mode, which may entail a matrix management system.

A sustainable demand-driven and cost-effective production system with integrated natural resources management has to be introduced keeping particularly in view the marginal and small farming system, which has become dominant in the state. Such an

approach should aim to increase productivity, decrease cost of inputs, increase efficiency of management systems, leading thereby to increase in profits from agriculture. The future of agriculture lies in a commercial approach based on the theory of inputs and outputs, demand and supply, and marketing and storage.

During this process of change, such environmental manifestations as health of soil, water, air, forests and agricultural labourers, have to be kept in view. Introduction of transgenic crops, either developed indigenously or brought from abroad, have to be introduced in the local environment, keeping in view the ethics, future requirements and developments, and probable effects on the biosphere. Biotechnology is an expensive and useful tool, which can be used profitably by agricultural and veterinary scientists, provided proper expertise, instrumentation and experimentation are at hand for its exploitation. We have to go a long way to achieve the high productivity levels in different crops attained by many countries (See Table 7). Keeping this in focus, PAU should gear its research programmes in a manner that agricultural production is revolutionized in Punjab as earlier, at the time of the green revolution. The state government has already provided the seed money of Rs. 100 crore to the university for improving its research and other facilities. It remains to be seen whether PAU can rise to the occasion to lead the agriculture of the state to unprecedented levels of success once again.

THRUST FOR NEW DEVELOPMENT INITIATIVES

Public and private investment: Public sector investment in Punjab is around 10 per cent of the Net State Domestic Product (NSDP) in agriculture. Gross capital formation in agriculture in 1998-99 was Rs. 2,157 crore at current prices, while at constant prices it was Rs. 1,633 crore (Table 17). Plan outlays for infrastructure and agriculture and rural development in Punjab have always been the highest among all the major states in all the plans. In the Eighth Plan, Punjab had invested a total of Rs. 618 crore for infrastructure development in agriculture at 1980-81 prices (Table 18). Unfortunately, the state has not been able to attract foreign direct investment in agriculture, or for other ventures, and ranks 14th among the states of India.

Table 17
Trend in Public Sector Investments in Punjab Agriculture (Rs. crore)

Year	Public sector investment		NSDP Agriculture at current prices	Public sector investment as % NSDP agriculture
	At current prices	At 1993-94 prices		
1993-94	1166.02	1166.02	12978	8.98
1994-95	1476.82	1354.17	14264	10.35
1995-96	1446.45	1227.56	15369	9.41
1996-97	1520.04	1215.45	18013	8.44
1997-98	1902.63	1453.85	18900	10.07
1998-99	2156.99	1633.14	20559	10.49

Source: Ramesh Chand 2000*, Policy Paper 11*, NCAP, New Delhi

According to the Reserve Bank of India (RBI) and the National Sample Survey Organization (NSSO) surveys, per hectare provisions of fixed capital formation were the highest in Punjab during 1980-81, but fell to the fourth position in 1991-92. Most of the private investment has gone into farm machinery and irrigation structures. As a result, the state has a high degree of mechanization of farm operations. Since capital intensity is increasing among all categories of farmers, particularly large farmers, it is making agriculture less profitable, as net returns are getting reduced due to the higher cost of cultivation.

Table 18
Public and Private Investments in Agriculture during different Plans (Unit Rs/ha at 1980-81 prices)

Plan	Public Investment		Private Investment	
	Punjab	India	Punjab	India
Fifth Plan (1974-75 to 1978-79)	853	311		
Sixth Plan (1980-81 to 1984-85)	713	258	262 (1981-82)	80 (1981-82)
Seventh Plan (1985-86 to 1989-90)	355	197		
Annual Plan (1990-91 to 1991-92)	128	187	173 (1991-92)	126 (1991-92)
Eighth Plan (1992-93 to 1997-98)	618	188		

Source: Ramesh Chand 2000, *Policy Paper 11*, NCAP, New Delhi.

The decline in public investment is mainly due to diversion of resources to subsidies for fertilizers, rural electricity, irrigation, credit and other agricultural inputs, rather than for creation of assets. The declining trend in public sector agricultural investments has to be reversed by increasing allocation of public funds for agriculture. As the state is facing a severe resource crunch, public investment can be increased only if the present flow of subsidies on such inputs as power, water and fertilizer are reduced.

Employment generation: In the post-green revolution situation in Punjab agriculture, farm mechanization and paddy-wheat crop rotation has greatly influenced the labour employment pattern. Abundant labour are employed during the sowing and harvesting seasons. They are relieved after the operations are over. This has reduced the duration of employment of casual labour and peasants on the farms. The capitalist pattern of agricultural development has not only increased casualization of the workforce but also the share of hired labour, which is mostly migrant and comes during the season from Uttar Pradesh, Bihar, Rajasthan and other states. The affluence of farmers, achieved during the green revolution, has also affected their life-style and mindset. They now spend more on consumable items, social functions and, aspire to own scooters and cars. The youth from the farming community at best drives a tractor but shuns hard work on the farm, which is normally passed on to the hired labourer. This pattern has created a paradox of scarcity and surplus of the labourforce in the state.

Trends of employment*: The Planning Commission has estimated that Punjab will have a very low growth rate of employment, that is, 0.73 per cent per annum during the Ninth Plan period. The labourforce is projected to grow at the rate of 2.27 per cent per annum. Consequently, 10,65,000 persons will be unemployed during the Ninth Plan. The data collected by the Economic and Statistical Organization of Punjab indicate that the unemployment situation in the state is more serious than projected by the Planning Commission. Labour absorption capacity of agriculture is on the decline in Punjab. The annual rate of decline is the highest for paddy (2.36%) followed by wheat (2.22%), maize (1.61%) and sugarcane (0.98%). Only in the case of cotton has there been an increase of 0.19 per cent per annum, but the overall requirement of labour has increased at the rate of over one per cent per annum. The trend of overall increase in labour absorption in the seventies was reversed in the eighties and nineties. Total labour absorption in

*This and the next sub-section are drawn heavily from S.S. Gill, `Agriculture, Crop Technology and Employment Generation in Punjab', published in *Future of Agriculture in Punjab*, edited by S.S. Johl and S.K. Ray, published by the Centre for Research in Rural and Industrial Development, January 2002.

agriculture stood at 480 million man-days during the triennium ending 1983-84. It declined to about 432 million man-days during the triennium ending 1996-97 (Table 19).

