

Chapter 2

The Role of Technological and Institutional Changes in the Growth and Transformation of Agriculture in Punjab

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2.1 Introduction

Uneven performance of agriculture across regions in India and the factors shaping it has been a subject of interesting debate among academic researchers and policy makers in recent decades. Differences in the pace and patterns of technological change, institutional setting and environmental conditions have been identified as the crucial factors causing uneven patterns of agricultural growth.¹ Those who base their arguments on the crucial role of institutions state that it was the property right regimes created during the colonial period that contributed to the differences in the pace and pattern of agricultural growth across regions in the post-independence period. It is argued that in the regions where land rights were created and taxes were collected directly from the peasants by the colonial administration showed greater

¹There exist a large number of studies on regional dimensions on agricultural growth in India. A few of the important contributions are as follows: Vaidynathan (2010), Bhalla and Singh (2010) and Birthal et al. (2014).

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dynamism in agricultural growth compared with other regions.² Those who critique this argument substantiate their position by focusing on the fact that even before the British rule, considerable differences existed in the pattern of agricultural development within the Indian subcontinent.³ Those who consider technological change as the main driving force behind agricultural growth base their argument on the fact that irrespective of the differences in the institutional settings, agricultural technology has spread, during the green and post-green revolution periods making the growth process spatially broad based and dynamic and hold the view that technological progress is more important than institutional reforms in accelerating the pace of agricultural growth.⁴ While recognizing the importance of technology and institutions in shaping agricultural growth, another view is that the sources of disparity is also rooted in the variations in the environmental conditions. Some region could succeed in spreading the green revolution due to the policies and programmes for removing the environmental constraints (Roy 2007).

It appears from the various empirical and analytical studies that for a coherent explanation of the differential process of growth across regions, institutions, technology and environment need to be treated as part of the factors that shapes agricultural growth. However, unravelling the relative role of these factors is a challenging task due to the continuous interaction between technology and institutions in a given environment affecting the path ways of development.⁵ There are other exogenous and endogenous factors that have to be taken into consideration in providing explanations for the nature of interaction between technology and institutions. One of the significant factors to be taken into account is the linkage between population growth and technological change. In traditional agriculture with primitive or low level of technical change like shift in cultivation from short fallow to long fallow and to more intensive forms of cultivation for sustaining productivity and per capita output required labour-intensive investment in the creation of irrigation facilities, land development, soil conservation, etc. In societies characterized

²An important contribution in this respect is by Banerjee and Iyer (2005). There are also other interesting papers on the effect of colonial legal systems in shaping the present-day institutions such as Acemoglu et al. (2001, 2002), Engerman and Sokoooff (1997, 2002) and Sokoooff and Engerman (2000). In this paper, we follow North and Thomas (1973) in conceptualizing institutions in terms of rules, norms and values that include both formal and informal institutions, and organizations as institutions.

³See for details Weintraub (2005).

⁴The writings of Shultz (1964) have dominant influence in this line of thinking: his point was that it is the missing knowledge base that contributed stagnation in agriculture and what the state should do is to invest in agricultural research and technology generation and facilitate its rapid diffusion.

⁵Historical experiences of various countries show that (i) institutional arrangements hamper or discourage development or dissemination of new technology, (ii) institutional arrangements encourage or assist the developments and dissemination of new technology, (iii) the type of technology and its pattern of dissemination either hamper or discourage institutional changes and (iv) the type of technology and its pattern of dissemination either encourage or assist institutional changes.

by higher levels of population densities, the choice would be towards more labour-intensive and yield increasing technology.⁶ In the evolution of technology, it is also argued that technological innovation would be determined by the changes in relative factor prices intended to overcome resource constraints by generating a sequence of innovations leading to the substitution of technical inputs for the limiting factors.⁷ Historical experience of USA, Japan and Western Europe provide evidence to support the induced innovation hypothesis. While in Japan, both land-saving and labour-saving technological change had taken place, in the USA and Western Europe, it was largely labour-saving technologies. It was also seen that in societies where capacities for endogenous technical changes do not exist, it could take place through diffusion and adaptation of technologies imported from other countries.

An important insight we could derive from the various analytical and empirical studies is that for understanding the role of technology and institutions in shaping agricultural growth it would be useful to adopt a historical approach by bringing in exogenous factors like population growth and endogenous factors like the capacity to innovate. Though there had been a number of studies that attempted to examine the contemporary developments in various facets of the agrarian economy with its historical roots, studies that explicitly treat the role of technology and institutions in shaping agricultural growth are very few.⁸ The present paper is an attempt to contribute to this literature. It is done in the context of the state of Punjab.

The case of Punjab will be insightful from a number of perspectives: Punjab has been the forerunner in the agriculture-induced economic growth in the country. The driving force behind the growth of agriculture in the state has been the modern biophysical technology that led to rapid increase in productivity of crops, faster income growth, decline in poverty, and structural changes in the economy. The technological changes also have brought in institutional changes not only in relation to the agricultural sector, but also for the entire state and society. However, the agricultural sector in the state is confronted with deceleration in productivity and output growth; the growth in agriculture in the past has witnessed a negative impact on the environment and ecology. Since, the state is the main producer of food grains for the country, the deceleration of agricultural growth is of major concern for the entire country. Given this background, it may be of interest to examine the interaction between technology and institutions in Punjab agriculture and its implications for sustaining the growth process.

The rest of this chapter is organized as follows. Section 2.2 will review some of the salient aspects of agriculture in Punjab during the colonial period. This is followed by a review of the growth process in agriculture, especially from the

⁶The main contributor to this argument is Boserup (1965). See her pioneering notes on conditions of agricultural growth.

⁷See Hayami and Ruttan (1971).

⁸A number of papers put together in this perspective are available in Narayana and Mahadevan (2011). An important contribution in this context is also by Boyce (1987).

perspective of technological change in Sect. 2.3. Section 2.4 will examine the changes in the institutional structure of agriculture. Section 2.5 will highlight the implications of technological and institutional changes on the wider development of the state.

