

AGRICULTURAL SCIENCE AND TECHNOLOGY IN THE PUNJAB  
IN THE NINETEENTH CENTURY

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During the nineteenth century, as in other known periods of history, agriculture was the premier industry of the Punjab not only in terms of production and employment but also in terms of income and progress achieved. The fertile and for the most part uniformly sloped land of the Punjab combined with its other physical and ethnological features, e.g. river systems, rainfall, depth of water-table below the surface, and its industrious and frugal peasantry, etc., represented the wealth of the province on which depended the welfare of the people and the prosperity of the government alike. The development of agriculture and its concomitant, irrigation, was, therefore, one of the major concerns of the governments who ruled the land of the five rivers in the period under review.<sup>1</sup>

In the beginning of our period the territory between the Satluj and the Indus and even beyond was under the Kingdom of Lahore and that between the Satluj and the Jamna was under the British Paramountcy and largely ruled by the petty native chiefs. Ranjit Singh died in 1839 and his kingdom fell to the British in 1849. Thus by the middle of the nineteenth century the entire Punjab plains from the Jamna to the Indus had come under the British rule.

At the outset this country presented every variety of cultivation from the most luxuriant to the most sandy deserts and the wildest prairies of grass and brushwood. The high standard of cultivation prevailed in the region along the submontane tracts. This belt formed the northern portion of the country and was from 50 to 80 miles wide. Here the rainfall was high, water was near the surface and a large number of wells were at work. The river valleys were the only other thickly cultivated areas. Outside these belts cultivation was very rare. The uplands between the rivers were vast areas of waste lands having fertile soil which could become very valuable on the availability of water. These uplands were inhabited by the nomad pastoral tribes. They occasionally cultivated land also but the extent of their cultivation depended on the amount of rainfall in a given year.<sup>2</sup>

The study of agriculture in the Punjab in the nineteenth century is very useful because this was a period of transition from the medieval to the modern period of Indian history. The Kingdom of Lahore in the early nineteenth century ushered in an era of comparative peace and order and thus stimulated extension of agriculture. But the latter half of the century manifested a revolutionary change when the size of cultivation in the Punjab, both intensively and extensively, increased enormously. The total cultivated area increased from 21 million acres in 1868 to 28·11 million acres in 1901.<sup>3</sup> It was the cumulative result of the introduction of various scientific and technological innovations contributing, directly or indirectly, to the development of agriculture. The major among these were the changes in the modes of irrigation, varieties of crops, implements, techniques of cultivation, live-stock breeding and the steps to check the devastation of land by *chos* and water-logging, etc. This paper, therefore, is an inquiry into the nature and scope of these developments with the study of the representative facets and illustrative cases based on the critical analysis of the British Government sources and non-government works on the subject.

In the first half of the nineteenth century the rapid political change and continual warfare were unfavourable for the rapid advancement of agricultural science and technology.<sup>4</sup> In the Punjab the Lahore Darbar and the East India Company were busy in the extension of their respective empires. As a result more stress was given on the expansion of the traditional modes of cultivation and irrigation and comparatively little was done for the introduction of new scientific innovations.

Ranjit Singh, however, was the first ruler in the Punjab who thought of large scale utilisation of canal water for the irrigation of the crops.<sup>5</sup> Both the perennial and inundation canals were excavated and expanded in the early nineteenth century. The territory commanded by the Lahore Kingdom had more extensive irrigation system than that of the East India Company. The petty chieftains due to their limited resources rarely undertook such measures at a high level. Under the Kingdom of Lahore inundation canals were excavated particularly in the south-west, in Multan and Derajat, both by the State and the private individuals with the help of the State. They took their supply from the Satluj, Chenab and Indus rivers.<sup>6</sup>