Table 19
Estimated Total Employment in Principal Crops ('000 Man-Days) in Punjab

Year (Triennium ending)	Paddy	Wheat	Cotton	Rapeseed & Mustard	Others	All Crops
1983-84	141519.47	149786.39	61184.16	3943.11	123946.73	480379.86
1992-93	144871.20	143271.44	69735.66	3527.01	84152.21	445557.52
1996-97	139836.04	139281.45	65351.34	3557.21	83644.51	431670.55

Source: S.S. Gill, `Agriculture, Crop Technology and Employment Generation in Punjab', published in *Future of Agriculture in Punjab*, edited by S.S. Johl and S.K. Ray, published by the Centre for Research in Rural and Industrial Development, January 2002.

Note : 1. Employment is calculated by multiplying, area under different crops by per hectare employment in respective crops (i.e., paddy, wheat, cotton, rapeseed and mustard). In the case of other crops the weighted average (of four crops) per hectare employment is multiplied by the total area under other crops.

2. Total employment In 1992-93 over 1983-84 declined by 7.25 per cent and in 1996-97 by 10.14 per cent over 1983-84.

The major cause of this decline is the sharp decrease in man-days required per hectare in crop cultivation. The high level of mechanization in sowing, irrigation and harvesting of paddy and wheat has progressively replaced human labour by machine labour. Draught power has virtually disappeared from the agricultural scene in Punjab.

Employment pattern: The problem of under-employment is quite serious for domestic labourers, as half the time there is usually no work available for them. At the same time, unemployment is on the rise, both among educated and uneducated youth in rural areas, mostly in the age-group between 15-20 years. The employment-generation strategy and policy has to be multi-pronged, bearing in mind the capabilities and aspirations of the unemployed youth and the availability of resources in the state. The long-term strategy demands that in the next 10-15 years, nearly half the cultivators and about 20 per cent of the agricultural labourers have to be shifted outside agriculture both within and outside rural areas. Non-farm employment has to be expanded in major areas, so that the potential workforce presently engaged in agriculture and allied activities are shifted to these sectors. Decentralized development, or block planning, has to be accompanied by major investments by the public or private sector for marketing, storage, processing and transportation. This can also take care of the uneducated and unemployed youth.

There is generally a mismatch between the aspirations of the unemployed and the policies pursued for creating employment opportunities. Rural educated job-seekers aspire to secure white-collar government or semi-government jobs. On the other hand, the government is not willing to act as a major employer of such youth. Alternative opportunities for skill-development through vocational training has to be popularized at the village level. Simultaneously, the corporate sector has to be encouraged to enter the rural areas with their programmes, so that employment generation activities are created. Self-employment skills have to be imparted and credit facilities made available for translating their aspirations into reality in rural areas. The machinery of the Planning Commission needs to be activated with well thought-out policies and action programme, as the task is colossal and calls for multi-directional co-operative efforts.

Contract/commercial/organic farming: In order to give a boost to the supply of commodities for the processing industry there is a need for their production in contiguous areas around processing units. For this, usually commercial or contract farming is undertaken. In the case of sugar production, commercial farming is already in vogue as many farmers produce sugarcane in defined command areas of the factory and supply the cane to it. However, in a situation where the factory operates below its capacity, commercial cane growers suffer loss due to non-utilization of their produce. Farmers suffered similar losses when Pepsi Corporation switched over from contract farming to commercial farming in the case of tomato.

Contract farming has the advantage of the buyer entering into a contract with the required number of farmers and taking their entire produce at a previously fixed price, irrespective of the market fluctuations at the time of the harvest. Contract and commercial farming are being practised in Punjab on a limited scale, as the corporate sector with processing units have not entered the scene in any significant manner. Both the systems of farming are of advantage to growers.

The biggest impediment to the expansion of contract/commercial farming is the small land-holdings of the majority of the farmers. In either case a large number of farmers have to be inducted into the system in a contiguous manner. The reluctance of a few farmers in between, jeopardizes the efforts of contract or commercial farming. The land-lease and tenancy system have to be re-oriented and modified to help farmers to extend ready support to contract/commercial farming.

Organic farming, particularly in the case of fruits, vegetables, cotton and sugarcane, is the buzz word in the West, where the green movement is transforming food habits of people. Organic farming helps in the improvement of the physical health of the soil by increasing moisture-holding capacity, regulating soil temperature and by improving the texture and structure of the soil. Organically grown commodities fetch a two to four times higher price. For growing organic foods, the certifying agencies have to be in place to monitor the authenticity of organic cultivation. Proper monitoring during cultivation is an important integral component of organic farming. Farmers with small holdings, who cannot afford to use such capital inputs as fertilizers and pesticides, if imparted proper skills and advice to grow organic foods without any chemical input, would be happy to grow such crops, provided marketing costs and pricing are remunerative. Organic farming can succeed in a big way with proper research and extension inputs, coupled with incentives for marketing.

The government of India has sanctioned Rs. 75 lakh for improvements of soil health in 2002-03, to popularize the centrally sponsored organize forming scheme. The following components are being covered under this scheme:

1. Green manuring
2. Verming composting
3. F.Y.M.

Information boost: Information technology is yet to make inroads in the development of agriculture in India. In advanced countries, every village is interconnected with the county office and the state headquarters, for a free flow of information about agricultural operations, weather, marketing structure and crop intelligence, and price trends, besides many other issues concerning crops and allied activities. Computers have become common household items with the farmers, because the information available is so huge that the farmers sieves through it carefully to extract what is of use for them in the context of their problems. The farmer can get in touch with experts to seek their advice

in no time, on day-to-day problems of crop growth animal health etc. Informatics-led agricultural development is a step towards precision agriculture and enhances the quality of life of the farming community. There is need for a sophisticated information and communication technology (ICT) network with farm and non-farm linkages for the sustainable development of agriculture in Punjab.

