Chapter 4
Performance of Agriculture in Punjab

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4.1 Introduction

Punjab had been a star performer in agriculture during the heydays of the green revolution. Its agricultural GDP grew at 5.7% per annum during the period from 1971–72 to 1985–86, which was more than double the growth rate of 2.31% achieved at all-India level in the same period. It was Punjab's spectacular performance, first observed in large wheat surpluses and then in rice, that helped India free itself from food aid under the PL 480 and its associated political strings. Punjab became a symbol of India's grain surpluses, giving India much needed food security. But after 1985–86, the green revolution showed signs of waning and Punjab's agricultural growth slowed to 3% per annum over the period 1985–86 to 2004–05, almost the same as achieved at the all-India level. But the real challenges to Punjab's agriculture emerged when its growth crashed to just 1.6% per annum during 2005–06 to 2016–17, which was less than half the all-India agricultural GDP growth of 3.6% over the same period. Owing to the earlier years of high agricultural growth, Punjab had one of the lowest poverty ratios (7.7% in rural Punjab) as per Tendulkar poverty line in the country in 2011–12, which was almost one-third the level of poverty at the all-India level. Providing food security to the country and reducing its own poverty to the lowest levels within India has been Punjab's most laudable achievements.

But lately, as a result of decelerating agricultural growth, Punjab has lost its pre-eminent position of being the state with the highest per capita income in India, a rank it had held since its inception in 1966 until 2002–03. If current growth trends continue, it will not be a surprise if Punjab slips further down in this hierarchy.

Among the many steps taken by the state, three interventions played the most important roles in the state's impressive performance in agriculture. These are (i)

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provision of irrigation facilities, (ii) all-weather roads to provide rural connectivity and (iii) an assured market for agricultural produce. The state has successfully bought 98.5% of gross cropped area (GCA) under irrigation and the state provided free power to encourage production of cereals. A successful procurement mechanism provided an assured market for farmers' produce. These policy interventions played a critical role in augmenting agricultural GDP and farmers' income. However, the same policies had a severe repercussion on sustainability of the state's agriculture. The availability of free power and an assured market encouraged farmers to produce rice even though Punjab does not have agro-climatic conditions conducive to rice production. As a result, the water table in the state has been depleting fast because of the high-water requirement for paddy cultivation. Currently, 80% of the blocks are overexploited in the state.

This raises some fundamental questions. Where did Punjab go wrong? And how can it get back to a high-growth path of more than 5% per annum in agriculture and an overall GSDP growth rate of more than the national average of 7-8% per annum, say for the next 10-15 years? It is these questions that we try to address in this study on Punjab agriculture, identifying the sources and drivers of growth that could be replicated in the laggard states, and how best to accelerate state's own agricultural growth.

The chapter is organised in six sections. After a brief introduction in Sect. 4.1, an overview of Punjab agriculture is provided in Sect. 4.2. In Sect. 4.3, the composition and sources of agricultural growth in Punjab have been analysed. Section 4.4 presents the econometric analysis to identify the drivers of agricultural growth in Punjab. In Sect. 4.5, we have analysed budgetary allocations to examine how far the state government has been able to correct the historically and overwhelmingly skewed support in favour of crops, particularly grains, and whether higher allocations have been made to the horticulture and livestock sector in recognition of both the changes in the composition of Indian diets as well as the potential these sectors hold in terms of increasing the incomes of agricultural households. Finally, in Sect. 4.6, we present some concluding remarks based on our empirical and econometric analysis and recommend policy prescriptions to sustain high growth in Punjab.

4.2 Overview of Punjab Agriculture

Punjab is situated in the northern part of India bordered by Jammu and Kashmir to the north, Himachal Pradesh to the east, Haryana to the south and Rajasthan to the southwest. Punjab has an area of 50,362 km^2, which is 1.5% of the total geographical area of the country. Punjab's climate is influenced by the Himalayas in the north and the Thar Desert in the south and southwest. The state receives only 61.9 cm (normal) rainfall, of which 75% is received during the monsoon months. The agricultural sector accounts for 85% of the water consumption in the state. Due to increased demand for water and a reduction in canal capacity, the area irrigated by tube wells has been increasing. As a result, ground water is being overexploited for irrigation

purposes. The present ground water development[1] in the state is 172% and ground water is overexploited in 80% of the blocks[2] (CGWB 2016).

4.2.1 Agricultural Growth in Punjab

After Punjab was reorganised in 1966, a set of policies was undertaken, which paved the way to the state becoming a dominant agro-based economy. As India was a food scarce economy after independence, the main goal was to achieve self-sufficiency in food grain production. In order to do that, the green revolution strategy was adopted, initially focusing on Punjab, Haryana and Western UP. The adoption of new agricultural technologies consisting of high yielding varieties of seeds (wheat), chemical fertilisers and irrigation facilities helped the Punjab economy achieve a high growth trajectory. The sector grew at 5.70% per annum in the period 1971–72 to 1985–86. The growth rate dropped to 3% in the period of 1986–87 to 2004–05 and further to a level as low as 1.9% in the more recent period of 2005–06 to 2018–19, which is almost half the all-India average of 3.7% (Fig. 4.1).

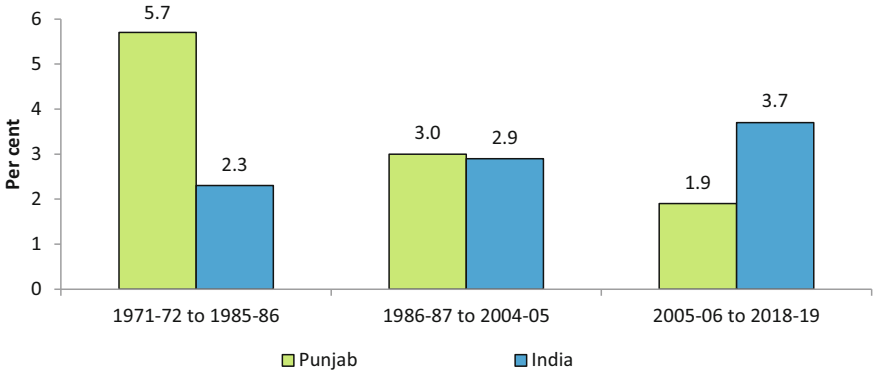


Fig. 4.1 Agriculture growth in Punjab and India. *Source* Government of India, central statistical organization and government of Punjab (www.pbplanning.gov.in)

[1]The stage of development is defined as the ratio of annual ground water draft to net annual ground water availability, expressed in percentage terms.

[2]According to the Central Ground Water Board (North Western Region, Chandigarh 2016), 110 of the total 138 administrative blocks have been overexploited. Of the overexploited blocks, 4 are categorised as critical and 2 as semi-critical; 22 blocks have been categorised as safe.

4.2.2 Agricultural Livelihood in Punjab

The state's population in 2011 was 27.7 million; the estimated population for 2018 is 29.9 million, which is 2.2% of India's population. In Punjab, 39% of the workforce was engaged in agriculture according to Census 2001. This fell to 35.6% in 2011 (34% according to Labour Bureau 2015–16). The contribution of the agricultural sector in the state's GDP declined from 48% in the triennium ending (TE) 1982–83 to 26% (at current prices) in TE 2016–17. Although Punjab established itself as the richest state in the country by improving its agriculture, a structural change is taking place in the economy with the share of agriculture in workforce and its contribution to GDP declining over the years. But the sector is still quite important in the state's economy.

Agriculture is largely dominated by marginal and small farmers in all Indian states. However, the case is different in Punjab, where the sector is largely dominated by semi-medium and medium farmers. In 2015–16, small and marginal farmers (who accounted for 33% of total farmers) with a holding size less than 2 ha operated on 10% of the total area operated while semi-medium and medium farmers (62% of total farmers) operated 68.6% of area. Large farmers (5.28%) accounted for 21.6% of area. The average landholding size has declined marginally from 3.79 ha in 1995–96 to 3.77 ha in 2010–11 and to 3.62 ha in 2015–16 (Table 4.1).

The average monthly income per agricultural household stood at Rs. 23,133 in 2015–16, which is the highest in India. Income grew at 4.3% per annum during 2002–03 to 2015–16, which is higher than the all-India growth rate of 3.7% per annum in the same period. The state has gone through an increase in the share of income coming from cultivation and farming of animals and a decline in the share coming from non-farm business and wages and salaries segment in the period of 2002–03 and 2012–13. However, the trend reversed during 2012–13 to 2015–16. Figure. 4.2 compares the composition of agriculture household income in Punjab with India in 2015–16.

4.2.3 Cropping Pattern in Punjab

The land use pattern in Punjab has remained unchanged over the years with net sown area marginally declining from 83 to 82% between TE 1986–87 and TE 2014–15. Forest area increased marginally from 4.4 to 5.1% in the same period. Net sown area and net irrigated area in TE 2014–15 stood at 4.1 million hectares (ha) and 4.0 million ha, respectively. Gross cropped area and gross irrigated area per 100 persons are 28.4 ha and 27.9 ha, respectively, which are much higher compared to the all-India figures (16.2 ha and 7.5 ha, respectively).

The biggest challenge facing Indian agriculture is the decreasing land holding size. But Punjab has experienced an increase in land holding size over the years. Average land holding size increased from 2.89 ha in 1970–71 to 3.77 ha in 2010–11.

Table 4.1 Operational holding in Punjab, 1995–96 to 2015–16

	1995–96			2010–11			2015–16		
	Area (%)	Number (%)	Size of holding (ha)	Area (%)	Number (%)	Size of holding (ha)	Area (%)	Number (%)	Size of holding (ha)
Marginal	2.95	18.65	0.6	2.55	15.62	0.61	2.36	14.13	0.60
Small	5.78	16.78	1.31	6.78	18.57	1.38	7.33	18.98	1.40
Semi-medium	20.08	29.31	2.6	21.56	30.83	2.64	24.87	33.67	2.67
Medium	42.29	27.98	5.74	43.18	28.35	5.74	43.75	27.93	5.67
Large	28.89	7.28	15.05	25.93	6.62	14.75	21.65	5.28	14.85
All classes	100	100	3.79	100	100	3.77	100	100	3.62

Source Agricultural census

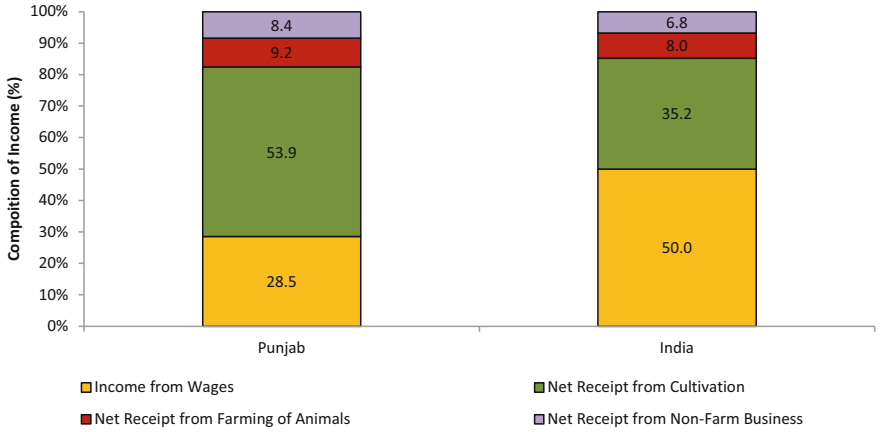


Fig. 4.2 Composition of agricultural household income from different sources in Punjab and India in 2015–16. *Source* NSSO

There has also been a reduction in the workforce engaged in agriculture in the state, which implies rural-urban migration. But some other studies have attributed the rise in average landholding to the rapidly declining water table in the state. They point out that the rapid decline in the water table requires the deepening of existing wells, inflating the cost of production. This has forced small and marginal farmers to sell off their land (Sarkar and Das, 2014).