In the Multan series there were 23 canals of a total length of 619 miles excavated from the Satluj and Chenab rivers.<sup>6a</sup> These canals in construction were of very primitive type. They had no headworks, head regulators, distributaries and uniformity of depth and breadth. The water freely entered into them in an uncontrolled volume. They worked only for a few months in the summer season when the water level in the rivers was quite high to enter into them. The bed of these canals and water level in them were below the level of the adjoining lands. The water for irrigation purposes was used not by overflow but by lift either by constructing a well on the canal bank called *jhallār* or by cutting a ditch channel from the canal up to the field and then to lift the water by human labour.<sup>7</sup> This apparatus was very laborious and involved a lot of work but was slightly better than the irrigation by wells. Instead of irrigating tablelands (*bār*) between the rivers, where the irrigation was badly needed, they

irrigated the low lying riverain lands (*bet*) along the river channel. Moreover, irrigation was confined to the small belts along the course of the canal hardly exceeding one mile on each bank.

The two perennial canals in the Punjab were the Hasli Canal and the Western Jamna Canal. Both of these were expanded on traditional lines. They had unbricked headworks and then lineages were not very effective. The imperfect and bad alignment of Western Jamna Canal led to swamps and water-logging in Karnal, Rohtak and Delhi districts.<sup>8</sup> The case study of the Hasli Canal illustrates the standard of canals in the Punjab. The headworks of the Hasli were on a branch of the river Ravi a mile above Madhopur. The entire water of the branch was directed into the canal by a strong dam of gabion-work and boulders constructed across its 610 feet long bed. This dam being from its very nature and position, exposed to damage from floods, had to be renewed every season at a large expense.<sup>9</sup> Owing to the total absence of the means for regulating the quantity of water admitted at the head so long as the dam remained sound the entire discharge of river's branch passed into the canal. The bank of the canal being extremely narrow and surface of the water much above the natural level of the ground the water inundated the canal and fell rapidly into the river.<sup>10</sup> Hasli followed a natural line of drainage in the country with a tortuous and uncertain course of 110 miles. In width it varied from fifty to fifteen feet and in depth from seven to two feet. It crossed the streams running down from the hills above Pathankot by means of dams made of boulders and cuts liable to damage from every flood and requiring yearly renewal. It received the tribute of natural drainage on its way. Where the country was very low the bed of the canal was very high and it often led to water-logging and frequent breaches in the canal. Its volume at the time of annexation was 200 cubic feet per second and it benefitted a few villages between Madhopur and Dinanagar, irrigating only 18,787 acres. It was estimated by the early British engineers that the remodelling of the canal was going to be costlier than its fresh construction.<sup>11</sup>

In the early nineteenth century efforts were made towards the betterment and extension of cultivation little by way of new appliances and much by the establishment of model farms and bringing waste lands under cultivation. The persons bringing waste lands under cultivation were charged revenues at concessional rates and in most cases also acquired proprietary rights in the lands thus cultivated. Under the Lahore Darbar the *chaudharies* and *muqaddams* were given revenue-free lands either directly by the State or through *zamindars* of the villages for the purposes of extending cultivation and also to set an example of model cultivation to be followed by others.<sup>12</sup> Loans for the construction of wells were given to the poor peasants to make the cultivation of more valuable crops possible. Husbandman was encouraged in every possible way to become a good cultivator. By this scheme many tracts such as the Doaba, Riarki and Darap were brought under intensive cultivation.<sup>13</sup> In the south-western districts, Diwan Sawan Mal encouraged the outsiders and capitalists to sink wells on leases to bring waste lands under cultivation.<sup>14</sup>

In the region protected by the British the cultivation was extended also by the measures resorted to by the Lahore Darbar. For example, the tract around Sirsa which had almost become a waste after the terrible famine of 1783, number of villages rose from 35 in 1800 to 431 in 1850, and 35 per cent of the total area was brought under cultivation.<sup>15</sup> As the Commissioner of the Jullundur Doab (1846-49) John Lawrence encouraged the construction of wells and other agricultural improvements in several ways.<sup>16</sup> It appears that during the early nineteenth century both in the Lahore Kingdom and the British territory the Persian wheels gradually gained a wider currency.<sup>17</sup>