2.2 Agriculture in Punjab: Some Historical Insights

The present state of Punjab was part of the erstwhile Punjab province of British India. Most of the studies done by economic historians for the colonial period related to Punjab Province. In this section, we plan to draw from the works of few scholars who did pioneering research on this region.⁹

The British annexed Punjab in the year 1849. They found the region with vast potential for development, contribution to the revenue base and consolidation of the political power of the British Empire. There existed already a prosperous irrigated agriculture in the northern parts of the province. The canals existed were the inundation canals along the Jamuna River and the Hosely canal constructed to provide perennial waters from the river Ravi to the city of Lahore and Amritsar. The hard working peasants of Punjab were exporting agricultural products such as sugar and indigo to Sind and Kabul. The main reasons cited for the colonial investment in canal irrigation were (1) to mobilize revenue by promoting irrigated agriculture and (2) many regions were affected by a series of famines during the first half of the nineteenth century. Where ever agriculture development based on canal irrigation the famines did not occur or its incidence was lighter. By investing in irrigated agriculture, the expectation was to save expenditure on the famine relief.¹⁰ (3) With the expansion of agriculture, it would be possible to export wheat, cotton, indigo and other agricultural commodities, and horses and mules to the British Empire. (4) By developing agriculture and bringing in economic prosperity, the Empire expected to gather support of the people to sustain the colonial regime. The scope for expansion in irrigated agriculture was enormous due to low cost in the development of canal irrigation due to the topography of the region and the perennial supply of water from the Himalayan Mountains. Population density was very low and plenty of unoccupied crown land was available. It was possible to move people from other regions to settle down there without disturbing traditional property rights. The sale of the crown land also offered the scope for mobilizing additional revenue to the state. The development of agriculture in the region would lead to the growth of cities and towns and could broaden the base of taxation of the State. The

⁹This section has been drawn largely from the works of Paustan (1930) and Hirashima (1978).

¹⁰The region was visited by famines in 1802, 1812, 1817, 1824, 1833 and 1837. Rainfall was low and unpredictable. The causes of famine were (i) lack of rainfall which precluded the possibility of producing food for subsistence during periods of drought and (ii) lack of transportation facilities and means of communication. Famines created a balance between population and food supply; see Paustan (1930) for details.

mutiny of 1857–58 prompted the British to expand the construction of Railways to the region for the faster movement of troops; but it also helped the transport of agricultural commodities to the market towns and export destinations and paved the way for the rapid commercialization of agriculture. The Bari Doab canal that was already yielding some revenue at the time of annexation was modified during the first year of the British rule. Sikh soldiers who were retrenched after the mutiny were used in the construction of canals of Bari Doab between river Ravi and river Bias. Colonization started first in the Sind canal system where considerable extent of waste lands (more than 2.3 lakh acres) was available. Population from the adjacent districts were moved to Sind. Government constructed main canals, and the own farm development was left to the settlers. Colonization in the lower Chenab canal started in 1892, where people from the densely populated districts and the nomadic tribes were encouraged to come and settle.

The impact of the colonial policy of encouraging agricultural development was evident from a number of indicators. Area under cultivation had increased at a faster rate along with the increase in the percentage of canal-irrigated area to total cultivated area during the period 1861–1921. Cultivated area increased from 20 million acres in 1861–29 million acres by 1921. The percentage of canal-irrigated area increased from 6.3 % in 1861 to 36 % in 1921. The pace of irrigation expansion took place at a faster rate during the first two decades of the twentieth century. Compared to the area expansion, the growth of population was at a much slower rate: the size of the population was about 16 million in 1861 and it increased to 21 million by 1921. In other words, the per capita land available for cultivation had increased along with improvements in its quality due to the rapid expansion of irrigation. The expansion of irrigation was accompanied by attempts to improve the yields of crops by developing improved seed varieties in the Lyallpur Research Station by the Imperial Council of Agricultural Research. The expansion of irrigated agriculture resulted in significant increase in productivity of crops, especially that of wheat. The yield of irrigated wheat was considerably higher than unirrigated wheat as evident from the yield data compiled for the early parts of the last century by Paustan (1930) (see Table 2.1). There were no evidences that showed significant impact of agricultural research on crop yields. The link between the research centre

Table 2.1 Average yield of wheat in irrigated and unirrigated crops in Punjab province in British India (pounds/acre)

District		1901	1912	1923
Lahore	Irrigated	752	660	1000
	Unirrigated	382	520	520
Lyallpur	Irrigated	–	1000	1200
	Unirrigated	–	480	500
Multan	Irrigated	960	960	960
	Unirrigated	720	750	600

Source Paustan (1930)

and the peasants were mainly through the large farmers.¹¹ As revealed by Paustan's estimate, the value of output per acre of irrigated land and per capita agricultural output showed substantial improvement. His estimates showed that the value of production per acre of irrigated land in 1926–27 as Rs. 45 and the estimated per capita production as Rs. 20.

Until the annexation of Punjab by the British, land rights were exercised on the basis of leases by the rulers. During the period of Mughal rule in the sixteenth and seventeenth centuries, land revenue was collected by non-hereditary, transferable state officials (the Mansabdari system introduced by Emperor Akbar). After the collapse of Mughal rule in the early eighteenth century, these local officials gained power in several areas and often became de facto hereditary landlords and petty chiefs in their local areas. Later, the British had succeeded in replacing the customary system of land tenure by a more legally based one, in which land rights were defined and recorded through courts. These resulted into creation of private saleable property rights. With recording of titles, land began to achieve a trading value and frequent changes in land ownership took place. According to Paustan's estimate, the value of land per acre in 1869–70 was Rs. 10 and by the year 1919–20 it increased to Rs. 275. He attributed the acquisitive ethos of the Punjab peasant as one of the strongest reason for the increase in land prices. Another study, the structural disparities and irrigation development in Punjab during the British period, by Hirashima (1978) showed that the creation of private property rights on land during the colonial period accompanied by expansion of irrigated agriculture had resulted in the expansion of the land market, with land prices moving at a higher rate than the product prices.