Punjab is a progressive agricultural state and the agricultural university is the brain behind the supply of information. When inter-connectivity and the information base are strengthened, at least up to district headquarters at the beginning, and subsequently to each Panchayat, access to information will increase many times and so will productivity. The time has come for the networking system to be put in place to give another boost to sagging agriculture in the state.

Export production: With the introduction of WTO the expectation was that states with surplus agricultural produce would be able to export their material and earn profits. But these expectations have been belied, because of inability to access the world market on account of competitiveness and quality requirements. In 1998, the share of agricultural and allied products in the total export of Punjab was about 54 per cent, according to Punjab Small Industries and Export Corporation. This includes cotton textiles, yarn, readymade garments and hosiery.

Punjab produces eight million tonne of surplus wheat, which is available for export, but most of it cannot be exported because of inability to reach quality requirements. Only durum wheat, which is good for pasta and pizza, is being exported. Similarly, Basmati rice produced in Punjab is quite competitive and so is cotton. Scope for exporting fruits and vegetables to neighbouring countries of the Middle East and Southeast Asia is high. But uncertainties in deliveries of required quality and quantities often make exports unpredictable. Technological breakthroughs in biotechnology, tissue culture, green-house technology, etc., have to be achieved, to acquire an edge over other countries. Exports can be further boosted when fruits and vegetables are processed and packed according to international specifications. Punjab has had some success in the export of such processed vegetables, as *sarson ka saag*, tomato ketchup, mixed pickles, squash, fruit jam, honey and spices marketed by MARKFED. Dehydrated peas are also exported. However, while a great potential exists for export, the quantum of fruits and vegetables processed for the purpose is very small.

Exports of dairy products in the form of ghee is limited to the Middle East and the Gulf countries. Other dairy products have a potential, which is still to be exploited. Similarly, there is a market for meat and meat products abroad, but the potential has not been realised because of competition from European countries.

Floriculture, however, is a preferred item for export because of the climatic advantage. The benefit of climate allows certain flowers to be grown at a time when these are not available in the western countries. Punjab, being land-locked, export of perishable material such as flowers, fruits and vegetables are at disadvantage, which can be removed by opening up the northern trade route for export to Afghanistan, the Central Asian Republics and the East European countries.

Problems that the exporters of Punjab face are no different from those of other states. Both pre-shipment and post-shipment problems exist, besides transportation and infrastructural difficulties. Absence of market intelligence is hampering export promotion, as international requirements of quantity and quality inputs and pricing are not instantly available. A networking system is needed to overcome this problem. Punjab has set up a new company called Punjab Agro Export Corporation Limited (PAGREXO) on the

pattern of AGREXO of Israel. All agricultural items exported by Israel to different countries are branded under the name of AGREXO. Similar is the objective of PAGREXO. PAGREXO has been successful in exporting kinnows, grapes and a few selected vegetables, such as okra, bittergourd, melons and tinda. This corporation is a boon to exporters, as it tackles most of the pre-shipment problems and also carries out some post-shipment measures. Such a corporation should be managed well to boost exports.

DIVERSIFICATION OF FARMING SYSTEM

It was the compulsion of the acute food shortage in the country in the sixties that made the Central Government give a fillip to the production of foodgrains. Several policies were framed at the Central and State levels to give a boost to foodgrains production. Punjab contributed significantly to these efforts and played a leading role in ushering in the green revolution in India. Now a situation has come when the granaries of Punjab, as well as of the Centre, are overflowing with foodgrains. Even then, the emphasis on foodgrains production in Punjab is continuing, primarily because of guaranted purchase by government at administratively fixed prices. As a consequence, crop production in Punjab has progressively become less diversified. Problems arising from the limited diversification of cropping activities prompted the state government, as early as 1985, to appoint a committee for suggesting remedial measures. Popularly known as the Johl Committee, it recommended shifting 20 per cent of the area under the wheat-paddy system to such crops as maize, oilseeds, sugarcane, fruits, vegetables and forests (Table 20). It also suggested introduction of dairy enterprises on a large scale, for which the area under fodder crops had to be doubled, from 0.7 million to 1.4 million hectares by the year 2000. Despite these recommendations, the area under rice and wheat increased steadily, mainly due to assured remunerative prices offered for these crops. Clearly, the committee's recommendations received scant consideration from government as well as from the farming community.

Table 20

Area of Different Crops Based on Recommendations Made by Johl Committee (1986) and Actual Observed Area (Million Ha) in 1999-2000

Crops	Actual area	Proposed area		Area present (1999-2000)	The trend	
	1985-86	1990-91	2000-01		Suggested	Actual
Wheat	3.15	2.90	2.40	3.39	-	+
Paddy	1.70	1.52	1.25	2.60	-	+
Maize	0.26	0.30	0.40	0.16	+	-
Pulses	0.20	0.29	0.38	0.11	+	-
Other foodgrains	0.16	0.19	0.20	0.04	+	-
Total foodgrains	5.47	5.20	4.63	6.30	-	+
Rapeseed & Mustard	0.15	0.23	0.30	0.06	+	-
Other Oilseeds	0.06	0.09	0.18	0.10	+	+
Total Oilseeds	0.21	0.32	0.48	0.16	+	-
Sugarcane	0.10	0.13	0.20	0.11	+	..
Cotton (American)	0.47	0.55	0.68	0.48	+	..
Cotton (Desi)	0.09	0.10	0.12	0.09	+	..
Vegetables including Onions	0.04	0.05	0.20	0.14	+	+
Fruits	0.04	0.08	0.13	0.07	++	+
Fodders	0.72	0.90	1.41	0.61	++	-
Forests	0.28	0.40	0.56	0.28	+	..
Total Cropped area	7.17	7.40	8.20		+	+

Note: + Increase - Decrease .. Stagnant (no trend) ++ Increase to double or even more

Source: M S Bajwa, 'Strategies for Agricultural Research and Development' quoted in *Future of Agriculture in Punjab*, Published by CRRID, 2002.