The major crops grown in Punjab are wheat, rice, maize, cotton, sugarcane and horticultural products. Over the years, Punjab has concentrated on food grain production with the area under food grains as a share of gross cropped area increasing from 76.5% in TE 1986–87 to 82.9% in TE 2015–16, while the share of cotton, sugarcane and oilseeds has declined significantly. In TE 2015–16, the area under cotton, oilseeds and sugarcane was 5.1%, 0.6% and 1.1%, respectively. Within the food grain sector, the state specialises in rice and wheat production; the share of maize declined from 3.9% in TE 1986–87 to 1.6% in TE 2015–16. The total gross cropped area in the state is 7.9 million hectares and, with excellent irrigation infrastructure, 98.5% of the gross area sown is irrigated. Cropping intensity, which is measured by the ratio of gross cropped area to net sown area, was 190 in TE 2014–15.

Within cereals, wheat has traditionally been the dominant crop, but the higher profitability of rice, ensured by free water and an assured market prompted farmers to shift to rice cultivation. As a result, the area under rice kept increasing and stood at around 37% in TE 2015–16. The area under wheat remained stagnant at around 44%.

The area under fruits and vegetables has remained more or less constant over the years. Fruits and vegetables constitute 1.1% (90,000 ha) and 3% (244,000 ha) of the total gross cropped area in 2017–18, respectively.

4.2.4 Determinants of Agriculture Growth

Physical infrastructure such as irrigation, power and road play an important role in agricultural growth. Investment in these sectors facilitated the intensive use of inputs. Simultaneously, better use of inputs like fertilisers, high-yielding variety of seeds, farm mechanisation and credit augment farm productivity. The green revolution strategy, adopted to increase food production, consisted of a combination of (a) high yielding varieties of seeds (b) irrigation facilities and (c) the use of chemical fertilisers and pesticides. Agricultural growth was enormous during 1970–1985. It is imperative to discuss the role of these drivers in ensuring high agricultural growth in Punjab.

4.2.4.1 Irrigation Infrastructure

As discussed earlier, normal rainfall is only 62 cm, with the south–west monsoon contributing 79% of the total rainfall. Thus, the quantum of rainfall is quite low and is concentrated in the months of July–September. Hence, providing irrigation facilities was essential for the unconstrained supply of water for cultivation. With the use of HYV seeds, irrigation became a necessary technology to increase production during the early years of the green revolution. The state has successfully brought 99% of gross cropped area under irrigation (Fig. 4.3).

In TE 1986–87, 61% of the net irrigated area was under tube wells and other wells. Over the years, Punjab went through a major shift from canal irrigation to tube well irrigation as demand for water increased. Tube well irrigation ensures steady flow of water, and credit facilities and free electricity made it possible to enhance the use of centrifugal tube wells as the major source of irrigation. In TE 2013–14, around 73% of the net irrigated area was under groundwater irrigation (Fig. 4.3). But unwise use of water is leading to over exploitation of groundwater. The present

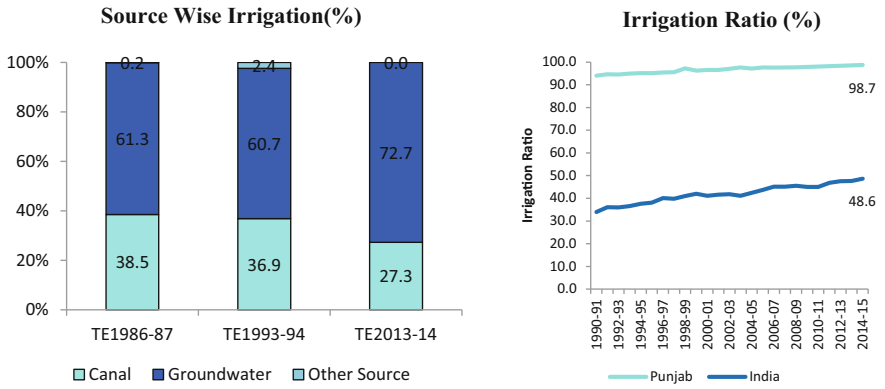
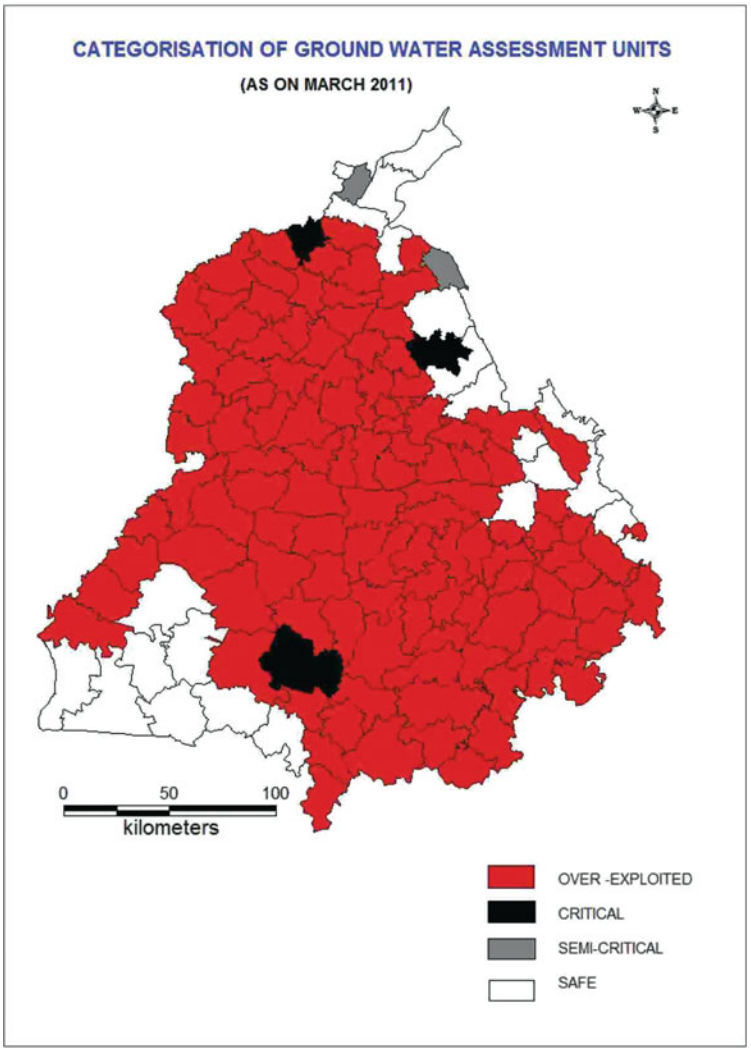


Fig. 4.3 The irrigation situation in Punjab. *Source* Directorate of economics and statistics

groundwater development in the state is 172%[3] and groundwater in 80% of the total geographical area is over utilised. The water table declined by 70 centimetres per year from 2008 to 2012 (http://punenvis.nic.in/accessedon28.4.2017). With one kilogram of rice consuming 3000–5000 L of groundwater, large-scale production and export of rice from Punjab is an unsustainable idea.



With its semi-arid nature, Punjab was more appropriate for the production of wheat and maize. But irrigation policies made water easily accessible to the farmer

[3]Ground water development is a ratio of the annual ground water extraction to the net annual ground water availability.

and free electricity reduced the economic cost of water. At the same time, the food procurement policy of the Government of India for the central pool ensured good returns on wheat and rice production. As a result, Punjab shifted from a traditional wheat-maize cropping pattern to a water intensive wheat-rice cropping pattern. This cropping pattern is not only ecologically unsustainable but is also making cultivation economically unviable. Because of groundwater depletion, centrifugal pumps are being increasingly replaced with submersible pumps, which lead to increased production costs. The consumption of energy for pumping water from deeper underground layers is also increasing, adding to the cost. This alarming situation needs to be addressed with utter seriousness.

The Government of Punjab enacted the Punjab Preservation of Subsoil Water Act in 2009 to check ground water depletion. Under this act, "no farmers shall sow nursery of paddy before 10th day of May of the agricultural year or such other date notified by the state". This legislation has been quite successful saving up to 7–8% of water as compared to May transplanting but as per the Central Ground Water Board's 2016 data, out of 138 blocks in Punjab, 110 continue to be overexploited (80%), thus posing an enormous challenge to sustainable agriculture.

4.2.4.2 Power for Agriculture

Power pricing policies played an important role in augmenting production during the green revolution. The sale of electricity for agriculture as a share of total electricity sales has remained consistently higher than all-India share (Fig. 4.4). There has been a 57% increase in the number of pump sets energised in the state between 2000–01 and 2015–16. The power intensity in the state, measured by power sales per hectare of GCA, was 1356 kwh/ha in TE 2015–16, which was much higher than the national average of 847 kwh/ha.

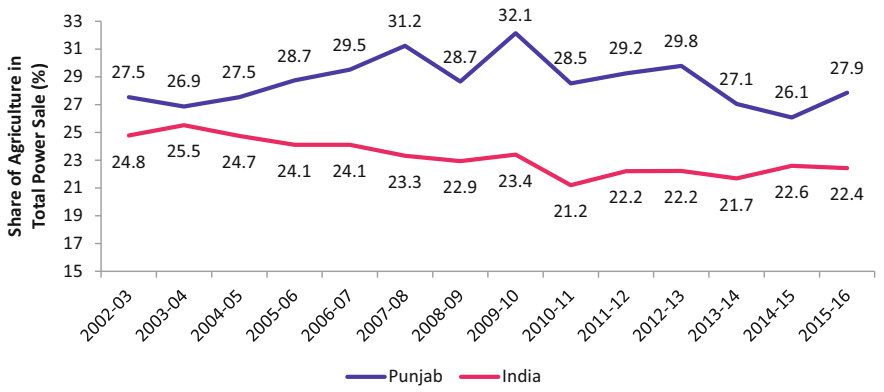


Fig. 4.4 Share of agriculture in total power sale. *Source* Report on the performance of state power utilities, various issues

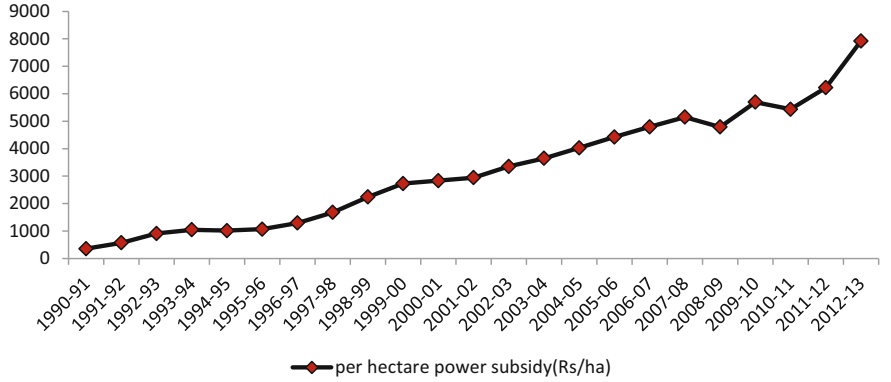


Fig. 4.5 Trends in power subsidy per hectare of GCA in Punjab (Rs./ha). *Source* Gulati and Terway (Upcoming Paper)

This free power has increased the subsidy burden and led to inefficient use of power, resulting in an alarming depletion of groundwater. In the initial years of the green revolution, a part of the electricity cost was recovered from the farmers on a per unit consumption basis. In the second half of the 1970s, the net return from wheat cultivation fell sharply and there emerged a strong movement to reduce input prices. In the late 1970s, the basis of electricity pricing was changed to a flat tariff. From 1984 onwards, there was a reduction in the charges on electricity connections as well. Electricity for the agricultural sector was made free in 1997 and continues to be so till date.