After the land market was established, land prices started to increase. It was found that deflated price of land or land value in real terms increased at a compound rate of 6.43 per cent per annum during 1862–1900 and 4.86 during 1901 to 1928. It was also found that during the period 1891 to 1942, the annual growth rate of gross agricultural product at current prices was 1.34 per cent and land prices 4.92 per cent (Hirashima 1978).

With the development of the land market, peasants began to use their land as equity capital for raising credit from the informal credit market. The rich land owners also acted as intermediaries to the revenue administration in the collection of land revenue from the peasantry. They could retain a part of the revenue collected with them in addition to income from cultivation. This constituted their sources of capital to lend money to the peasants by taking land as the mortgage at exorbitant rates of interest. Thus, along with the prosperity created by irrigated agriculture, and the development of the land market, credit markets began to develop, and the uncontrolled activities of the money lenders resulted in large-scale alienation of land. The British passed the Land Alienation Act in the Punjab in 1901 that pushed the money lenders out of the land market. Wealthy farmers with sufficient initial capital began to invest their surplus in the purchase of land and land

¹¹For an insightful discussion of the impact of Agricultural Research in British India, see Pray (1984). His data suggest that the impact of research on crop yield was small.

prices continued to increase. The outcome of this process was the widening of structural disparities in agriculture, especially the increasing concentration of land. In sum, development of irrigation as a leading input in agriculture had resulted in economic prosperity: but it also contributed to the development of the land and credit markets and widening of the socio-economic disparities.

2.3 Technological Change and Agricultural Growth Since Independence

Partitioning of British India into two independent nations, namely India and Pakistan, resulted in the division of Punjab province. Major part of the canal-irrigated area formed parts of the Pakistan Punjab. Given the immense potential of agricultural development in the Indian Punjab, Government of India, in the first Five Year Plan, gave considerable importance to the development of canal irrigation in the state by investing in the Bhakra Nangal Project with multiple goals of expansion of irrigated area and generation of electricity. The use of other technologies to improve yield levels was largely based on the traditional technology. In the 1950s, the districts of Punjab recorded higher rates of agricultural output growth (Minhas and Vaidyanathan 1965) compared to most other regions in the country. As it is well known that the food crises in the early 1960s forced the policy makers in the country to initiate the new strategy for agricultural development. This strategy was based on the use of high yielding variety of seeds and fertilizers in the districts well-endowed with irrigation facilities. The strategy also contained the provision of cheap credit and assured procurement of output by the state. The state of Punjab immensely benefited from this strategy. There exist a large number of studies that had examined the various dimensions of the green revolution. For the purpose of developing our argument in this paper, we shall draw our insights from this literature.

One of the most significant technological changes in Punjab agriculture since the early spread of green revolution had been in the quality irrigation. The percentage of area under irrigation to the net sown area was about 40 % in the mid-sixties, with canal irrigation accounting for about 60 % and the rest largely with wells and tube wells. However, over the last five decades, the irrigation coverage increased from about 75 % in the early 1970s to nearly 98 % by 2009–10. During this period, much of the expansion in irrigation took place in the development of wells and tube wells (see Table 2.2). This is evident from the sharp fall in the percentage of area irrigated by the canal system and sharp increase in the percentage of area irrigated by wells and tube wells.

In the mid-1960s, about 85 % of the total land area was already brought under cultivation. The expansion of irrigation has contributed to the rapid increase in cropping intensity from about 126 in the early sixties to 140 by seventies and further to 190 by 2009–10 (see Table 2.3). Along with the expansion of the leading

Table 2.2 Percentage of area under irrigation in Punjab

Year	Area irrigated as percentage of net sown area	Source-wise irrigated (percentage of area)			
		Government canals	Tube wells and wells	Others	Total
1960–61	54.00	58.00	41.00	1.00	100.00
1965–66	59.00	57.00	39.00	4.00	100.00
1970–71	71.10	44.53	55.09	0.38	100.00
1980–81	81.00	42.28	57.33	0.38	100.00
1990–91	93.00	42.97	57.12	0.41	100.00
2000–01	95.00	23.82	76.13	0.05	100.00
2008–09	97.20	27.31	72.59	0.10	100.00

Source Calculated from statistical abstract of Punjab, various issues

Table 2.3 Selected indicators of agricultural development in Punjab

Year	Cropping intensity (%)	Proportion of area under HYV (%)		Consumption of NPK (kg/ha)	No. of tractors per 1000 NSA in hectares
		Rice	Wheat		
1965–66	129	5.41 ^a	35.00 ^a	–	0.35
1970–71	140	33.33	69.03	37.51	1.33
1980–81	161	92.64	98.04	112.67	28.36
1990–91	178	94.17	99.97	162.62	68.53
2000–01	187	95.98	100	165.34	102.13
2008–09	190	100	100	223.46	118.01

Source Calculated from statistical abstract of Punjab, various issues

^aFigures for the year 1967–68 are taken from Sidhu (Sidhu and Byerlee 1991)

input, the other components of the technology, namely high yielding varieties, and use of chemical fertilizers also expanded at a rapid rate. The green revolution that took place initially in wheat has been rapidly accompanied by rice in the recent decades. The percentage of area under high yielding varieties of rice and wheat recorded 100 % coverage by 2009–10; the use of chemical fertilizer showed a sixfold increase per acre in the past five decades. The spread of agro-mechanical technology in agriculture began to take place at a rapid rate in the post-green revolution phase. The number of tractors that was roughly about one per 1000 ha of net sown area, in 1970–71, increased to 28 by 1980–81, and further to 68 in 1990–91, and reached a level of more than 100 by 2000–01. Along with tractors, other complimentary equipments, harvesters and threshers also showed a similar trend. It is to be noted that the technological change in Punjab agriculture followed the classical sequence of irrigation technology followed by biochemical technology and subsequently the agro-mechanical technology.