Considerable efforts were made to improve the live-stock in the province. Ranjit Singh maintained a number of good drought stud bulls in different *thānās*. Cattle fairs were held in different localities for encouraging cattle breed amongst the cultivators.<sup>18</sup> The pioneering work in this field, however, was done by the British when Major Livingstone established a Cattle Farm in Hissar in 1813. Its objects were two-fold: first to breed bullocks of superior size and quality for ordinance purposes and secondly to provide and distribute high class bulls for breeding purposes. Cross-breeding between cows of the Harianah breed and other kinds of good bulls was practised. They produced powerful drought resisting cattle. The pure breed of cattle maintained here were Gujrat, Ungole, Nagore and Mysore. There was a constant demand for Hissar bulls for breeding purposes which indicated their excellence.<sup>19</sup>

With the annexation of the Kingdom of Lahore by the British in March, 1849 the whole of the Punjab came under one sovereignty. A new phase, now, began both in the agricultural developments and the socio-economic history of this region. Scientific and technological innovations of the West were introduced and had a free play in the Punjab. Irrigation works of great magnitude with permanent head-works, head regulators, well defined courses and extensive systems of distributaries were constructed. These were Upper Bari Doab Canal, remodelled Western Jamna Canal, Sirhind Canal and Lower Chenab Canal. These canals brought the extensive arid but fertile waste uplands between the Jamna and the Jhelam under cultivation and turned their semi-desert appearance into the fields covered with green crops. The development of this great irrigation system was one of the most novel and gratifying changes under the British rule. It not only filled up immense blanks upon the map of India but also provided sustenance and livelihood to the millions of people. The most important among these, the Lower Chenab Canal, became one of the biggest canal systems in the world and marked a great landmark in the economic history of India in general and the Punjab in particular. In the closing decade of the nineteenth century it laid the foundation of the famous Chenab Colony. This colony opened the doors of the great Punjab canal colonies which were perhaps the crowning achievement of the British in the Punjab.<sup>20</sup>

An assessment of the advancement made is the science of irrigation in the Punjab in the late nineteenth century is illustrated by the study of various developments involved in the construction of the Upper Bari Doab Canal which superseded the

old Halsi Canal. At first the whole volume of water from river Ravi as in other rivers available for irrigation was estimated.<sup>21</sup> The British formed a good idea of the slope of the country and also of the necessity of making artificial falls or rapids. While preparing such schemes attention was given both to the less of expenditure and more of benefits.<sup>22</sup> The headworks of the Bari Doab Canal were built at such a point that the high bank of the Ravi was used to check the immediate heavy fall in the upper part of the canal and thus artificial rapids were avoided. The minimum discharge of the Ravi being calculated to be 2,752 cubic feet per second, the regulator at the head was constructed to admit into the canal a supply of 3,000 cubic feet per second. Of this 1,000 cubic feet, were subtracted for Kasur and Sabraon Branches, 500 cubic feet for the Lahore Branch and 1,500 cubic feet for the Main Branch Lower. All these branches and distributaries had a uniformity of breadth and depth and decreased with a decrease in the amount of water. For purposes of irrigating the whole of the Majha tract its natural drainage lines, i.e. Patti, Kasur, Hudiara and Kiran (Sakki) Nalas, which divided the space between the Beas and the Ravi into five minor *doabs* were duly considered. The four *doabs* between the river Beas and the Kiran Nala were provided irrigation by Sabraon, Kasur, Main Branch Lower and Lahore Branch from Beas to Ravi respectively. These branches departed from the main canal before the actual beginning of the natural drainage lines.