Figure 4.5 shows that the electricity subsidy per hectare has been increasing steadily. Power policy was an important element in the successful implementation of the green revolution. But inefficient and wasteful use of power and water is making farming itself an unsustainable means of livelihood and there is urgent need to restructure the power policy. Punjab has already adopted feeder separation for agricultural use in 10,911 villages out of a total of 12,272 villages. But the inefficiency in the consumption of electricity in Punjab's agriculture still persists and urgent steps need to be taken to curtail this.

4.2.4.3 Fertiliser Consumption

Crop yields can be augmented significantly through optimal utilisation of fertilisers. Wheat and rice are the most nutrient exhaustive crops in Punjab and the monocropping of paddy and wheat in the past four decades has led to a steady decline in macro (NPK) as well as micro (zinc, iron, manganese) nutrients in the soil. The Government of India has encouraged the use of chemical fertilisers by heavily subsidising it. Fertiliser consumption has steadily increased in Punjab and stood at 231 kg/ha of GCA in 2016–17, which is very high compared to all-India fertiliser

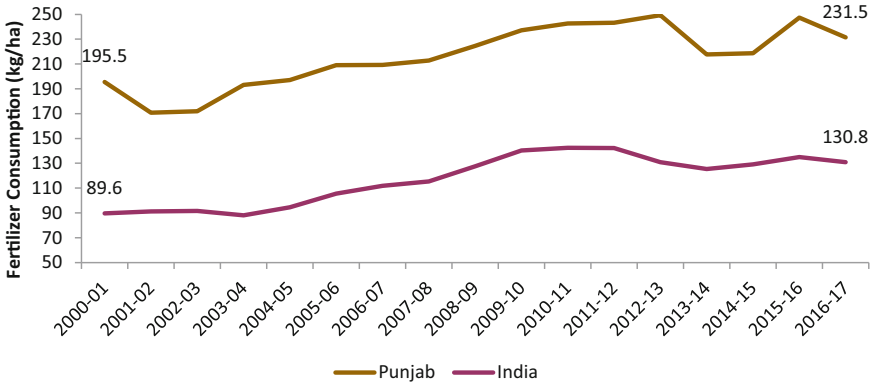


Fig. 4.6 Fertiliser consumption (kg/ha). *Source* Fertiliser association of India

consumption of 130.8 kg per ha of GCA in the same year (Fig. 4.6). It initially contributed to an increase in productivity in Punjab. But now, it has become a vicious cycle of higher use of fertilisers and decreasing soil fertility. There is no doubt that the fertiliser subsidy has helped achieve self-sufficiency in food grain production but it has also led to the inefficient use of fertilisers. The extremely low price of urea has resulted in the imbalanced use of fertilisers, which has affected the fertility of land. The NPK ratio in Punjab is 31.4:8:1 against the generally recommended ratio of 4:2:1 (and a national average of 7:3:1), which has affected crop productivity. In order to improve yield, famers are pumping more nitrogen into the soil, thus degrading the soil. The subsidy burden of the state stood at Rs. 7022 crore in 2012–13.

Studies have shown that (Gulati et al. 2015) this imbalance in the use of fertilisers can be solved by switching to direct cash transfers to farmers on a per hectare basis. Farmers should be incentivised to get soil testing done and to procure soil health cards by linking these to cash transfers. Moreover, the import duty on urea should be reduced to zero and prices should be determined by the interplay of demand and supply.

4.2.4.4 Procurement Policy

The goal of growth with equity involves the dual objectives of ensuring a minimum price to farmers and assured supply of food grains at affordable prices to vulnerable sections of society. The Food Corporation of India (FCI) was set up in 1965 which, along with other state agencies, undertakes procurement of wheat and paddy. Coarse grains are procured by state agencies as per the government's direction but not on a regular basis. The MSP is supposed to make sure that price does not fall below a certain level. Procurement under the price support scheme was adopted to ensure remunerative prices to farmers for their produce, which works as an incentive to

increase production. The minimum support prices are recommended by the Commission of Agricultural Cost and Prices (CACP) which, among other items, considers the cost of cultivation and a profit margin for farmers. To facilitate procurement, a large number of purchase centres for wheat and paddy have been set up at various *mandis* and key points.

Punjab contributes considerably to the procurement of rice and wheat and this has played an important role in its agricultural progress. Around 95% of rice and 65% of the wheat produced in the state was procured by government agencies in Punjab in 2016–17 (Fig. 4.7). Thus, there is an assured market for most of the farmers' produce, which works as an incentive for the production of just wheat and paddy. Punjab contributed 30% of the rice and 46% of the wheat in the central pool (2014–15).

Punjab, Haryana and Uttar Pradesh produce a large amount of rice although Punjab is not geographically suitable for rice production. It was made possible by the provision of extensive irrigation facilities and procurement at MSP. Because of an assured market, rice production increased over the years. However, rice is not the staple food in Punjab and rice procured in Punjab is transported to states in the East, North-East and South India. This imposes additional transportation costs. As rice is the most remunerative *kharif* crop owing to the assured MSP, farmers prefer to grow rice over other crops (for example maize). The food procurement policy in Punjab is also responsible for the change in cropping pattern, which has an impact on the environment. The policy that worked as a catalyst for growth in Punjab's agriculture has now become detrimental to the sustainability of its agriculture. Specialising in cereals was great when India was suffering from food shortages; however, the situation today is different. Stocks of cereals in FCI godowns crossed 80 million MT in July, 2012, way above the buffer stock norm. Some of the state specific policies in Punjab have also been distorting the market mechanism. The Punjab government

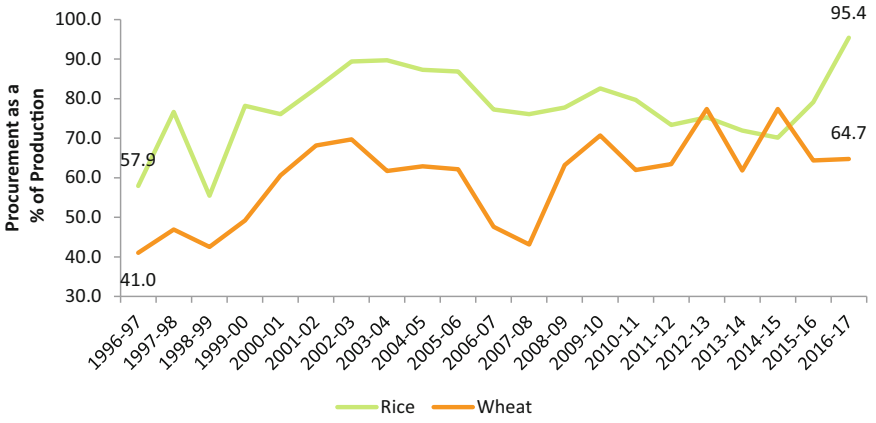


Fig. 4.7 Procurement as a share of production in Punjab. *Source* Department of food and public distribution

Table 4.2 Statutory levies and taxes in major wheat and rice producing states

Wheat				Rice			
State	Rate in 2012–13	Earlier rate	Year	State	Rate in 2012–13	Earlier rate	Year
Punjab	14.5	12.5	2010–11	Punjab	14.5	12.5	2011–12
Haryana	11.5	10.5	2010–11	Andhra Pradesh	13.5	12.50	2011–12
MP	9.20	3.20	2009–10	Odisha	12.00	8.50	2011–12
UP	8.50	7.50	2009–10	Haryana	11.50	10.50	2010–11
Uttarakhand	7.50	6.50	2011–12	Chhattisgarh	9.70	8.70	2010–11
Rajasthan	3.60	4.10	2008–09	UP	9.00	8.00	2008–09

Source cacp.dacnet.nic.in, Price policy for Rabi Crops 2014–15

charges heavy commission/levies/cess on the purchase of wheat and rice, amounting to 14.5%, which is much higher than the 2% in Gujarat and West Bengal (Table 4.2). This makes the food processing industry extremely reluctant to buy their raw material from Punjab. In fact, there have been instances of flour millers from Punjab buying wheat from UP. Revenue from these taxes/levies accrues to state government. In the new GST regime, there is an urgent need to rationalise the structure of taxes and levies so that private sector is not disincentivised from purchasing agricultural commodities in Punjab.

4.2.4.5 Roads

Roads are a basic infrastructure for economic development. Road connectivity is an important indicator of market accessibility. Transport facilities enhance the interaction between different agents, starting at the farm level to the household consumption level. It becomes even more crucial when it comes to perishable agricultural commodities. Often, farmers are forced to sell their products at prices even lower than the cost of cultivation just to avoid the rotting of crops. Advanced road and transport facilities ensure that agricultural commodities reach *mandis* on time and their quality is not compromised. The road infrastructure in Punjab is among the most developed in India. Road density in Punjab has increased from 564 per thousand sq km in 1970–71 to around 2151 per thousand sq km in 2015–16. Further, surfaced roads as a percentage of total roads is 90.6% in Punjab, one of the highest in the country (Fig. 4.8). All villages in the state are linked by roads.

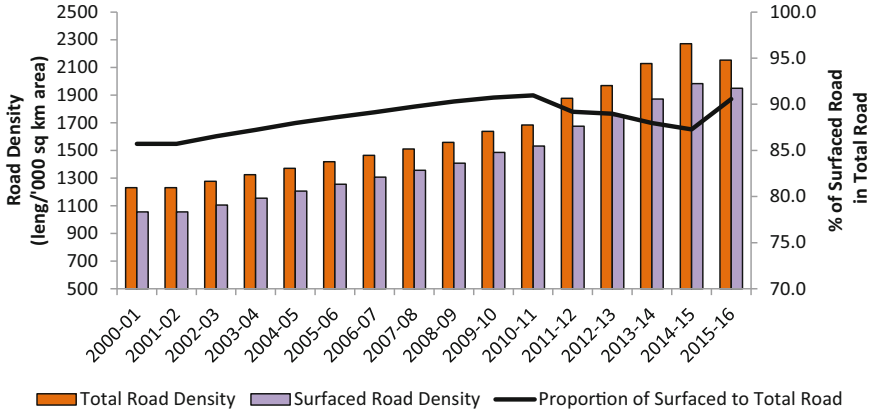


Fig. 4.8 Situation of roads in Punjab. *Source* Ministry of road transport and highways

4.3 Sources and Composition of Agriculture Growth

The share of value of output from different agricultural sub-sectors as a share of the total value of output from agriculture and allied activities (at current prices) has been calculated.