What has been the impact of technological change on the long-term growth of agriculture in the state? To answer this question, it is useful to highlight briefly its

Table 2.4 Trend growth rate of area, yield and production of major crops in Punjab (%)

Period	Wheat	Rice	Maize	Bajra	Barley	Pulses	Oilseeds
<i>Area</i>							
1970–80	2.31	12.37	-3.54	-9.71	-3.42	-1.23	-5.11
1980–90	1.26	5.39	-5.49	-18.86	-8.09	-7.84	-3.08
1990–2000	0.19	2.42	-1.9	-8.81	-3.55	-5.63	-0.97
2000–09	0.42	0.51	-0.91	-2.01	-6.79	-10.15	-3.92
<i>Yield</i>							
1970–80	2.3	5.5	0.21	-0.68	4.94	-0.46	-0.32
1980–90	3	1.28	-1.26	-3.28	5.45	3.61	2.95
1990–2000	2.06	0.08	2.62	-3	2.34	-1.28	0.06
2000–09	-0.28	1.54	2.22	2.05	0.87	2.13	2.4
<i>Production</i>							
1970–80	4.67	18.55	-3.34	-10.32	1.35	-1.68	-5.41
1980–90	4.3	6.74	-6.68	-21.52	-3.08	-4.51	-0.22
1990–2000	2.26	2.5	0.67	-11.55	-1.29	-6.83	-0.92
2000–09	0.14	2.06	1.29	0	-5.98	-8.23	-1.62

Source Calculated from statistical abstract of Punjab, various issues

impact on the growth of output of crops and the component elements. The production of wheat and rice, the crops that benefited largely from the new technology had shown high rates of growth in the 1970s and 1980s (see Table 2.4). However, the rates of growth began to show deceleration in the 1990s, and in the first decade of the present century. Looking at the contribution of changes in area and yield of these crops, it becomes evident that (i) in the case of wheat, its area contribution was significant in the 1970s (since area increased by about 2.3 % per annum); in the subsequent decades, the contribution of area expansion has become insignificant. (ii) As far as rice is concerned, the expansion of area has been significant in the early decades, but it began to decelerate sharply in the last two decades. Coming to the rates of growth in yield levels, it is seen that (i) the productivity of wheat has increased by about 2–3 % in the decades from 1970 to 2000, and in the subsequent decade, it showed a falling trend. (ii) In the case of rice, productivity growth was very high in the 1970s but in the subsequent decades, it has increased but at a much lower rate. The performance of large number of other crops including coarse grains, pulses and oilseeds has been very dismal. The production of these crops has declined. In all these crops, area under cultivation has shown decline overtime. However, yield growth has shown a revival in the last decade.

A much better picture on the emerging pattern of agriculture in the state becomes evident, if we look at the contribution of various crops to the total share of gross cropped area (GCA) (see Table 2.5). Rice and wheat contributed to roughly half of the GCA in the early 1970s, with wheat accounting for 40 %, rice 11 % to GCA. Overtime, the area under these crops increased; they now account for about 77 % of GCA. The contribution of rice has also increased, but that of wheat remained around 41–44 %. From the changes in the share of various crops in GCA, it is

Table 2.5 Percentage share of various crops in gross cropped area in Punjab (%)

Crop share (in percentage) in gross cropped area (GCA)												
Period	Rice	Wheat	Rice and wheat	Bajra	Maize	Barley	Oilseeds	Pulses	Sugarcane	Cotton	Other	GCA
1970-80	10.88	40.45	51.33	2.19	8.39	1.27	4.85	6.32	1.79	8.89	14.98	100
1980-90	22.27	43.38	65.65	0.52	3.97	0.78	2.74	3.08	1.29	9.03	12.92	100
1990-00	28.99	42.7	71.69	0.11	2.26	0.5	2.36	1.28	1.46	8.42	11.92	100
2000-09	33.09	43.77	76.86	0.08	1.97	0.28	1.02	0.51	1.41	6.74	11.15	100

Source Calculated from statistical abstract of Punjab, various issues

evident that there has been a decline in the diversification of agriculture. The state has been concentrating its resources in the production of rice and wheat as high-valued commercial crops. These trends in the cropping pattern can be linked with the scale of production, input subsidies and the policies of the government. The procurement policies of government have remained limited to rice and wheat which has encouraged the farmers to opt for these specific crops. Moreover, high intensity of agricultural mechanization combined with input subsidies such as electricity, water and fertilizers facilitate farmers to have large-scale farming operations where wheat and rice suit the best under present agro-climatic conditions. However, due course of time, productivity of these crops have reached at a plateau (see Table 2.4) due to reasons related to environment and over-mechanization. The declining productivity of these crops has severely affected the overall growth of agricultural sector of the state.

The overall growth of agriculture in the state was high in the 1970s and 80s with a rate of growth of about 4–5 % per annum (see Table 2.6). However, it has decelerated to around 2.6–2.7 % in the subsequent decades. In comparison, industry output has shown some improvement in the rate of growth in the last two decades; the service sector also showed a marginal increase in the growth. The overall growth in NSDP was about 5.3 % for all the decades except in the 1990s, where it had shown a rate of growth of 4.5 %. In terms of the composition of output, the contribution of agriculture (including the allied sectors) to NSDP was 50 % in the early 1970s (see Table 2.7). Though it has shown a decline in the recent decades, compared to the other states and for the country as a whole, the share is still high: about 35 % in 2009–10. The share of manufacturing sector has increased from 13.8 to 43 %. The shift in the sectoral composition of NSDP has been accompanied by

Table 2.6 Trend growth rate of each sector in Punjab, 1970–71 to 2000–10 (%)

Period	Agriculture	Industry	Services	NSDP
1970–71/1979–80	4	6.7	6.9	5.2
1980–81/1989–90	5.1	6.9	4.5	5.3
1990–91/1999–00	2.7	7.1	5.1	4.5
2000–01/2009–10	2.6	8.4	5.9	5.3

Source Calculated from statistical abstract of Punjab, various issues

Table 2.7 Sectoral share of agriculture in net state domestic product in Punjab 1970–80 to 2000–10 (%)

Period	Agriculture	Industry	Services	All
1970–71 to 1979–80	49.9	13.8	36.3	100.0
1980–81 to 1989–90	45.5	15.3	39.2	100.0
1990–91 to 1999–00	42.5	19.6	37.9	100.0
2000–01 to 2009–10	35.0	22.3	42.7	100.0