The farmers have found the paddy-wheat combination relatively more remunerative and less risky due to assured pricing and guaranteed purchases. Options for growing other crops, suggested from time to time, have failed due to a relatively higher order of instability in their crop yield, low return and poor marketing facilities. The study by Ramesh Chand (March 1999) has proposed three types of diversification options for Punjab: i) items of mass production and consumption – small-scale enterprises, such as dairying, growing of pulses and oil-seeds; ii) concentration on area-specific enterprises of moderately high-value commodities in different agro-climatic zones and sub-zones, such as cotton, vegetables, potatoes, sugarcane, basmati rice, etc., to enhance the income of farmers; and iii) limited zone/site-specific diversification through non-conventional high-value crops for elite consumption, such as floriculture, exotic vegetables, mushrooms, etc., which are perishable and require specialized marketing. Medicinal, aromatic and spice crops are also a site-specific alternative for bringing about diversification in small areas in Punjab.

Several other options for diversification have been suggested from time to time and some of these have also been experimented with in Punjab. Sunflower and soyabean were introduced as alternate crops and their cultivation was extensive in the state. However, after a few years, farmers began to abandon these crops, because prices fluctuated year to year and marketing became a problem. The failure of this experiment has made Punjab farmers cautious about undertaking any further experimentation on diversification. Returns from the options suggested by expert scientists are generally lower than the existing wheat-rice cropping pattern practised by the farmers.

Constraints to diversification from wheat and paddy crops can be removed when the suggested alternative crops become remunerative, have ready accessibility to markets and are free from risks of attack by pests and diseases. The need and urgency to grow legume, pulses and oilseeds is high, because the country imports these products every year. The problem these crops face is that although a support price is announced for them, procurement through the regulated market is not in place. Even the returns from these crops do not favourably match those of wheat or paddy. In order to encourage the cultivation of pulses and oilseed crops in particular, some incentives are needed to compensate the farmers for the shift from wheat/paddy in an appropriate manner.

Shifting to cultivation of fruits and vegetables, including off-season and exotic vegetables, flowers, medicinal plants, etc., are other alternatives which experts have suggested by experts from time to time. Diversification into other allied sectors of dairy farming, fisheries, mushroom growing, etc., have also been mentioned. These suggestions, though seemingly attractive, are capital-intensive and full of several risk factors including demand, marketing, processing and consumption.

Factors that have encouraged the Punjab farmer to grow more and more wheat and paddy over the years, namely minimum support price and assured procurement, cannot and should not be allowed to remain operative in the present situation. A gradual withdrawal, reduction or modification in these support measures is needed, which in turn will prompt the farmers to diversify from these crops. At the same time, an alternative package of options should be made available to the cultivators, so that the adjustment to new crops takes place smoothly.

Institutional agencies have to come forward to provide suitable credit for the production of crops involving high capital. For other groups of crops, pricing, marketing and risk factors have to be thoroughly worked out. The Punjab farmer has become very commercialized and venturing to cultivate any new crop is viewed from different angles

before adoption. A strong research and development base, coupled with strong extension activity, is needed to convince the farmers about diversification from the present cropping system. A suitable policy framework has to be developed to extend the idea of diversification to a select group of crops in well-designated areas of the state, through a strong base of research and extension. It may also require financial incentives for which a relevant policy needs to be framed.

The state government is now making concentrated efforts to induce changes in the cropping pattern. Tables 21 and 22 show the state government's plan for bringing about crop-pattern changes in the Kharif and Rabi seasons during the Tenth Five Year Plan. The state government is even actively considering a proposal to provide monetory compensation to the tune of Rs. 10,000 per ha for achieving targeted changes in the cropping pattern.

Table 21
Targets for Different Agricultural Crops for the 10th Five Year Plan (2002-07) for Kharif Crops (Area in ,000 hectares)

Crop	Present area 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	Area to be shifted from rice to other crops
Rice	2506	2230	2100	1900	1700	1500	-1000
Basmati rice	105	150	175	200	225	250	+145
Maize	164	200	220	250	300	350	+186
Bajra	5	7	10	15	20	25	+20
Kharif Pulses	41	50	70	90	110	130	+89
Kharif Oilseeds	23	30	35	50	60	80	+57
Sugarcane	121	150	170	180	200	220	+100
Cotton	474	625	640	675	700	725	+251
Vegetables, fruits, fodder and agro-forestry	455	452	474	534	579	614	+159
Total area sown in Kharif	**3894**	**3894**	**3894**	**3894**	**3894**	**3894**	**+1007**

Source: Data provided by Department of Agriculture, Punjab

Table 22
Targets of Different Agricultural Crops for the 10th Five Year Plan (2002-07) for Rabi Crops (Area in ,000 hectares)

Crop	Present area 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	Area to be shifted from wheat crops to other
Wheat	3400	3100	2935	2790	2630	2400	-1000
Durum Wheat	10	100	150	200	250	300	+290
Barley	33	45	50	55	60	65	+32
Rabi Pulses	18	40	60	75	105	125	+107
Rabi Oilseeds	54	135	175	200	225	250	+196
Sugarcane	10	25	50	75	100	150	+140
Rabi, fodder, vegetables, fruits, agro-forestry	320	400	425	450	475	555	+235
Menthe, Celery floriculture Ornamental trees	0.20	0.25	0.30	0.35	0.40	0.45	+0.25
Total area sown in Rabi	3845.20	3845.25	3845.30	3845.35	3845.40	3845.45	1000.25

Source: Data provided by Department of Agriculture, Punjab

ANIMAL HUSBANDRY AND DAIRY FARMING

Dairy

Punjab is also important for its dairy products. Unfortunately, however, the yield of milch animals and their total production in the state is not in consonance with the levels attained in developed countries. In 1966, Punjab had 15 lakh buffaloes and 10 lakh cows. There numbers have now increased to 37 lakh buffaloes and 12.5 lakh cows. During the last two decades, the area under fodder crops has remained around seven lakh hectares, constituting less than 10 per cent of the total cropped area. The per day availability of fodder in the state works out to about 10-12 kg per animal against the national average of five kg per animal. The optimum requirement is 40 to 50 kg per animal. Obviously, the milch animals are under-nourished and hence produce less milk.