Agriculture and allied activities are divided into eight sub-sectors (1) cereals, (2) pulses, (3) oilseeds (4) sugar (5) fibre (6) fruits and vegetables (7) livestock and (8) other crops. Figure 4.9 highlights the composition of the agrarian economy. In TE 2015–16, cereals (40.9%) constituted the highest share in the GVOA, followed by livestock (31.3%) and fruits and vegetables (6.3%). Between TE 2002–03 to TE 2015–16, the proportion of GVOA accounted for by cereals declined sharply from 47 to 41% while there has been a significant increase in the share of forestry and logging from 0.5 to 8.3% (Fig. 4.9).

To calculate the sources of growth, the current series of value of output of each segment is deflated by the WPI of all commodities at 2011–12 prices. Then year-on-year growth of each segment is calculated by taking the absolute year-on-year difference in GVOA from each segment as a proportion of the previous year's GVOA from agriculture and allied activities. Agriculture and allied activities grew at 3.55% in the period 2000–01 to 2015–16. The contribution of different sectors to the total growth of agriculture and allied activities shows that the highest contribution came from the livestock sector (34.9%) followed by cereals (29.6%) forestry and logging (19.4%), and fruits and vegetables (11.3%) (Fig. 4.10).

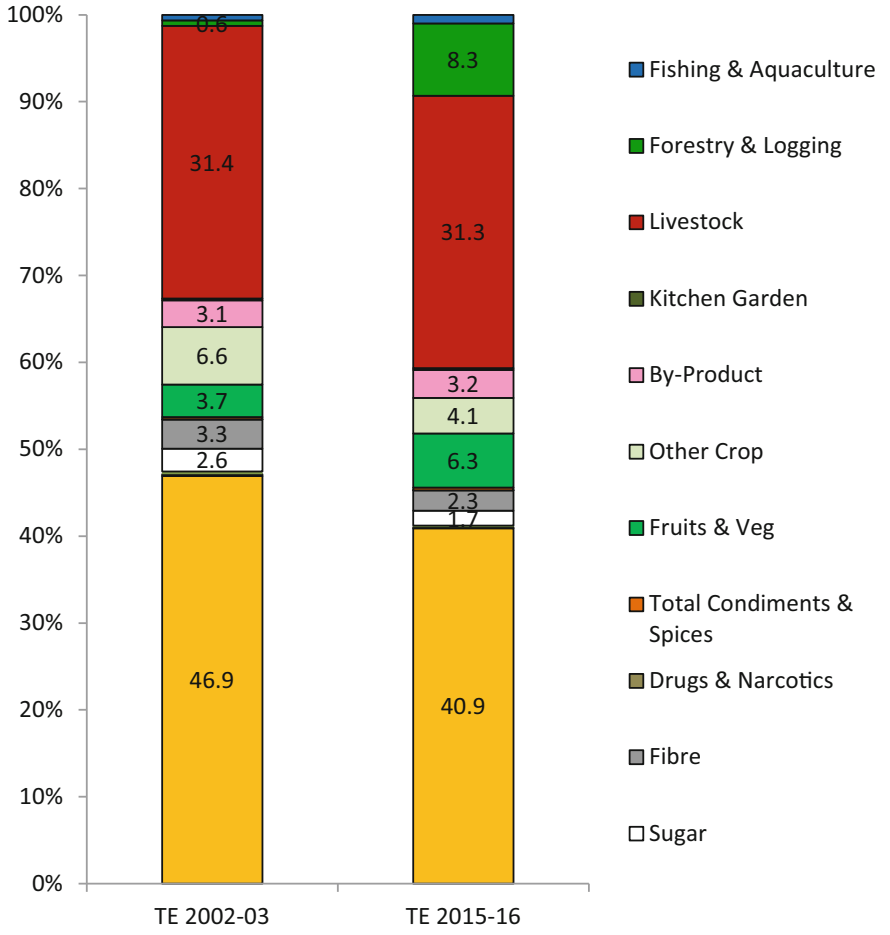


Fig. 4.9 Sector-wise shares in total value of output from agriculture and allied sector (at current prices). *Source* Calculated by authors using CSO data

4.3.1 Food Grains and Non-food Crops

Important crops produced in Punjab include rice, wheat, maize, *bajra*, sugarcane, oilseeds and cotton. However, rice and wheat alone constitute 80% of the total gross cropped area. In tandem with the increase in acreage under wheat and rice cultivation, the production of these crops also increased rapidly. Production of wheat increased from 4.8 million MT in TE 1970–71 to 15.9 million MT in TE 2016–17 (Fig. 4.11). Similarly, the production of rice increased from 0.57 million MT to 11.5 million MT in the same period (Fig. 4.11). The state's share in total rice production in the country increased from 1.40% in TE 1970–71 to 10.8% in TE 2016–17 while the share of wheat declined from 23.2 to 17.2% in the same period. The share of cotton

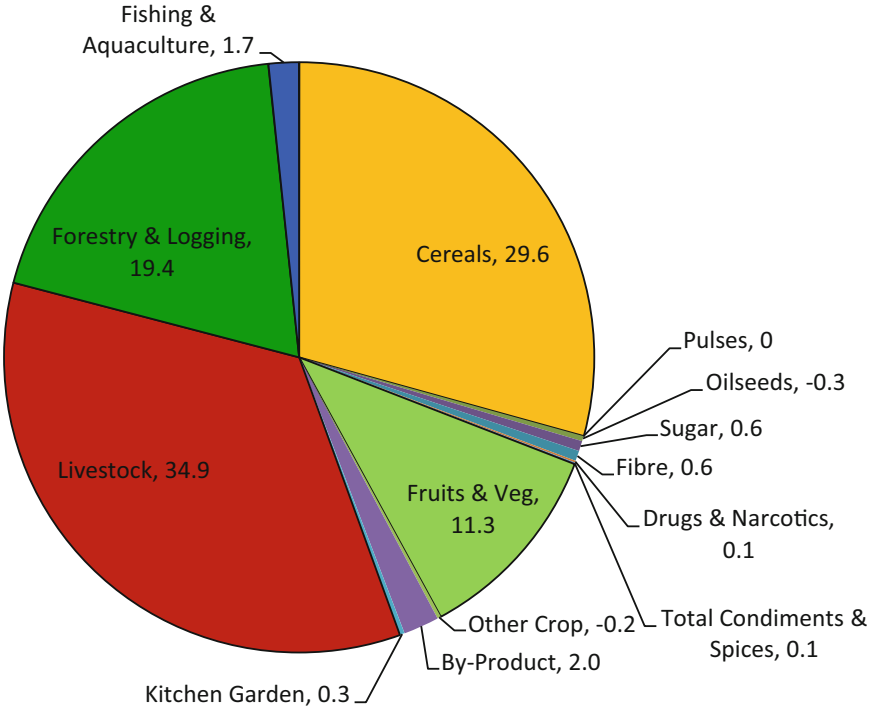


Fig. 4.10 Sources of growth 2000–01 to 2015–16 (Share in growth contributed by each segment). *Source* Calculated by authors using CSO data

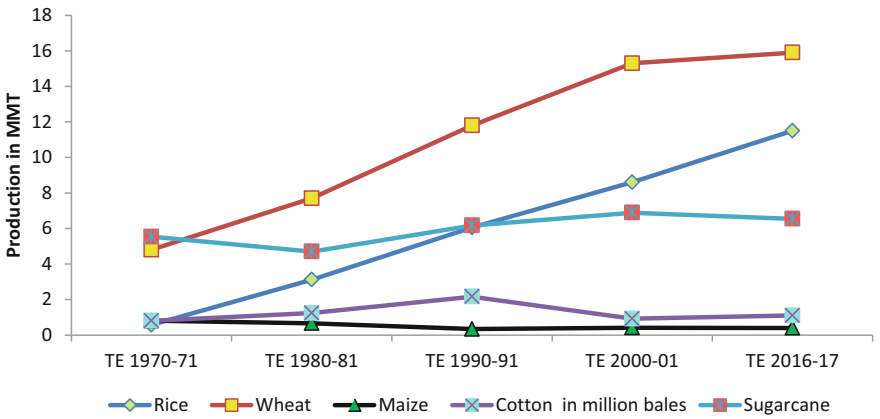


Fig. 4.11 Production of important crops in Punjab. *Source* DES

Table 4.3 Productivity of major crops in Punjab and India

Yield (MT/ha)	Rice		Wheat		Maize		Cotton		Sugarcane	
	Punjab	India	Punjab	India	Punjab	India	Punjab	India	Punjab	India
TE 1970–71	1.5	1.1	2.2	1.2	1.5	1.1	0.327	0.326	38.6	48.4
TE 1980–81	2.8	1.2	2.7	1.5	1.6	1.1	0.331	0.160	54.3	52.1
TE 1990–91	3.2	1.7	3.7	2.2	1.6	1.5	0.503	0.227	61.5	64.0
TE 2000–01	3.3	1.9	4.5	2.7	2.6	1.8	0.317	0.213	62.2	70.2
TE2016–17	4.0	2.4	4.5	3.0	3.7	2.6	0.546	0.486	76.5	70.4

Source DES

also declined from 16.1 to 3.5%. The cropping pattern has shifted to rice with 36% of total gross cropped area under rice production.

Punjab already has achieved very high productivity for all its important crops and the state does not have much scope to improve yield (Table 4.3). Clearly, diversification from the wheat-rice cropping pattern to other crops is important to both increase farm incomes and to conserve soil and water resources.

4.3.2 Horticulture

Fruits and vegetables together constitute only 4.23% of the gross cropped area. However, the sector contributed 11.3% to the total growth in agriculture and allied activities between 2000–01 and 2015–16. The gross value of output from fruits and vegetables has increased but the year-on-year growth has been erratic (Fig. 4.12).

Punjab makes a very small contribution to the total production of fruits and vegetable in the country (2% of fruits and 2.7% of vegetables). The production of fruits increased from 0.75 million MT in 2005–06 to 2.0 million MT in 2018–19 (Fig. 4.13). Similarly, the production of vegetables increased from 2.43 million MT to 5.0 million MT in the same period (Fig. 4.13). The increase in production can be attributed to a rise in the yield per hectare for both vegetables and fruits as the area under these crops did not change much over the years. In terms of production in 2016–17, the important vegetable crops produced in Punjab are radish (2nd largest producer), carrot (2nd largest producer), peas (3rd largest producer), potato (6th largest producer), bottle gourd (7th largest producer) and cauliflower (10th largest producer). *Kinnow*, orange, *malta*, lemon and guava are the important fruits grown in Punjab. The state is currently the second largest producer of mandarin, accounting for 25% of the country's production. Moreover, the state is the sixth largest producer of oranges as well as guava.