Source Calculated from EPW Research Foundation, 2009, and CSO, 2010

Note Series are constant at 1999–00 prices

Table 2.8 Percentage distribution of workers in each type of activity in Punjab during 1961–2001 (%)

Years	Cultivators	Agricultural labourers	Agricultural workers	Workers in household industries	Other workers	Total
I	II	III	IV (II + III)	V	VI	VII
1971	42.6	20.1	62.7	3.2	34.2	100
1981	35.9	22.2	58.1	2.6	39.4	100
1991	31.4	23.8	55.2	1.3	43.4	100
2001	23	16.4	39.4	3.4	57.3	100
2011	22.62	16.32	38.94	3.65	57.39	100

Source Census of India, various years

shifts in the distribution of workers across different sectors (see Table 2.8). The percentage of cultivators declined from 42.6 % in 1971 to 23 % by 2001 and maintained the same level by 2011. The share of workers in the household industry was very negligible in the state, and the share of “other workers” increased from 34 % in 1971 to 57 % by 2011, with the significant increase taking place between 1981 and 2011. Such transfer of population from agriculture to non-agriculture has taken place due to a variety of factors; the most significant among such factors has been the overcapitalization of agriculture that resulted in decline in the viability of small and marginal farms and shift of farmers to the non-farm sectors for their employment and livelihood. The mechanization of agriculture has resulted in decline in labour use per unit of cultivated area and reduction in the employment prospects in agriculture. Consequently, it appears that the younger generation is moving away from agriculture labour to the other sectors. The agricultural induced non-farm sector growth has provided opportunities for labour from the farm sector to gradually shift from agriculture to the non-agricultural sectors. However, the question being debated is whether such shifts have resulted in improvement in their levels of living. As we argue in the next section, this process has implications for institutional transformation in the agricultural sector.

2.4 Institutional Changes and Agricultural Growth

Technological changes in agriculture and its impact on agricultural growth and development has induced a number of changes in the property rights relating to the ownership and access to land and other natural resources in the state. In this context, analysis of the data from various rounds of the National Sample Survey showed the following trends. (i) There has been a gradual increase in the percentage of households owning land in the marginal size class of holding. This has taken place due to the downward mobility of households from the higher size categories. The share of owned land of the small and marginal size groups has shown gradual increase overtime. Obviously, the increase in the share of these categories has been

due to the decline in the share of the higher size groups. However, it is not possible to see uniform pattern in the higher size groups. Interestingly, since 1990–91, the semi-medium and medium size class showed a fall in their percentage share, but that of the larger size group showed an increase from 12.2 to 15.3 % (see Table 2.9). (ii) A comparison of the trends and patterns in the distribution of ownership and operational holdings showed the higher size groups, as the gainers from the distributional changes. It occurred largely through the operation of the land lease market (see Tables 2.9 and 2.10). (iii) The fact becomes evident from a look at the percentage of holdings leasing in land by size groups holdings (see Table 2.11 for details).

The fact that the changes taking place in the land market has been favourable to the higher size groups of holdings is also evident from the directional changes in the index of land concentration as well as the percentage share of various household size groups in both owned and operated area. The Gini coefficient of land

Table 2.9 Percentage distribution of households and area owned by size class in Punjab, 1971–72 to 2002–03 (%)

Size class of ownership holding ¹	Percentage of households				Percentage of area owned			
	1971–72	1981–82	1992–93	2002–03	1971–72	1981–82	1991–92	2002–03
Marginal (0.002 to ≤1.000 ha)	67.5	66.8	69.6	76.3	4.4	5.5	7.1	9.1
Small (1.001–2.000 ha)	8.3	10.0	9.9	9.5	8.8	10.7	12.3	15.6
Semi-medium (2.001–4.000 ha)	12.7	11.6	12.2	7.9	25.0	22.8	30.2	25.3
Medium (4.001–10.000 ha)	9.1	9.9	7.1	5.1	37.9	42.2	38.0	34.5
Large (>10.01 ha)	2.2	1.4	1.0	1.0	23.6	18.5	12.2	15.3
All classes (ha)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source NSSO 59th round, household ownership holdings in India, report No. 491

Note ha indicates hectares

¹The size classification of land holdings has been adopted from National Sample Survey Organization (NSSO). NSS report No. 492, some aspects of operational land holdings in India, 2002–03, Chap. 3, can be referred for further details

Table 2.10 Percentage distribution of operational holdings and area operated by size categories of operational holdings in Punjab 1971–72 to 2002–03 (%)

Operational holding	Percentage of holdings				Percentage of area operated			
	1971–72	1981–82	1992–93	2002–03	1971–72	1981–82	1991–92	2002–03
Marginal (≤1.000 ha)	11.7	59.0	63.2	66.3	1.5	3.9	6.2	7.3
Small (1.001–2.000 ha)	19.1	10.4	11.4	11.2	7.1	8.9	10.7	11.7
Semi-medium (2.001–4.000 ha)	32.7	14.0	13.9	12.9	24.3	21.8	26.7	26.2
medium (4.001–10.000 ha)	30.5	14.2	9.8	7.8	45.1	45.9	40.6	36.4
Large (>10.000 ha)	6.0	2.5	1.7	1.9	22.1	19.6	15.8	18.5
All classes	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source NSSO, 59th round, some aspects of operational land holdings in India, report no. 492

Table 2.11 Percentage distribution of operated area by type of possession for each size class of operational holding in Punjab for 2002–03 (%)

Operational holdings	Owned	Leased-in	Others	All
Marginal (≤ 1.000 ha)	95.38	3.79	0.83	100.00
Small (1.001–2.000 ha)	89.92	10.08	0.00	100.00
Semi-medium (2.001–4.000 ha)	81.14	18.87	0.00	100.00
Medium (4.001–10.000 ha)	80.17	19.83	0.00	100.00
Large (> 10.000 ha)	85.44	14.56	0.00	100.00
All classes	83.16	16.83	0.01	100.00

Source NSSO 59th round, some aspects of operational land holdings in India, report No. 492
Note

1. Calculated only for kharif season

2. Includes the categories otherwise possessed and operated but not possessed on the date of survey

Table 2.12 Distribution of owned and operated area by household size groups 1961–62 and 2002–03

Household size groups	Distribution of owned area		Distribution of operated area	
	1961–62	2002–03	1961–62	2002–03
Bottom 60 %	6.1	2	23.5	4.9
Middle 30 %	43.4	36.7	43	40.6
Top 10 %	50.5	61.3	33.5	54.5

Source Nair and Banerjee (2011)

ownership for Punjab was estimated 0.717 for 1961–62 and it increased to 0.800 for 2002–03 (Nair and Banerjee 2011). The change becomes more evident from the distribution of owned and operated area by household groups for 1961–62 and 2002–03 (see Table 2.12). This land concentration has taken place in spite of the fact that the state had done legislation on the tenancy act and introduced ceiling on land holdings.