On an average, a buffalo in Punjab yields about 1,300 litres of milk in its lactation period of about 210 days. The inter-calving period is 15 to 18 months. In the case of crossbred cows, the average lactation yield is over 3,500 litres of milk with a calving interval of 12 to 14 months. Unfortunately, consumers in Punjab do not like cow's milk, because of its low fat content and yellowish colour, whereas all over the world cow's milk is in demand. The per capita availability of milk is about 870 gm in Punjab against 204 gm for India, 592 gm for Haryana and 330 gm for Himachal Pradesh (1998).

Livestock enterprises account for about 14 per cent of the state domestic product of Punjab, which is one-third the share of agriculture. For a herd of 10 animals, the cost has been worked out to be Rs. 2,64,000 for a buffalo-herd unit and for a crossbred cows-herd unit it is Rs. 2,98,000 per lactation period. However, the net income is estimated, at Rs. 31,803 for crossbred cow as against Rs. 20,672 for buffalo-herd units (Joginder Singh and Dhaliwal, 2002). The higher profitability of a crossbred cow-herd unit is because of a higher milk yield.

Due to heavy pressure of growing wheat and paddy, the area under fodder has been decreasing, and so has the composition of the live-stock population. During 1977-1997, the total bovine population increased by nearly 19 per cent, but, while the population of cattle as a whole decreased by 20 per cent, the stock of buffaloes increased by more than 50 per cent (Table 23). As a viable means of diversification, cultivation of fodder has to increase along with increase in livestock population, in order to make it more productive. In such countries as USA, Canada, Israel, Denmark, New Zealand and others, dairy farming as an enterprise is very successful and crossbred cows have an average lactation milk production of 10,000 litres per cow. This suggests that there is a tremendous possibility for increasing cow's milk production if scientific methods are used. Such an increase in buffalo's milk production is difficult, as high milk-yielding genetic stock is not available.

Table 23
Livestock and Poultry (in'000) in Punjab (in '000)

Year	Cattle	Buffaloes	Horses & Ponies	Donkeys	Sheep	Goat	Camel	Total livestock	Poultry
1972	3390	3796	50	65	388	537	102	8646	3017
1977	3312	4110	76	61	498	722	74	8996	5539
1990	2832	5578	33	36	508	537	43	9678	15276
1997	2639	6171	34	23	436	414	30	9857	11457

Source: *Statistical Abstract, Punjab*, various issues

There is also considerable scope for reducing the cost of milk production by: a) improving the animals through crossbreeding and introduction of a exotic breeds; b) improving the feed and making it more balanced and nutritious; and c) proper management under hygienic conditions.

In order to make dairy enterprises economically attractive the aim should be:

- Developing herds of crossbred cows with lactation yield of not less than 5,000 litres.
- Calving at two and half years of age and with a calving interval of 12 to 14 months.
- Import of a substantial number of pure breed exotic cows with lactation yield of not less than 5,000 litres and calving at two years of age with a calving interval of 12 months.
- Drastic reduction in dependence on buffaloes.
- Retaining and developing only a limited number of buffalo herds, yielding a minimum of 2,500 litres of milk per lactation.
- Scientific herd management system and livestock breeding policy.

The PAU has recommended cross-breeding of cows with the use of Jersey cows in the sub-mountain rain-fed areas and Holstein Friesians in the plains region of Punjab. The nutrient component of milch animal deserves special attention, as most of the present herd are under-nourished.

The state has abundant roughage (wheat and rice crop), which can be used in making silage through processes developed by PAU. Additional nutrients can also be added to this silage. Authentic frozen semen from pedigree bulls is necessary for cattle breeding, need which, if necessary, may be imported from designated countries. Animal health is another component, which has to be put on a strong footing, so that the optimal use of potentials of animals is maintained.

Milk production

Punjab has 49 milk plants in the co-operative and private sectors with a handling capacity of 50 lakhs litres of milk per day. Of these, 11 milk plants belong to Milkfed Punjab, which handles over 15 lakh litres milk per day. Nine of these plants manufacture milk powder, ghee and pasteurized milk in pouches. The 28 milk plants in the private sector, with a capacity of 35 lakhs litres per day, manufacture milk powder and ghee. Some multinational companies, such as Smith Kline & Beecham, Wockhardt Limited, etc., do not make pasteurized milk but manufacture special value-added milk products for sale in India and abroad. Several of these milk plants are unable to procure enough milk due to competition with each other and, as a result, 35 to 45 per cent of their installed capacity remain idle. Some of the milk plants in the private sector have already closed down and some are on their way out. The situation demands urgent steps to revive the dairy industry by supplementing milk for the use of milk plants.

Although the Prevention of Food Adulteration Act is applicable to milk and milk products, in practice it is seldom applied to retail vendors. However, it is rigorously applied in organized dairies. The unhygienic conditions prevailing in small dairies and city-based

'*dudhias*' is not only dangerous to milch animals from the health point of view, but even consumption of such milk, which is obtained unhygienically, is harmful to consumers. Unfortunately, little is being done about the hygiene of milch cattle and of the process of milking the cattle and storage and distribution. Introduction of high technology for producing hygienic milk for consumption and maintaining proper health of the milch cattle, have assumed extreme urgency.