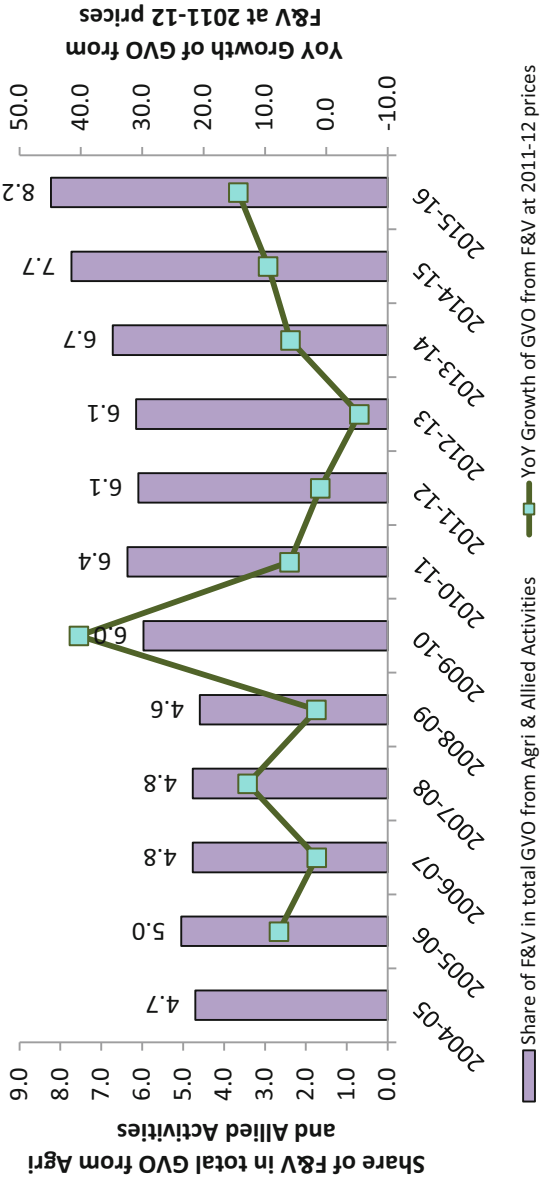


Fig. 4.12 Percentage share of fruits and vegetables in GVOA and year-on-year growth of GVO from fruits and vegetables. *Source* MOSPI

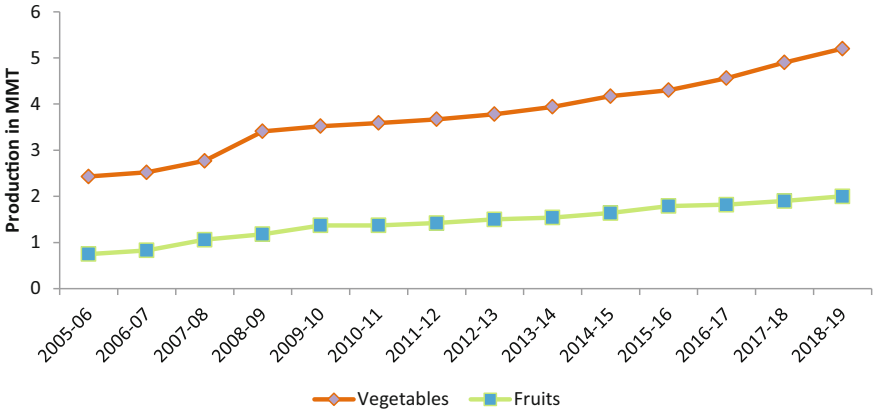


Fig. 4.13 Production of fruits and vegetables in Punjab (million MT). *Source* Different reports of national horticulture board

4.3.3 Livestock

The livestock sector is an important sub-sector in the state as it accounted for 31.3% of the total value of output in TE 2015–16. The composition of livestock products in the total value of output from the sector is as under:

4.3.3.1 Milk

Dairy contributes 82% of the total value of output from the livestock segment (Fig. 4.14). Milk production has increased impressively in the past, making the state India's sixth largest producer after Uttar Pradesh, Rajasthan, Madhya Pradesh, Gujarat and Andhra Pradesh despite its small geographical area and population. Milk production (Fig. 4.15) grew at 2.2% per annum in the period 2001–02 to 2009–10, but the growth rate has increased in recent years. The state has the highest per capita milk availability of 1037 grams/day (TE 2016–17). Monthly per capita consumption of liquid milk in rural and urban Punjab are 11.9 L and 10.9 L, respectively, which is high compared to the all India average of 4.3 L and 5.4 L, respectively. Given the practice of vegetarianism among the upper caste in the state, milk and dairy products hold a significant share in the food basket of households. Therefore, there exists significant domestic demand.

The Punjab State Co-operative Milk Producers' Federation Limited (Milkfed) was established in 1973 to provide a remunerative milk market and to disseminate technical inputs to milk producers. Milkfed is a three-tier system with the Federation at the top as the apex body at the state level, milk unions at the district level and co-operative societies at the village level. Verka is the brand under which milk and milk products are marketed by the Punjab State Co-operative Milk Producers' Federation.

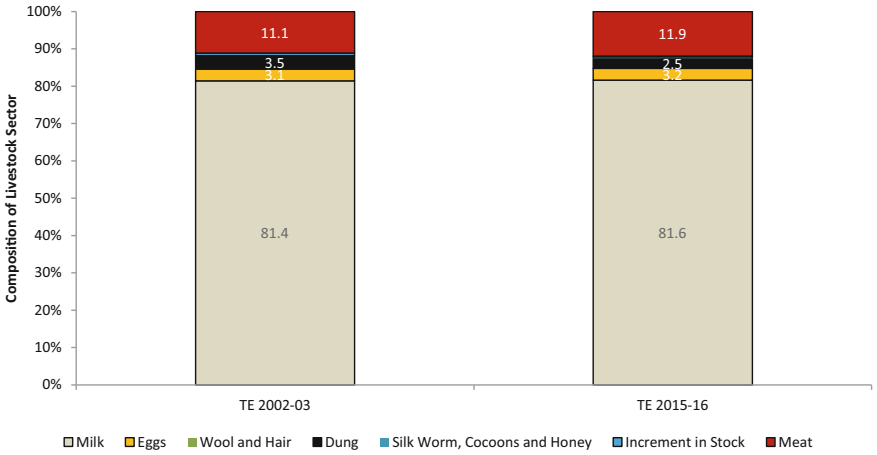


Fig. 4.14 Composition of livestock products (Current Prices). *Source* CSO

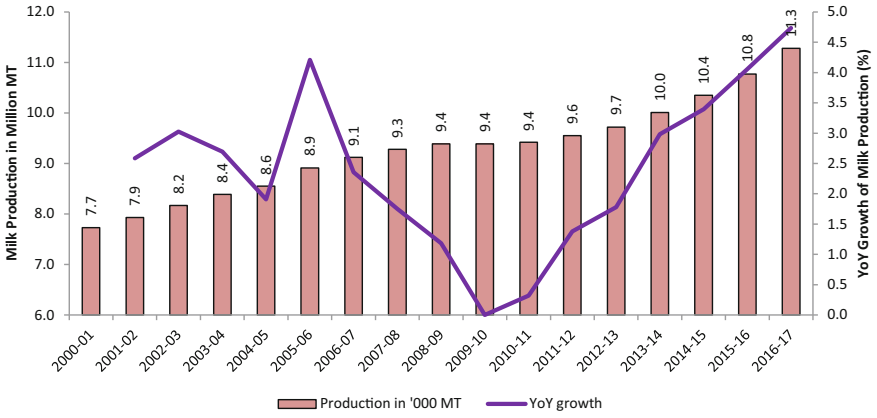


Fig. 4.15 Production and average growth of milk in Punjab for 2000–01 to 2016–17. *Source* NDDB

Non-members are only allowed to sell to Milkfed in the lean season. There is no upper limit on the quantity sold by a member. The Verka brand is available in Punjab, Haryana, Himachal Pradesh, Jammu and Kashmir and even in Northeast India. Ghee is exported to countries in the Middle East, Australia, Japan, New Zealand and Malaysia. In 2016–17, there were 7954 dairy co-operative societies with about 4.05 lacs producer members. Nestle India set up its first manufacturing facility at Moga. Dairy co-operatives procure just about 5% of the total production in Punjab, which is much lower than the 53.7% procured in Gujarat (Fig. 4.16). The rest is marketed through the unorganised sector comprising local vendors. The main problem with the unorganised sector is the presence of many middlemen between producers and

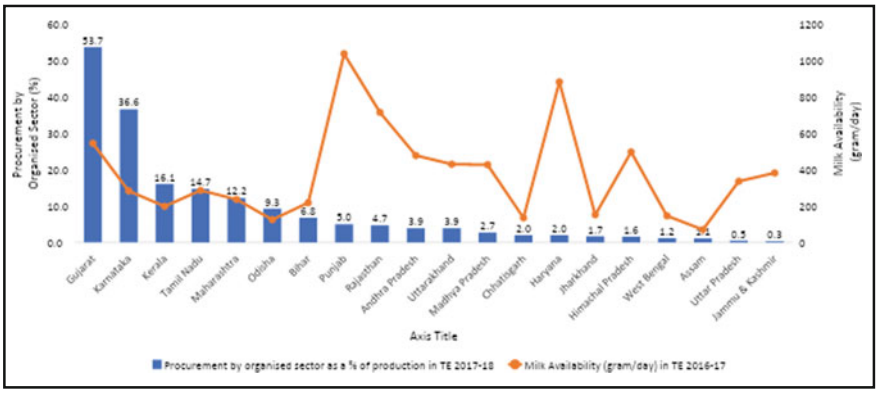


Fig. 4.16 Milk availability and procurement in major producing states. *Source* NDDB

consumers that prevents producers from receiving a remunerative price for their produce (Rajendran et al. 2004, Journal of Food Distribution Research). Punjab should follow the example of Gujarat and increase the participation of the organised sector in the marketing of milk and milk products.

4.3.3.2 Meat and Egg

The share of meat in the gross value of output (GVOA) has been more or less stagnant (3.7% of GVOA) in the past two decades. According to the latest livestock census (2012), the total livestock and poultry population in Punjab are 81.2 lakh and 167.9 lakh, respectively. The estimated meat production in 2016–17 stood at 248.6 thousand MT. The production of eggs in Punjab was 47,825 lakh in 2016–17. The per capita availability of eggs is 166 per annum in Punjab.

Although Punjab accounted for only 3.5% of total meat production in the country in TE 2016–17, the state's share in buffalo meat production is higher and it is the third largest producer of buffalo meat in the country, the top two producers being Uttar Pradesh and Maharashtra. The meat sector of the state is dominated by buffalo meat followed by poultry. The following figures show production of buffalo meat and poultry in Punjab and state's share in all-India production (Figs. 4.17, 4.18).

The buffalo meat sector in India is export-oriented as there is good demand for Indian carabeef due to its quality and price competitiveness. The country exported 1.3 million MT of buffalo meat in 2017–18 for US $4036.9 million (APEDA). The state needs to take the initiative to make cattle free from foot and mouth disease to fetch better prices for non-milching buffaloes.