The changes in the direction of land concentration will have to be seen in the larger background of the nature and direction of technological change. To be more specific, the following relationship and process needs to be taken into account in explaining this; firstly, the changes in the composition of irrigation and its technological base. As we noted earlier, the dominance of canal irrigation has been significantly reduced in recent decades as a result of rapid increase in wells and tube wells that required considerable own farm investment. Since well- and tube well-irrigated lands are more productive than canal-irrigated area, there has been faster adoption of this technology. The density of well irrigation began to increase rapidly resulting in decline in the water table leading to further investment in the deepening of well. The capacity created in well irrigation required a minimum size of holding to make it viable. From this perspective those who have excess capacity, leasing in land from others or selling water had become an option. On the other

hand, those without access to well irrigation, leasing out their land had become another option to be followed. The outcome of these processes has been the increase in the land lease market and also the development of the water market. Secondly, a similar process seems to have taken place in the other components of the agro-mechanical equipments, namely tractors, harvesters and threshers. In the early phase of green revolution, the intensity of labour use per unit of cultivated area has increased, and in the absence of local labour, large-scale in-migration of labour from other states began to occur. The scarcity of local labour began to increase with shift of labour from farm to non-farm sectors. The rapid diffusion of agro-mechanical technology in the post-green revolution period has contributed to the saving of labour in ploughing, land preparation, sowing, transplanting, harvesting, thrashing, and transportation. As demonstrated by the data from the cost of cultivation studies, the expansion of farm mechanization has resulted in the decline in labour use per unit of cultivated area. Since, the density of machinery and equipments has increased overtime, those with excess capacity in relation to their owned area began to rent out their machinery and equipments or lease in land to make use of the economies of scale. Conversely, those who could not afford this, it was possible to hire the equipments or lease out their land. Development of a rental market for machinery and equipments and further development of the lease market has been the outcome of this process. The intensification and expansion of cultivation has also changed the traditional property rights relating to the grazing rights for landless and marginal farmers who own livestock. Since, there are standing crops in the fields for most parts of the year; grazing of animals after the harvest season has become highly restricted.¹² However, the sharp reduction in the work animal stock as a result of mechanization has contributed to the prospects for raising more animals for milk production. The development and expansion of dairy cooperatives, and marketing and processing of milk have induced farmers to take dairying as a source of employment and income.

The institutional changes noted above in response to the technological changes needs to be viewed in the context of the changes in the commercialization of input and output markets. The government control over input and output prices of wheat and rice promoted a certain degree of specialization in production with various institutional linkages (both public as well as private). These institutions facilitated the commercialization of agriculture during the early years of green revolution (Ladejinsky 1969; Ghosh 1979). The farmers started selling a major part of their output in the market. Not only the product market got commercialized, they also started participating in the input markets on regular basis due to considerable increase in the use of inputs like high yielding varieties of seeds, chemical fertilizers, and mechanized tools such as pumping sets, electric motors, threshers, tractors and harvest combines (Bhalla et al. 1990; Satish 2006; Sidhu and Byerlee

¹²According to a recent survey on the practice of keeping livestock in India, the percentage of households sending their animals for grazing is negligible in the states of Punjab and Haryana. However, in the neighbouring states of Rajasthan and Uttar Pradesh, the practice is still widespread. See DRS (2013) for details.

1991). In this way, the prices (both input and output) became the direct concern for the farmers. To boost the benefits of green revolution and to encourage the farmers, substantial resources were transferred to Punjab for infrastructural investment and agricultural subsidies. However, credit supplied by formal institutional agencies (commercial banks and cooperatives) were not sufficient to meet the increasing need of credit (both short and long terms). Since the new inputs were purchased with cash, the farmers of Punjab had to invariably invest a substantial amount of cash in every crop (Gill 1996; Jodhka 2006). Given that their own resources were limited, they invariably had to borrow, either directly from the informal credit market, or via commission agents through whom they sold their marketed surplus. Subsequently, the existence of Arhtias (money lenders) became very crucial since they fulfilled the gap in availability of credit from institutional sources and the total demand for credit in the rural Punjab. Historically there has been slow expansion of banking system in the rural areas of Punjab. The slow penetration of bank branches in the agrarian society has led to low level of availability of institutional finance and to high dependency on money lenders (Gill 2004). The role of money lenders were not confined to the credit market alone but to various other input and product markets. The above arguments are evident from the data available from the All India Rural Debt and Investment Surveys. The latest round of published data for 2002–03 showed that more than 2/3rd of the borrowings by farmers were for meeting these production credit needs and purchase of farm assets (see Table 2.13). The data also show that in spite of the progress made in the expansion of formal credit institutions, more than 60 % of the outstanding debt by farmers was to the money lenders (see Table 2.14). Available data also showed that the situation remained without much change over a long period. In order to bring out the role of money lenders and commission agents in the credit market, it would be useful to elaborate more on this. As we noted, the private ownership of land was established in Punjab during the British period (Hirashima 1996). It was not the farmers who judged the value of the land but the money lenders. They played their big role in setting up the land market. Through the process of accounting of both input and output markets, they managed to value the price and rent of lands (Hirashima 2000). Up to the time when the famous Punjab Land Alienation Act of 1900 was enforced, it was the money lenders who participated in land market transactions. The money lenders realized that the land transactions were more profitable than traditional money lending and grain marketing. Therefore, the formalization of land markets started after the intervention of money lenders into the market. The rising land ceiling had also given the signal to large farmers and the professional money lenders to acquire more land. It was the small and marginal farmers and landless labourers in villages who did not participate in the land market (Hirashima 2008). However, inflation of land prices seemed to be benefiting the small chronically deficit farmers, as they sold their smaller area to repay their debts (Shergill 1986).