OTHER ANIMALS AND THEIR PRODUCTS

Piggery: Rearing pigs as a commercial venture is still to be established on a sound footing in the state. Economically, it is a very active biological feed converter with a ratio of 1:4. Its meat is highly rich in fats, and bacon and other meat products made out of it are of great commercial value both in India and abroad. However, scientific methods of pig rearing are not readily available to pig keepers; hence, most of the animals remain scavengers and as such their meat can be harmful for human consumption. On the other hand, a well organized pig rearing stall can be of great economic value, where pure exotic breeds are maintained in hygienic conditions and fed with balanced diet. Consumption of its meat can increase and its byproducts could be exported.

Poultry: In Punjab, poultry grew phenomenally during 1977 to 1990, when the number jumped from 30 lakh to 152 lakh, but declined to 115 lakh in 1997 (Table 21). This decline is attributed to reduced profitability and increased competition from the poultry industry of South India. Besides meat, 2,630 million eggs are also produced by the chickens. On an average 240 eggs per layer per annum are produced, whereas well-bred chickens of Denmark, Australia and the Netherlands produce anywhere between 300 to 350 eggs per layer per annum. Chicken breeding needs improvement both for meat and egg production. Even proper feeding and healthcare can improve meat and egg production from the existing stocks considerably.

Rabbits: Rabbits are prolific layers, herbivores and can efficiently convert fodder to food. They can convert plant protein of little value into 20 per cent of high value edible meat. Comparable figures for other species are 20 to 23 per cent for broiler chicken, 16 to 18 per cent for pigs and eight to 13 per cent for beef. Rabbit meat production is economically cheap and is an attractive proposition, especially when the aim is to produce quality animal protein. Russian Chinchilla and New Zealand whitebreed rabbits have given very encouraging results in meat production, i.e., about 1.6 to 2 kg meat in 84 days. Over 2,000 of these can be raised on one acre of land producing berseem and lucerne. Rabbit's skin is also a saleable product, which can fetch much money depending upon the breed. Angora-wool rabbits provide an additional source of income as the wool, used for woollen garments for infants, is quite expensive and much in demand. Development of rabbitories, if properly encouraged is economical and remunerative for small-scale ventures.

Sheep and goat: Sheep and goat rearing has a stigma attached to it among Punjab farmers as it is considered to be an enterprise meant for Scheduled Castes and marginal and small farmers. The population of goats and sheep in 1997 was 12,20,000 and over a period of 20 years it has come down to 8,50,000, a decline of more than 30 per cent (Table 21). Milk, meat and wool are the main products of goat and sheep. Little has been done by way of research for the improvement of their stock. Wool production has been picking up for sometime in the past, but meat production is still in the unorganized sector. There is urgent need for improving breeds of goats and sheep for quality wool,

increased meat and milk production, and for scientifically organized abatoires for hygienic processing of meat and its products.

Byproducts of animal wastes are very useful, as hides, skins, horns, bones, animal fat, bristles, blood, hooves and hair can be profitably exploited for diverse purposes. Many medicines are derived from various organs and excretions of these animals, which have great value in the pharmaceutical industry. At present, byproducts, except skins and hides, are of little value. Considerable scope exists in the scientific utilization of the by-products of these animals with economic benefits.

Fisheries: After the green and white revolutions, Punjab is now on the threshhold of a 'Blue Revolution'. A trend has already been set in favour of diversification to fish farming. Farmers are engaged in intensive fish culture in ponds and tanks on modern scientific lines through composite fish culture of fast growing species. There is great potential for pisciculture in the state. Fisheries' resources of Punjab comprise 868 km of river, 11,200 km of canal, 5,804 hectare of small water reservoirs and lakes. In addition, there are 7,185 village ponds covering an area of 4,730 hectare, which are suitable, or can be made suitable, for fish culture after some renovation and water-supply arrangements. Besides, there are 5,228 village ponds covering an area of 2,664 hectare, which require major renovation to make these fit for fish culture. Some farmers have also started fish tanks on their farm-land as a measure of diversification because of its lucrativeness (*State Industrial Profile of Punjab*, Ludhiana, 2001).

The economics of fish farming is quite attractive, as returns over variable cost under proper management practices are nearly one and half times those of paddy-wheat rotation. The only capital expenditure involved is deep excavation of land for fish ponds. Fish culture is a highly specialized occupation and requires technical skill in production and marketing. The state government has arranged to provide fish fingerlings for fish cultivators, but has not taken care of skill upgradation, pricing and marketing. If these are provided, inland fish farming can be a very profitable enterprise for medium and large farmers.

Apiculture: Punjab Agriculture University (PAU) has been encouraging bee farming and a large number of farmers have taken up this enterprise successfully. Since 1978, the number of bee keepers has increased from 34 to 1,25,000, beehives from 165 to 1,25,000 and honey production from seven to 2,200 tonne per annum. Dabur India Limited has given further boost to honey production in the state by entering the market for the purchase of crude honey. With more corporate sector firms entering this arena, and inputs of improved technology, honey production can further improve, particularly by involving small and marginal farmers.

Sericulture: Since 1994, sericulture has come under the jurisdiction of horticulture. There are 16 government sericulture farms. Over two lakh mulberry plants have been planted and distributed in the kandi areas. This activity is confined mostly to the kandi areas and the sub-mountain regions, where plantations of mulberry are available and a government agency undertakes to collect the cocoons. Absence of silk-weaving factories and collection centres are limiting the progress of this enterprise. Though it is a cottage industry which can give employment to women and small farmers in particular, it is not yet receiving due attention.