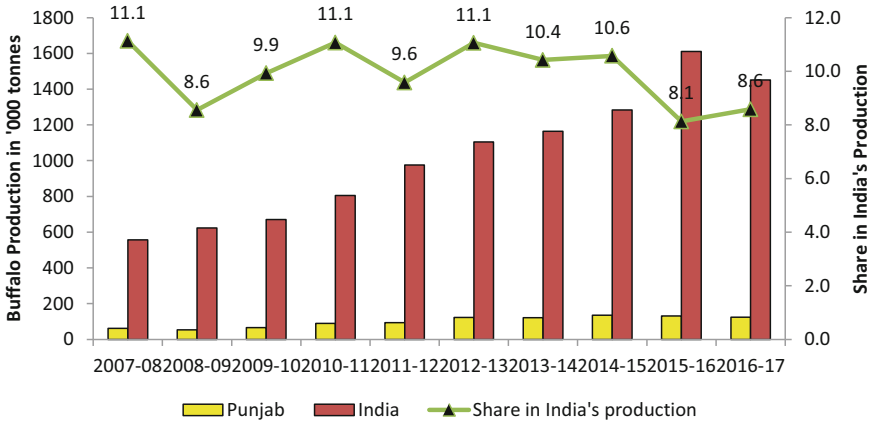


Fig. 4.17 Production of buffalo meat in Punjab and its share in all-India production

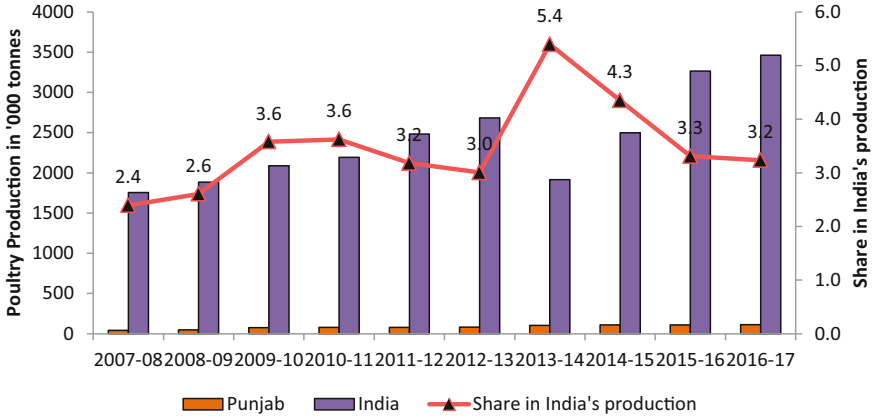


Fig. 4.18 Production of poultry meat in Punjab and its share in all-India production. *Source* Basic animal husbandry and fisheries statistics

The state can also target the domestic market of meat through the promotion of poultry and mutton. Punjab has done well in the poultry sector despite the rising cost of poultry feed. It has been catering to the demand for eggs within the state and in J&K. The Barwala–Derabassi–Lalru cluster in Punjab/Haryana is already the largest poultry cluster in north India but due to cheaper land in UP, a large number of Punjab poultry farmers are setting up units in UP. The Government of Punjab needs to formulate an attractive policy to get investment in the sector as it has the raw material for feed and a large market for eggs and poultry meat within the state and in J&K.

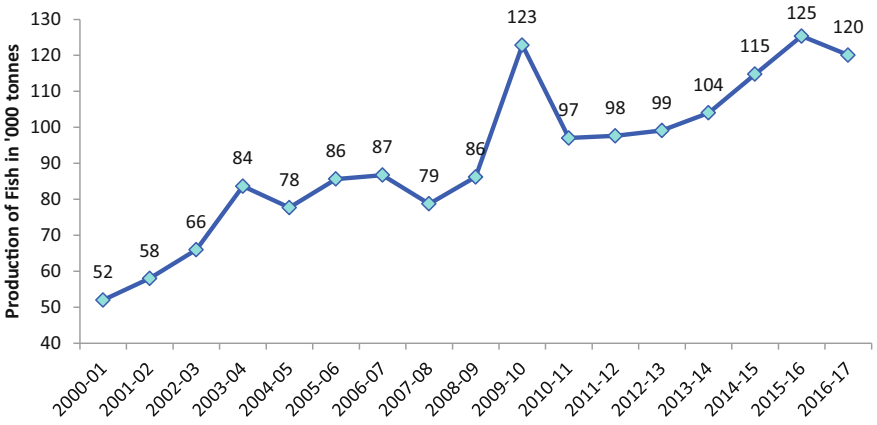


Fig. 4.19 Fish production in Punjab. *Source* Handbook of fisheries statistics

4.3.3.3 Fisheries

Fisheries contribute only 1% of the total value of output from agriculture and allied activities (TE 2015–16). Only inland fish can be produced in Punjab as it does not possess any coastline. There are 868 km of river, 13 notified reservoirs, 11,200 km of canals and 14,510 acres of small reservoirs in the state. In addition, there are 9318 constructed village ponds, covering an area of 32,597 acres. Fish production increased at a rate of 6.3% per annum for the period of 2000–01 to 2016–17 (Fig. 4.19).

Quality seed production should be promoted through the private sector so that fish seed is available at affordable prices. Fish seed production has remained almost stagnant in Punjab while it has increased steadily in the neighbouring state of Haryana (Fig. 4.20).

Tube wells installed at fish farms require electricity. Fish farming can be encouraged in water logged and salinity affected areas by providing assistance for fish ponds. But cold storage and other marketing infrastructure should be improved to increase the marketable surplus and reduce wastage.

4.4 Econometric Analysis for Drivers of Agricultural Growth

The performance of the agricultural sector is influenced by several supply side factors as discussed above, the broad ones being the use of inputs in farming operations, price incentives and infrastructure facilities. It is difficult to analyse the effect of all the variables in a simple framework because these variables would affect agricultural performance through various mechanisms. In this section, we make an attempt to

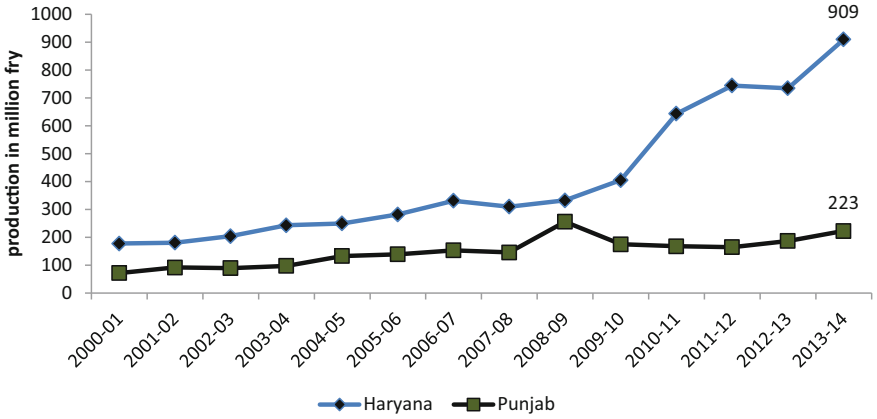


Fig. 4.20 Fish seed production in Punjab and Haryana. *Source* Handbook of fisheries statistics, 2014–15

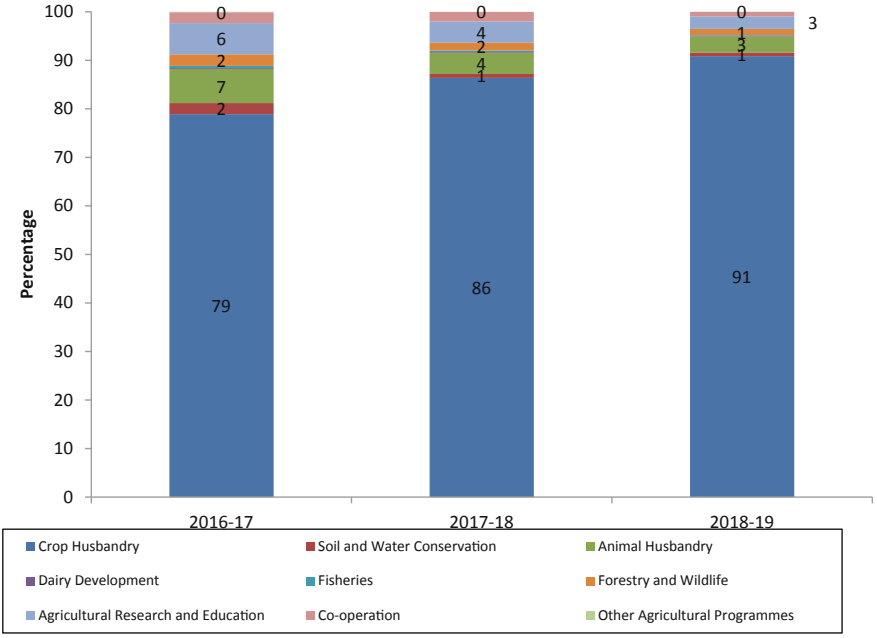


Fig. 4.21 Allocation to broad heads as a share of total allocation to agriculture and allied activities

find out the drivers of agricultural growth in Punjab through an econometric model. For example, fertiliser consumption and irrigation infrastructure are both crucial for agriculture but are highly correlated and hence, cannot be taken in the same equation due to multicollinearity. Table 4.5 in the Annexure gives the correlation

Table 4.4 Variables and definitions used for the model

Variable	Definition
GSDPA	GSDPA is the log of gross domestic product from agriculture and allied activities (2004–05 prices)
IRR	Log of ratio of gross irrigated area (GIA) to gross cropped area (GCA)
TOT	Log of the ratio of GDP deflators for agriculture and industry for Punjab
SRD	Log of surfaced road length per thousand sq. km of area

matrix of the variables. Keeping aside this limitation, it is observed that GSDPA shows a significant and positive correlation with irrigation, terms of trade between agriculture and industry and surfaced road density.

The function is defined:

$$Y_t = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \tag{1}$$

here, X_1 is Irrigation Ratio; X_2 is surfaced road density; and X_3 is terms of trade between agriculture and industry.

In our model, the logarithmic value of GSDPA is the dependent variable and the logarithmic values of variables mentioned above are the independent variables. The equation has been estimated using data from 1970–71 to 2015–16. We have run the model with different variables and have presented only those variables that have a significant effect on agriculture GDP (Table 4.4).

The estimated equation is as follows[4]:

GSDPA= 7.7 +3.47IRR***+ 0.35ToT*** +0.37SRD**

(7.97) (4.43) (4.32)

Adj R-square = 0.97

Note: *** significant at 1per cent level (p-value < 0.01); ** significant at 5per cent level (p-value < 0.05)

The effect of irrigation, road and ToT are found to be significant in the model. Irrigation turned out to be the most significant factor affecting farm income. Since we have used a double-log model, the result indicates that a 1% growth in the irrigation ratio increases agricultural GSDP by 3.5%. It implies that unconstrained supply of water is very important for cultivation and ensuring irrigation has helped the sector flourish. Similarly, a 1% increase in terms of trade in favour of agriculture increased agriculture GSDP by 0.35%. Price policy plays a significant role in driving the sector and remunerative prices persuade the farmers to invest more. Strong marketing infrastructure and procurement facilities ensured that farmers can avail remunerative prices for their produce. Roads, which help access to input and output markets, play

[4]Numbers in the parentheses are *t* values.

a major role in agricultural development. A 1% increase in surfaced road density leads to a 0.37% increase in GSDP from agriculture. What this equation implies is that 97% of agricultural growth during this period can be explained by the increased irrigation ratio, road density and price incentives (ToT). The detailed correlation matrix is given in the annexure Table 4.5.