The land lease market emerged formally after green revolution. The heavy indebtedness of small and marginal farmers forced them to leave agriculture and lease out their lands to the large farmers. The phenomenon of “reverse tenancy” seemed to occur when the small farmers left agriculture and joined the ranks of

Table 2.13 Percentage distribution of outstanding loans by purpose of loan for each size class of land possessed of farmer household in Punjab in 2003 (%)

Size class of possessed holding	Capital exp. in farm business	Current exp. in farm business	Non-farm business	Consumption exp.	Ceremonies	Edu.	Medical	Other exp.	All	Percentage of indebtedted HHS
Marginal	13.3	7.0	7.9	20.9	21.5	0.1	8.8	20.5	100	56.7
Small	12.0	49.6	10.1	12.0	7.6	0.3	0.0	8.4	100	75.8
Semi-medium	28.9	49.1	4.9	1.6	6.3	0.0	1.2	8.1	100	82.7
Medium	33.4	38.6	0.7	9.6	10.9	0.0	2.9	4.0	100	83.6
Large	27.5	30.4	0.0	3.9	4.0	0.0	0.0	34.2	100	83.9
All classes	26.4	36.0	4.4	8.5	10.2	0.0	2.6	12.0	100	65.4

Source NSSO 59th round, indebtedness of farmer households, report no. 498

Table 2.14 Percentage distribution of outstanding loans of farmers' households by source of loan in Punjab in 2003 and 1971 (%)

Sources of debt/years	1971 ¹	2003 ²
1. Government	6.9	1.9
2. Cooperative society	32.0	17.6
3. Commercial bank	4.9	28.4
Institutional credit (1+2+3)	43.8	47.9
4. Agricultural/professional money lenders/landlord	25.1	36.3
5. Traders	12.3	8.2
6. Relatives and friends	14.8	6.3
7. Others	3.0	1.13
Non-institutional credit (4+5+6+7)	56.2	52.1
All	100.0	100.0

Source(s)

¹Adopted from Satish (2006)

²NSSO 59th round, indebtedness of farmer households, report no. 498

proletariat (Gill 1989; Singh and Grewal 2001; Vyas 1994). Tenancy at will was very prominent during the land reforms in Punjab due to the labour-intensive techniques in agriculture. When the tenancy reforms happened in the state, the official data showed a sharp decline in the incidence of tenancy. However, in reality magnitude of tenancy did not change much. It was after the inception of green revolution that the self-cultivation experienced a sudden increase due to the labour-saving techniques in agriculture, and thus, the decline of actual tenancy was witnessed (Singh 1989). This is how the technological changes have altered the land institution in Punjab since green revolution.

Further, impact of technological diffusion in the state has been seen through the inception of informal channels of commercialization. The moneylenders are playing their roles in a much bigger way than they did in the past. The phenomenon of multiple roles of the moneylender was first introduced by Malcolm Darling in his classic work *The Punjab peasant in prosperity and debt* in 1925 (Darling 1928). A money lender may be a landlord who finances his tenants and workers engaged on land; he may be a trader who finances the cultivator only to obtain exclusive rights to purchase his crop; or he may be an input dealer who lent money on the condition that inputs for cultivation must be purchased only from him (Gill 1996). A number of empirical studies have established the existence of interlinked contracts. A variety of interlinkages including those in land, labour, inputs and output markets in which credit is the central part can be found. Interlinked credit contracts were used as a mechanism to alleviate screening, incentive and enforcement problems (Gill 2004). In this way, the commission agents had displayed a greater foresight in the credit market than the formal institutional sources, by not insisting on land as collateral. Exorbitant rates of interest were charged and the cultivators were forced to pay it, because institutional credit was just not in adequate supply.

However to support the farmers, various policy measures of each successive government were directed towards the promotion of their interests (Jodhka 2006). This led to the diversion of public investment and subsidized inputs from urban to rural areas; this included provision of essential inputs such as water and power at highly subsidized rates; stabilization of agricultural prices; availability of cheap credit, availability of subsidized agricultural inputs such as fertilizers and insecticides. Therefore, dependency of farmers on government increased over time.

With due course of time, peasantry became the central question of the political interest. Dominant leadership of Akali Dal came out of capitalist farmers (Puri 1983). During the late 1960s to late 1980s, the Akali Dal expanded its base among the peasantry. Its mobilization capacity is also based on the peasantry. With the modernization of agriculture, expansion of education and with experience to rule Akali party produced a mature leadership from the upper layers of peasantry (Singh 1984). Various political parties of the states had supported the farmers' lobby and demanded the special provisions to entire state and farmers in particular (Gill and Singhal 1984). The demand of special provisions first came out from the Anandpur sahib Resolution that clearly demanded the economic advantages for the peasantry. These demands were for raising the level for land ceiling, cheap inputs and abolition of excise duty on tractors, and remunerative agricultural prices. Such demands basically served more the capitalist farmers (Corsi 2006). The development in recent past showed that the technological changes had not only altered the institutions concerning land but also the political agenda of the state. The present-day political situation proves the nexus of political powers with landlords and commission agents. The small farmers are either operating on the mercy of commission agents or in the process of leasing out land to the large farmers.