DEVELOPMENT OF HIGH VALUE AGRICULTURE

Horticulture: Fruits; The diversity of physiograhic, climatic and soil characteristics of Punjab allows successful cultivation of a variety of fruits, vegetables and flowers. There was a three-fold increase in the area under fruit production during 1981-82 to 1995-96, but in 1999-2000 there has been a considerable decline in the area under fruits. A total of 4,18,639 tonne of fruits were produced in the state during 1999-2000. However, there has been a decrease in production of 47 per cent in citrus, 16 per cent in mango, 11 per cent in guava and seven per cent in pears (Table 24). The per capita availability of fruits is 56 gm against the minimum recommended requirement of 85 gm. It is, therefore, essential that fruit cultivation in Punjab is taken up on a large scale, as a means of diversification, and to fulfill fruit requirements for table consumption, besides the processing industry.

Table 24
Area (Hectare) under Different Fruits and Vegetables in Punjab

Commodity	1981-82	1991-92	1995-96	1999-2000 (p)
Fruits				
Kinnow	3883	11807	26645	1434
Orange & Malta	5853	10987	13170	3317
Lemon	509	1096	1258	668
Mango	6817	11581	15211	5608
Litchi	336	1386	1990	1146
Guava	2853	4015	5833	4357
Pear	3616	7427	8226	2147
Peach	1038	3137	4237	1101
Plum	233	372	336	120
Grapes	308	2187	2336	1378
Ber	698	1671	2523	1735
Miscellaneous	2703	3258	3657	1198
Total fruits	28847	68835	84422	34209
Vegetables				
Potato	32715	30919	39095	63993
Topica	369	68	21	---
Sweet potato	432	55	30	4
Onion	1267	950	1615	2032
Other winter vegetables	12882	16246	14816	23864
Other summer vegetables	16160	12647	11812	20573
Total vegetables	63825	60848	77309	110266

Source : *Statistical Abstract of Punjab*, 1982, 1992, 1996 and 2000
Note : **P =** Indicates Provisional Estimate
R = Indicate Revised Estimates

Among citrus fruits, kinnow, lemon, oranges and malta are dominant. Productivity of these fruits in Punjab is around eight tonne per hectare, while in Andhra Pradesh it is 15, Karnataka 11 and Bihar 10 tonne per hectare. In Israel the productivity of kinnow is 65 tonne and orange 43 tonne per ha. The low productivity in Punjab can be ascribed not only to poor management and biotic stresses, but also to the use of imperfect technologies and poor quality plant material, which can be easily improved through scientific methods.

Grape cultivation also picked up in the state during 1991-92 to 1995-96, but has gone down considerably in recent years. The State Department of Horticulture entered into an agreement with the Israel Government for improving the quality of Perlette grapes in the state. During 1998-99, 205 hectares were covered for improvement. Grape productivity has improved, but remains far behind the international level. The situation with regard to other fruits is also similar.

The reasons for poor performance in fruit tree cultivation appear to be:

- Trees have become old and have been cut down without replacement.
- High yielding, certified and quick maturing plant materials are scarce.
- Diseases and pests are taking a heavy toll.
- The marketability of fruits is complex and uncertain
- Price structure fluctuates every season and is not remunerative.
- Lack of value addition, processing, storage and transportation facilities.
- Support to research and development is inadequate.

Efforts have to be made to overcome these impediments before fruit cultivation becomes attractive and remunerative.

Vegetables: Vegetable cultivation in the state has been on the increase since the last decade and the area under vegetables is more than one lakh hectare, out of which three-fourths of the land is under potato. PAU is a forerunner in generating hybrid seeds of certain vegetables including muskmelon, cucumber, egg plant, okra, chillies and tomatoes. Hybrid crops have given higher yields and higher returns to the farmers particularly when marketed in the cities. The state government has set up vegetable-seed farms at different places, which also serve as demonstration centres. Seedlings produced in these centres are supplied to farmers for cultivation. The popularity of the cultivation of red chillies has increased in recent years as dry chillies give good returns. The production of some of the vegetables is so high that often the market crashes and the cultivators suffer heavy losses because of the glut. Such crops as tomato, potato, onion and cauliflower are subject to gluts in different areas and as a result the farmers even do not harvest the crops. This clearly demonstrates that the potential of vegetable cultivation is high in the state but, due to lack of proper marketing and a processing industry, their off-take will depend a great deal on market forces.

Cultivation of off-season vegetables is yet to take off in the state. The technology is available and can be profitably employed by progressive vegetables growers of the state, with the financial backing of the state government. Such exotic vegetables as celery, broccoli, asparagus and leafy vegetables, such as basil, etc., are valuable crops preferred by foreign tourists. Their cultivation can fetch remunerative returns.

Cultivation of vegetables is capital- and labour-intensive, besides being risky. Most of the vegetables are grown for table purposes, while some are exported to the neighbouring states of Haryana, Himachal Pradesh, Jammu & Kashmir and Delhi. One of the options of diversification from wheat and paddy is vegetable cultivation. This can only succeed if the area under vegetables is increased and processing units, cold storages and dry freezing plants are established in areas where vegetables are grown. Suitable policy directions are needed so that vegetable-growing areas are delimited and get increasing support from industry. The corporate sector can play a pivotal role in establishing the required processing units, for which encouragement should come from the state

government and financial institutions. Above all, research input is a vital ingredient in increasing the quality and quantity of vegetables.

Flowers: Cultivation of flowers has attracted the attention of farmers and it is gradually increasing because of high demand in domestic and international markets. Production technologies have been perfected for gladiate, chrysanthenmum, carnation, marigold and rose. Marketing avenues, pricing, cold-storage facilities and transportation are some of the bottlenecks in extending their cultivation.

Other agricultural activities

Mushroom cultivation: There are three button mushroom spawn producing laboratories functioning at Patiala, Jalandhar and Hoshiarpur. These centres besides supplying the spawn also train the farmers for growing mushroom and provide suitable readymade compost at subsidized rates. During 1998-99, about 1000 tonne of button mushrooms were produced in the state.