To test for co-integration, we run the OLS regression in Eq. 1 and then run the ADF test on the residuals to determine stationarity. The series are co-integrated if the residual is stationary. The null hypothesis of non-stationarity is rejected at 1% level of significance. Hence, there is a long-term relationship between GSDPA, irrigation ratio, road density and terms of trade between agriculture and industry.

4.5 Assessment of Budgetary Allocation to Agriculture and Allied Activities

The government has played an important role in promoting agricultural growth in the past. The major commitment of the state government is to put the economy on the path of sustained growth in a manner that the benefits trickle down to the vulnerable sections. We have analysed the budgetary expenditure of the three financial years—FY 2016–17 (Actual), FY 2017–18 (RE) and FY 2018–19 (BE) to evaluate historical trends in budgetary allocations in the broad sectors and assess which area is getting substantial budgetary support. The broad budgetary allocation on agriculture and allied activities is shown in Fig. 4.21. The graph shows that crop husbandry constitutes the largest share of budgetary allocation (91%) with negligible share going to animal husbandry (3%) and research and extension (3%) for FY 2018–19 (BE). It is quite clear that potential of other sub-sectors in terms of augmenting farmers' income has not yet been tapped by increasing budgetary allocation in animal husbandry, dairy development and fisheries.

Crop husbandry comprises of food grains, horticulture and commercial crops. Disaggregated analysis of expenditure on crop husbandry shows allocation of funds on these areas. However it also includes expenditure on support services like extensions, crop insurance and input subsidies that apply to all segments of crop husbandry. The major allocations under crop husbandry are made for power subsidy (75%) in TE 2018-19 (BE) which is not surprising given Punjab's history of free power provided to agriculture (Fig. 4.22).

This section discusses both expenditure in agriculture (cereals, fibre, oilseeds, fruits and vegetables, livestock and fisheries) and expenditure for agriculture (road, irrigation, research and education, extension and training) from the state budget documents. The study finds that there has not been any substantial diversification of fund allocation towards areas with potential to augment income (Fig. 4.23).

Cereals are the largest contributor to the gross value added in agriculture at 40.9% in TE 2015–16; expenditure on cereals, however, is highly disproportionate and accounts for not even 1% of the total budget outlay in TE 2018–19. If power subsidy,

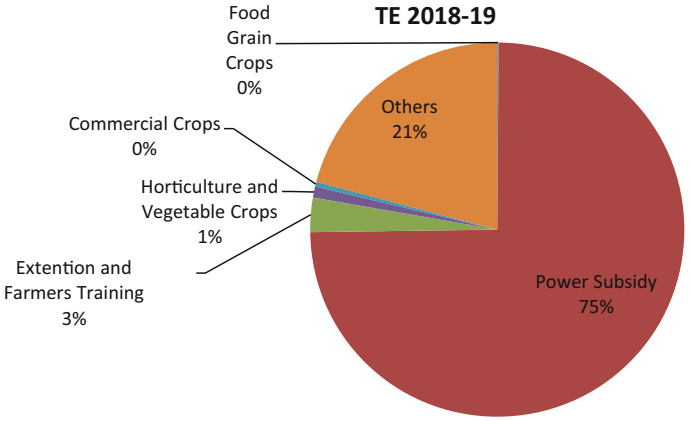
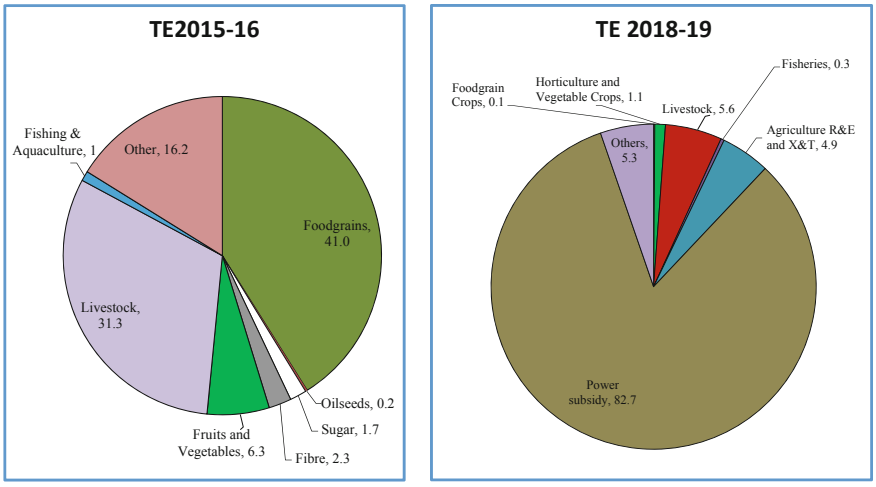


Fig. 4.22 Allocation to broad heads as a share of total allocation to crop husbandry in TE 2018–19



Sector wise Composition of GVO **Sector-wise allocation of Agricultural Budget**

Others in the sector wise budgetary allocation include co-operation, soil and water conservation, manure and fertilizers and seeds.

Fig. 4.23 Alignment of agricultural budget with GVO in agriculture and allied activities

given mainly for cereal crops is included in this analysis, it is found that this figure shoots up to almost 83%. Thus, almost the entire budgetary resource is spent for providing free electricity to farmers in Punjab. Free power leads to unchecked use of water, which leads to the rapid depletion of the groundwater table. To improve power and water use efficiency, power supply should be metered and charged beyond a fixed level of free supply and the subsidy (currently, Rs. 6236 crore in 2012–13) should be transferred to farmer's bank account on a per hectare basis.

The livestock sector, which stands next to food grain in terms of its contribution to GVOA and accounted for 31.3% in TE 2015–16 has received a budgetary allocation of merely 5.6% in TE 2018–19. Of the meagre sum spent on animal husbandry and dairy development, only about Rs. 9 crore are spent on veterinary services and animal health. An important sector like livestock has the potential to augment farmers' income in a substantial way but the financial neglect, which reflects the miniscule attention paid to the sector, is a matter of concern.

Fruits and vegetables contributed 6.3% in the GVOA and accounted for an expenditure of only 1% of the total expenditure incurred on agriculture and allied activities. Punjab contributes little to the total production of fruits and vegetable in the country. But the state is already doing well in the production of fruits and vegetables like mandarin, radish, carrot and peas and it can increase its production further by allocating more funds through schemes dedicated to these crops. More resources need to be spent on schemes like the National Horticulture Mission if the government is serious about diversification of crops from traditional food grains to high value crops.

Expenditure on fisheries is 0.3% as compared to its contribution of 1% in GVOA. But Punjab has the potential to develop fisheries in waterlogged and salinity affected areas by providing assistance for fish ponds, as mentioned above.

Roads are well developed in Punjab and it has one of the highest road densities (2152 per thousand sq km) as well as share of surfaced roads (91%) in the country. Expenditure on PMGSY roads increased from Rs. 221 crore in 2016–17 to Rs. 443 crore in 2017–18 and then decreased to Rs. 141 crore in 2018–19 (BE). However, given the existence of well-developed roads in Punjab, this decrease in expenditure is justified.

The irrigation situation in Punjab is among the best in the country and almost the entire area is irrigated in the state. Expenditure on major and medium irrigation (MMI) in Punjab is still high as the government has set aside about Rs. 2000 crore in FY 2018–19. The alarming groundwater situation in Punjab is well-known and the government must encourage the use of drip irrigation as has been done in other states. The state government has allocated a sum of Rs. 3.35 crore in FY 2018–19 for micro-irrigation in PMKSY. Concerted effort by the government will ensure better utilisation of the scarce groundwater resources available in Punjab.

4.6 Conclusion and Policy Recommendations

The econometric analysis in the previous section highlights the three factors that have been the drivers of agricultural growth in Punjab in the past: (i) expanded irrigation through tube wells (ii) assured remunerative prices for wheat and rice and (iii) expansion of all-weather roads. However, the growth that could be achieved by

developing roads, irrigation and markets has already been realised and exhausted. The state has successfully brought 98.5% of the gross cropped area under irrigation, which is commendable. The road infrastructure in Punjab is among the most developed in India. Transport facilities enhance the interaction between different agents, starting at the farm level to the household consumption level. This is particularly critical to facilitate the movement of perishable agricultural commodities. Surfaced road as a percentage of total roads is 91% in Punjab, one of the highest in the country. The share of wheat and rice procurement in total production is also the highest in the country. There is no real scope for further improvement in these areas. Therefore, in order to bring agricultural growth in Punjab back on track and get it growing at more than 5% per annum for another decade or more, we must look to other sub-sectors that could lead to high agricultural growth in the future. The future of Punjab's agricultural prosperity lies in the high-value sectors of agriculture. The combination of the highest irrigation cover, one of the best road infrastructures in the country and increasing holding size places Punjab in a privileged position[5]. What is required now is a correct mix of demand driven policies and incentives. Punjab's most significant problem has been free power, leading to huge depletion of water table as it tilted the cropping pattern towards paddy. The Johl committee report, 1986, had recommended a shift away from the wheat-rice cropping pattern to a wheat-maize one, which still remains valid. Punjab famers have not diversified from rice to other *kharif* crops in the absence of equivalent incentives. We make the following three sets of policy suggestions as the way forward for the agricultural sector in Punjab.

4.6.1 Diversification from Common Rice

Diversification to Maize : Currently, 0.13 million hectares, which is 1.65% of the GCA, is under maize cultivation in Punjab. The area under maize cultivation can be expanded by linking it to the processing industry for food and feed (especially poultry). Maize is used in many ways and these different uses should be explored to generate a market for various maize products.

(i) *Fodder Conservation*: Maize constitutes a primary ingredient for poultry feed in India. It can also be used as feed for dairy animals. Silage preparation is a scientific way of storing green fodder for dairy animals. It helps in supplying fodder for dairy animals on a large-scale during periods of scarcity without any nutrient loss. The criteria for forage to be used as silage include a high level of fermentable sugar, low level of protein and low buffering capacity. Based on these criteria, maize, oat, *bajra*, sorghum, lemon grass, etc., are considered suitable for silage making. In anaerobic conditions (without air), sugar

[5]Unlike other states, average landholding size increased in Punjab from 1970-71 to 2000–01and then declined marginally thereafter.

contained in green fodder is converted into lactic acid with the help of micro-organisms, which helps preserve green fodder for a longer period of time. It is a time and labour saving technology compared to the traditional way as fodder cutting, transport and chaffing is done only once, making it economically viable. Although India is ranked first in milk production in the world, the productivity of animals is not satisfactory. Good quality forages make a huge difference in milk productivity (50% increase in productivity). An adult milch animal needs 35 kg of fodder per day and according to the Indian grassland and Fodder Research Institute (2010), the country faces a net deficit of 35.6% in green fodder. As livestock contributes more than 30% of the total value of output in Punjab and the state is the fifth largest producer of milk in the country, the demand for fodder is very high in the state as it is in neighbouring Haryana and Uttar Pradesh. Silage making is a technology that can allow farmers to provide quality roughage throughout the year. In India, hay making was the traditional method of forage preservation. But silage making is a technologically advanced method that is not dependent on weather conditions and a variety of crops can be used. In some pockets of Punjab, silage making has been successfully adopted. The cost of making 1 kg of green fodder is only Rs. 3.12, and it is usually sold at Rs. 5/kg. A mini dairy with 10 cattle and 5 calves will require 150 tonnes of green fodder per year (Dairy Knowledge Portal, NDDB). There are 50 community based silage pits established in Hoshiarpur and Gurdaspur with 100% subsidy from Milkfed. But it needs to be scaled up. Currently, 540,000 ha of area is under fodder cultivation in Punjab (BAHFS 2010). Area under common rice can be replaced with maize and farmers can directly be involved in silage making. The state can emerge as the feed-hub of northern India.