2.5 Technology and Institutions: Wider Implications

In the preceding sections, we have made an attempt to provide an overview of the evolution of technology and institutions in Punjab. Linking the developments since the green revolution with its historical roots prior to independence provides interesting insights, it is seen that agricultural developments in both the periods, while bringing prosperity has resulted in institutional changes in the land market, and its functioning was mediated by the interlinked markets. The interlinked markets did result in the accumulation of surplus in the hands of large farmers, who ploughed it back into money-lending activities, and in trade and commerce that further reinforced their economic dominance. Though all the sections of the peasantry could participate in the process of technology-driven agricultural development, given the scale bias of the technologies, the large size groups of holdings could realize higher productivity and returns from investment. The marginal and small farmers whose profit margins were squeezed by various intermediaries in the interlinked market appear to be moving out of crop production into other non-agricultural activities, by either leasing out or selling their land to the higher size groups of holdings. It is to

be noted that the growth process in agriculture resulted in significant increase in income levels of the population and contributed to rapid reduction in the incidence of poverty.¹³

It is also useful to highlight briefly the changing role of the state (both at the centre and the state of Punjab) in creating an enabling policy environment for the rapid promotion of agricultural development in the state of Punjab. Coming to the role of the Government of Punjab, the following policy interventions formed part of the framework for stimulating the growth process (1) the consolidation of land holding, creation of infrastructure for transport, power, irrigation, development of market towns (2) investment of agricultural research and extension service and (3) provision of input subsidies of various types like, almost free canal irrigation and electricity for irrigation pumps; for the rapid diffusion and adoption of technology. Though, agriculture is a state subject, the role of the central government has been equally or more important in deciding the direction of changes in the agriculture of Punjab. A few points worth mentioning in this context were as follows: (1) the investment in the creation of irrigation and power projects (2) provision of input subsidies (especially for chemical fertilizer) and (3) procurement of the surplus grains produced in the state at minimum support price and moving it to the grain-deficit regions in the country for the public distribution system. Questions have been raised often regarding the effectiveness of the procurement policy in providing remunerative prices to the farmers. Enough has been written on this subject by experts, but it is sufficient to note that production has been increasing even when the profit margins were squeezed with rising input costs. (4) Economic liberalization initiated from the early 1990s followed by India signing the WTO agreement in 2000, provided both opportunities and threats for Punjab's agriculture. The domestic liberalization has resulted in the removal of trade barriers within India and the free movement of grains contributing to the rapid development of interstate grain trade. In the post-WTO period, the scope for export of rice and wheat to the world market has improved with more access to the importing countries. Since the cost of production is high in India as compared to many other exporting countries, the exporting surplus grain to the world market required subsidy from the central government. However, it required keeping domestic subsidies to less than 10 % of the agricultural GDP. Indian domestic market has been given market access to other exporting countries. With the integration to the world market, Indian domestic prices have become sensitive to the movement of food grain prices in the international market.

From a historical perspective, one could see that as agricultural growth and development expanded, older institutions have undergone change, and number of new institutions have evolved endogenously or introduced exogenously. Such a process has evolved not only in the state of Punjab, but also in the neighbouring

¹³There exist a large number of studies that examined the impact of agricultural growth on the reduction of rural poverty. An interesting study covering the experiences of selected state in the country is by Jones and Sen (2003).

state of Haryana and other regions of the country that witnessed technology-driven agricultural growth. The allocation of resources, and its utilization in the production process, and efficiency of production, has been shaped not only by the interaction between technology and institutions, but also among the institutions and institutional arrangements. The deceleration in the productivity growth of food grains, or falling factor productivity in agriculture, or degradation of the natural resource base witnessed is a product of these interactions. Reversing these trends is no more a development challenge that could be resolved by the state alone: many of the key decisions affecting the performance of agriculture has been taken by the national government, and therefore, realizing the goal of sustaining the agricultural growth process would require a collaborative effort between the national government and the state governments. How to realize this in a centre–state federal framework is a major challenge.

At the analytical level, it is interesting to comment on the viewpoints and theories we have drawn attention in the introductory section of this paper. The experience of Punjab is a definite pointer to the role of historical forces in shaping agricultural growth in the post-independent period at the regional level. The initial property right regime on land created by the British, and the investment in the expansion and modernization of canal irrigation combined with investment in railways contributed to the development of agriculture in the Punjab. The peasants got exposure to the management of irrigated agriculture with the technologies prevalent. The outcome that emerged was exploitative since there had been siphoning of the peasant's income by the money lenders and commission agents. The agricultural development since independence in the state of Punjab continues to persist with some of the institutions and institutional arrangements inherited from the past. On the positive side, the institutional setting that existed in the state before independence facilitated the peasantry to absorb the new technology in agriculture. The environmental conditions in Punjab with adequate supply of water could result in realizing higher levels of agricultural productivity.

The deceleration in the growth of agriculture in recent decades calls for further explanations at the analytical level. The quality of institutions that has emerged overtime could be one of the important factors to be taken into account in explaining the emerging situation of Punjab agriculture. Recent theoretical developments on institutions and economic performance argued that, where the institutions are grabber friendly it would pull down growth performance and where they are producer friendly, it would sustain growth (Mahlum et al. 2006). If we go by this argument, it would appear that the deceleration in productivity and output growth could be due to the decline in the quality of agrarian institutions that has emerged over time. The most striking aspects in this context are as follows: (i) the interlinked markets and (ii) institutions that are meant to regulate the use of natural resources. As we argued in the previous section, the interlinked markets have been working to the advantage of the large farmers, commission agents and money lenders and they could grab a good part of the income generated by the peasantry. So long as, the formal credit system do not succeed in reaching out to the credit requirements of the farmers and the state do not succeed in reforming the product

and input markets, the dominance of the money lenders and commission agents would continue to prevail. Reforming these institutions is essentially a political process in which political leadership would be in a position to construct coalition that gives legitimacy in policy making (Grabowski 2012). In a state like Punjab, where political coalitions derive their sources of strength from large farmers, money lenders and commission agents, political coalitions would always weigh their short-term political gain or loss to the long-term development needs of the state. If the political benefits flowing out of the development needs outweigh the short-term political loss, then ruling coalitions may incorporate in their development agenda “the development needs of the agricultural sector”. However, this would occur only if there exists an accumulated technological backlog for accelerating the growth in productivity. Unfortunately, the accumulated technological backlog for increasing productivity at the quickest possible time on a mass scale needs to be perfected for widespread diffusion and adoption which calls for well-informed decision-making by the national government.

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