During 1980-81 to 1990-91, mushroom cultivation had become popular in the state and a maximum of 35,000 tonne of mushroom per year were being produced. Subsequently the production declined because of lack of market and processing facilities for making soups and other value added products. Oyster mushroom and paddy straw mushroom cultivation can make this enterprise a round the year activity. This venture, given marketing, processing and pricing support can flourish to the advantage of small farmers.

Aromatic plants: The cultivation of aromatic plants, such as mentha, lemon grass and others, has been taken up by some farmers on an experimental basis. Some subsidy is also being given for mentha cultivation and about 40,500 hectare area was under mentha during 1998-99. Oil-extraction plants have been set up where the harvested mentha is consumed. Growers get adequate return from this crop. Similar arrangements can be made for other aromatic crops in the state, which could encourage diversification.

Development Strategies in the Context of Liberalization and Globalization of Agriculture (WTO)

Agreement on Agriculture (AOA) came into force with the establishment of the World Trade Organization (WTO) on 1 January 1995, to establish ‘a fair and market-oriented agricultural trading system’. The likely impact of this agreement has been greatly contested in India in general and Punjab in particular. Now that India is a signatory to WTO, many challenges have come up before the country (Ghuman, 2002). It aims at eliminating distortions in global trade of agricultural produce by:

- Lowering of domestic support to agriculture.
- Replacing all non-tariff barriers and eventually slashing down even tariff barriers.
- Providing access to the market of each member country.
- Lowering export subsidies in agricultural trade.

Unlike developed countries where agriculture is a business, in India agriculture is to a large extent a means of livelihood. Under the agreement, the member countries are obliged to gradually open up the agricultural sector to world trade. In this context, Trade Related Intellectual Property Rights (TRIP), social clauses and labour issues have a

special impact on Indian and Punjab agriculture in particular. Once export restrictions are removed it will be possible to export agricultural produce to international markets. However, volatility of world prices will definitely have an impact on domestic prices. It is expected that agriculturally developed regions like Punjab will gain in the long run from trade, because of opportunities for tapping export markets. But much will depend on the supply-side constraints that bedevil the agricultural market. Improvement in product quality has to be brought to international standards. It was with this concern that the Punjab Government appointed a committee under the chairmanship of Professor Y K Alagh to look into various aspects of WTO affecting Punjab. Some of its preliminary findings and recommendations are given below:

- Punjab's agriculture has been structured to produce foodgrains in response to the national mandate. To meet the emerging challenges, a concrete programme of diversification and raising value addition in each agro-climatic region of Punjab depending upon its soil and water reserves has to be developed.
- The new programmes must be provided financial and organizational support. It is estimated that an agricultural adjustment fund of Rs. 550 crore for three years would be required for the programme for quality upgradation, trading arrangements for foodgrains and diversification to high level sectors.
- At the Centre agricultural trade must be taken more seriously so as to provide an institutional system, including commodity board and insurance, etc., so as to be able to survive fluctuations that occur in world trade.
- Trade-efficiency would depend upon the level of production, marketing, processing, transport, etc. In general, Punjab farmers are at a considerable disadvantage compared to developed countries. Because of high transportation costs, wheat from Punjab will cost more at Mumbai than that coming from Australia.
- Recognized and strong farmer agencies need to be created who could collectively represent the farmers in the market to look after their skill and information-needs, market facilities and intelligence and credit-needs. Such an agency can provide export subsidies to farmers with small quantity of export surpluses under 'Green Box' measures.
- Punjab could also take advantage of backward area development exemption (Resource Poor Zones) for border areas, Kandi belt, etc., by providing infrastructure under 'Green Box' measures.

As such, the export competitiveness of Punjab agriculture is quite limited, as its main agro-products are wheat, rice and sugar, but it is competitive internationally only in cotton. Another crucial factor affecting competitiveness is cost of cultivation and yields of different crops. For this the Agricultural University has to play a lead role in devising ways and means for cost effectiveness in crop production.

Johl (2001) has argued that a farmer in a structurally distorted domestic market cannot be expected to compete cost effectively in a competitive globalized market. It has been suggested that answers to the emerging problems are to create a conducive environment in the agricultural sector to promote commercial farming and minimizes recourse to subsistence farming. Johl has made the following suggestions in this regard:

- An effective land market must be developed, which allows viable farm units to grow. The land-lease market must be streamlined so that larger farm units are created, which become commercially viable, start producing more and generate

employment. For creating effective land markets some of the agrarian laws will have to be amended.

- The administered pricing policy and procurement system must play a pro-active and complementary role to encourage production, keeping in view market demands. A shift from wheat and rice cultivation is urgently needed in favour of oilseeds and pulses.
- The variety of subsidies, provided directly or indirectly to farmers to facilitate crop production, needs a critical review and re-orientation so that these could be transferred to 'Green' or 'Blue Box' subsidy. This adjustment will be highly complementary and effective in rationalizing pricing and procurement policies and in meeting requirements of WTO regimes as well.
- Besides producing more per unit area, value addition and quality improvement of farm produce is the need of the day.

The western countries have commercialized the business of agricultural commodities by mere grading and packing the produce as it generates better demand and better prices. In Punjab, the concept of 'food parks' has been envisaged to process and market the produce as the advanced countries do, so that value addition increases sale and profitability.

Research and extension programmes are basic ingredients for the success of crop production activities. These have to operate as a link between the producer and the market, so that the producer's interests are kept above board and he is allowed to adjust his production programmes in accordance with market requirements of kind, quality and quantity. Under the WTO framework, Punjab agriculture should undergo a paradigm shift in strategy. From a `production-driven' agriculture, we have to move to a `demand-driven' one. For this, government needs to spend liberal amounts on R & D, infrastructure for the agro-processing industry, seed, biotechnology and product-quality development. This assumes more importance in view of the declining trend in public investment in agriculture. The challenges are enormous and must be met, if Punjab is to remain a leader in agriculture.

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