(ii) *Other Uses of Corn*:

a. Cornmeal: Prepared by grinding whole corn, it can be used as a replacement for wheat flour and used in baked food products like pizza, tortilla, corn bread and so on.
b. Corn syrup: It is used as a substitute of sugar in many products like soda, candy, cookies etc. Corn Oil: It is produced by squeezing the germs of the corn and is used as a food ingredient. Ethanol: Ethanol fuel or bio-fuel is made by distilling corn. It is a renewable resource and regular gasoline powered cars are run on gas blended with ethanol.
c. Pharmaceuticals: Preferred carbohydrate sources in antibiotics are corn syrup and corn starch. Over 85 different types of antibiotics are produced using corn.
d. Industrial products: Industrial products made from corn include absorbents for oil and hazardous waste, insecticides, fertiliser, industrial glue etc.
e. Alcoholic Drinks: Corn is the major source of carbohydrate in whiskey production.
f. Toothpaste: Sorbitol, produced from corn, is used in toothpaste. Thus, corn and its by-products have many uses.

The fast growing middle and high-income classes and changes in taste and preferences have led to an expansion in the market for processed foods, which offers new opportunities for the state to explore. In order to tap these opportunities, the state needs to strengthen the value chain infrastructure. Value chain is a vehicle by which new forms of production, technologies and logistics are introduced. The government should facilitate diversification away from rice towards maize and horticulture by creating the infrastructure for value chain development. Maize production can be incentivised by developing maize value chains, connecting farmers to feed producers, processed food industries making cornflakes, popcorn or food marts selling horticulture products like baby corn and sweet corn and producers of corn oil and ethanol. The maize crop faces a marketing problem because it contains more moisture (20–28%) than the optimal level (14%) required for processing. So, farmers are sometimes forced to accept a lower price. The government needs to provide proper infrastructure facilities including maize dryers in *mandis*. Some *mandis* have been provided maize dryers out of RKVY funds but not all *mandis* in maize growing areas are equipped with dryers. These problems need to be addressed on priority.

Promotion of Livestock Sector: Similarly, milk processing needs to be promoted aggressively by the state government. Although Punjab has the highest per capita per day availability of milk (1037 g/day) in the country, currently only 5% of the total milk production of the state is processed by the organised sector. The government should provide incentives to the private sector to improve milk processing in the state and set up several plants to process at least 30–35% of the total production in the coming five years. Moreover, only 30% of the total milk procured by Verka is converted into milk products. This share should be increased as sale of milk products generates more profit than liquid milk. Linking maize farmers with the dairy sector will help increase milk production through the supply of quality feed. But the abundance of liquid milk will put a downward pressure on its price. The government should incentivise the setting up of milk processing units. Following the example of Amul, the dairy sector in Punjab should target the market in the Middle East. Currently, marginal and small farmers are the major players in the dairy sector; hence, the formation of FPOs should be encouraged by the state government. Punjab can also make rearing of cattle more profitable to farmers through its vibrant dairy sector, and by developing meat processing, especially buffaloes, as an export-oriented industry. Farmers who want to sell their buffaloes for slaughter can fetch a better price for their non-milching healthy buffaloes if the state is declared free from foot and mouth disease.

Promotion of Horticulture: The state government needs to realise that growth in income through cereals has reached saturation and there is urgent need for value addition from high value dairy, fruits and vegetables. Only, 3.6% of Punjab's GCA is under fruit and vegetable production, compared to 8.3% at the all-India level. In order to promote the fruit and vegetable sector, protected cultivation should be promoted using drip and sprinkler irrigation. But it has to be backed by proper processing, grading and packaging infrastructure. The government should aim to bring at least 10% of cropped area under F&V in the next five years.

Fisheries: Large parts of Muktsar, Fazilka, Bathinda and Faridkot are waterlogged. A study by GADVASU has found that fresh water carp can successfully be reared in saline water. Hence, it provides a good opportunity to develop fisheries in these districts as it can offer alternative employment opportunities. But quality fish seed production has remained stagnant in Punjab, while it has increased steadily in neighbouring Haryana. The government should take steps to overcome these shortcomings through capital assistance to construct fish seed mills and carp seed farms.

4.6.2 Encouraging Food Processing Industries

The food processing sector should be the focus area in Punjab and farmers should be linked to processing units. The abundance of wheat and milk suggests the development of bakeries, flour mills, pasta manufacturing and other processing units that use wheat as raw material. Punjab's role in feeding the central pool for PDS should gradually come down. It will be taken up by other upcoming states like Madhya Pradesh and Uttar Pradesh. Due to high taxes (14.5%) on wheat, the processing industry has been reluctant to buy wheat from Punjab. In the past, private sector units located in Punjab have preferred to buy wheat from neighbouring Uttar Pradesh, where wheat is cheaper both because the MSP is not paid and because taxes are lower. Under GST reform, it is hoped that these taxes and levies will get rationalised as most raw agricultural commodities fall in the zero tax slab. A reduction in taxes and cesses by 12% will reduce the prices of these basic staples in the open market. The state should take it up as an opportunity to build a vibrant wheat and basmati rice processing industry, creating employment and linking farmers directly to processors. Special focus should be given to improve the value chain infrastructure, from farm to fork, in the state, given the perishable nature of the products that makes farming risky and farmers reluctant to shift from cereals to fruits and vegetables. The expressway linking Khanna to Kandla can minimise the transportation time and the state can exploit the opportunities offered by the Gulf market through speedy transportation of fruits and vegetables to the Middle East using cargo planes. But high taxes on processed food items under the new GST regime will hamper high value agriculture (fruits and vegetables, dairy, etc.) There is an urgent need to reconsider and bring down the rates to the 5% slab.

Contract farming is still not taken up on a large scale in the state. The state needs to operationalise the Contract Farming Act, 2013, to incentivise contract farming by corporate agencies and to promote the food processing industry in the state.

4.6.3 *Promote Sustainable Agriculture Especially with Respect to Water Use Efficiency*

Shift to DBT with respect to power subsidy: Electricity subsidy is an important component of subsidies that were introduced to increase agricultural growth and farm incomes. Although it has led to assured incomes, the combination of free water, power and procurement has led to rapid ground water depletion. Electricity consumption per hectare has increased over time, whereas agricultural production per unit of electricity consumption has not increased with free power supply; rather, it has been falling over time. This indicates serious inefficiency in the consumption of electricity in Punjab's agricultural sector, and steps need to be taken to curtail this. To improve power and water use efficiency, power supply should be metered and charged beyond a fixed level of free supply and the subsidy (Rs. 6236 crore in 2012–13) should be transferred to farmers' bank accounts. Transferring a fixed amount of cash (calculated using the average land holding) to farmers will provide an incentive to reduce the consumption both of electricity and underground water.

Shift to DBT with respect to Fertiliser Subsidy: Another problem faced by agriculture in Punjab arises from the imbalance in the use of fertilisers. Wheat and rice are the most nutrient exhaustive crops and the mono-cropping of paddy and wheat in the past four decades has led to a steady decline in macro (NPK) as well as micro (zinc, iron, manganese) nutrients. The state has encouraged the use of chemical fertilisers through subsidies and the economic cost was estimated at Rs. 7022 crore in 2012–13. Hence, it has become a vicious circle of higher use of fertilisers and low soil fertility. The fertiliser subsidy has helped achieve self-sufficiency in food grain production but it has led to inefficient fertiliser use. The extremely low price of urea has resulted in the imbalanced use of fertilisers biased towards urea, which has had an impact on the fertility of land. The NPK ratio in Punjab is 31.4:8:1 in 2016. Studies have shown that (Gulati et al. 2015) this imbalance in the use of fertilisers can be corrected by switching to direct cash transfers to farmers on a per hectare basis. Farmers should be incentivised to get the soil tested and get soil health cards by linking these to direct cash transfers. Moreover, import duty on urea should be reduced to zero and prices should be determined by market forces.

Propagating Micro-irrigation Technique: Given the gravity of the problem of water situation, the state government must consider making it mandatory for sugarcane farmers to use drip irrigation facilities. Karnataka has already done so; Maharashtra is considering a similar system. Out of 10 lakh ha area under sugarcane in Maharashtra, about 2.5 lakh ha is already under drip irrigation. Modern drip irrigation systems use computerised sensors that regulate the flow of water depending on temperature, humidity and nutrient levels in the soil. Moreover, water reaches the roots of plants, leading to better plant growth. The automated systems ensure optimum use of water. If the Government of Punjab takes sugar mills on board, it should not be difficult to persuade farmers to install drip irrigation systems over a period of two or three years. There are pilots being conducted in Punjab for drip irrigation in paddy. These need to be closely monitored and encouraged. The manufacturers of drip equipment

claim that using drip irrigation leads to savings of 65% in the case of water and 45% in the case of electricity while improving crop productivity by 40% as compared to flow irrigation. Micro-irrigation means more crop per drop.

Sustainable Futuristic Agricultural Development: Another important way to deal with power shortage is to promote solar power for powering irrigation pumps and generating solar power as the "third crop" by enabling farmers to sell surplus power to the state grid. This will help check depleting water tables too. Cold storages based on solar power can be cost effective. A beginning should be made in the case of potato cold storages in Jalandhar.

Overall, the strategy for Punjab agriculture needs to shift from food security concerns of the country to income augmentation of farmers. This can be done by gradually shifting towards high value fruits and vegetables, protected cultivation, and by focusing on the food processing industry to add value to wheat, rice and milk production in the state. The strategy also needs to be demand driven (plate to plough), exploring new and remunerative markets, as in the Gulf countries or even beyond to Europe and CIS countries. We are confident that with this shift in strategy, the state can turn around its agriculture growth back to more than 5% per annum, augment farmers' incomes and use its precious water resources in a more sustainable manner.

Annexure

See Table 4.5.

Table 4.5 Correlation matrix for the period 1970–71 to 2015–16

	GSDPA	Fertiliser consumption	Irrigation ratio	ToT	Total road density	Surfaced road density
GSDPA	1					
Fertiliser consumption	0.93***	1				
Irrigation ratio	0.94***	0.94***	1			
ToT	0.29**	0.06	0.07	1		
Total road density	0.94***	0.87***	0.87***	0.37**	1	
Surfaced road density	0.95***	0.91***	0.91***	0.25*	0.99**	1

*** significant at 1%, ** significant at 5%

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