Further, to spread the water over the *doab* under this scheme, to counteract the slope of the country, to command the collected volume of water and distribute it in a manageable way one masonry dam, four stop-dams, forty-six overfalls, four regulating bridges and five escape outlets were constructed. Besides these there were 142 bridges on this canal system. The course of the natural torrents like Jinah and Chakki was diverted by artificial means and the passing of their water across the canal was avoided. Trees in rows were planted on the canals. In the 1860s the Bari Doab Canal was the second greatest canal in India and was equal if not superior to the finest irrigation canals of Europe.<sup>23</sup> The improvement and extension of the canals continued after its first construction. For example, in 1897-98 on the Main Branch Upper of the Upper Bari Doab Canal the Tibri Regulator was fitted with steel gates and lifting gear. Survey of a new distributary on the Main Branch Lower were completed.<sup>24</sup>

A great advancement, similarly, was made in the construction and expansion of inundation canals. In 1853-54, Lieutenant Medley and Lieutenant Anderson of the Bengal Engineers surveyed the Derajat and Multan Canals to make more profitable use of their water for irrigation. They did a valuable work for the maintenance, management and improvement of these canals.<sup>25</sup> In the 1860s, both the *zamindars* and the government excavated and expanded a large number of canals to irrigate waste lands in the Dera Ghazi Khan district.<sup>26</sup> Between 1875 and 1897 fourteen canals called Grey canals were excavated in the Ferozepur district. These canals irrigated about four lakhs of acres.<sup>27</sup> In the year 1897-98 improvements were made on the Indus, Lower Satluj and Chenab series. In the Indus series, these, for instance,

consisted of the diversions of Kasturi and Chibri Canals, an alternative head for Mussuwah Canal and extension of Kot Daud, Sahiban and Khosawala *bunds*.<sup>28</sup> Moreover, the main Sarusti Canal was opened in 1896 and its Kaithal Branch in 1899.<sup>29</sup>

Another noteworthy development was the measures taken to check the increasing devastation of land by *chos* and water-logging. During the second half of the nineteenth century, the destructive hill torrents caused immense harm in the districts of Ambala, Hoshiarpur and Jullundur by way of soil erosion. In the early nineteenth century lands along the Shiwalik hills were covered with brushwood of spontaneous growth which served as a check on the destructive activities of the *chos*. With the advent of the British rule this natural flora was swept away to bring these lands under cultivation. As a result the hill torrents with their rapid flow of water and unfertile sand started the destruction of lands in the nearby districts. The government in 1876 took first steps to check the damage by *chos* in Hoshiarpur.<sup>30</sup> Two Acts were passed in 1890 and 1900 which gave large powers to the government for the protection of trees in the Shiwaliks and the reclamation of torrent beds in the plains.<sup>31</sup> People themselves made efforts to deal with this problem. In 1891, some landowners of village Panjwar in Hoshiarpur district organised a society on co-operative basis to save their lands from hill torrents.<sup>32</sup> An experiment was made with the plantation of Bindpula grass in the submontane areas of Ambala district. It served the purpose of stop-dams, checked fast flow of water and free access of unfertile sand into the plains. In this way it saved large tracts of land from erosion and danger of becoming the unfertile soil.<sup>33</sup>

The excessive canal irrigation or wrong alignment of canals, moreover, created the problem of water-logging which destroyed the fertility of land. It was a common phenomenon along the Western Jamna Canal. This defect was improved by the remodelling of the canal in 1878 and with the excavation of good drainage work.<sup>34</sup> It considerably decreased the area under *reh* or *shor* along the canal.<sup>35</sup> Some districts had a good system of drains constructed from the low areas (*chhambis*) and along the branches of the canals.<sup>36</sup> The improvement in the drainage system had apparently retarded the advance of *kallar* and helped in the reclamation of devastated lands.

In the late nineteenth century experiments were conducted also in the field of agriculture and many new varieties of crops suitable to the climate and soil of the Punjab, were introduced. They were potatoes, flax, tea, New Orleans cotton, sugarcane, indigo, tobacco, English fruits and vegetables, etc.<sup>37</sup> The question of agricultural improvements in the Punjab received some attention of the East India Company but the first regular step in this direction with some success was taken by the Agri-Horticultural Society of the Punjab. The objects of the Society were an overall improvement in agriculture. With the help of the government officials it conducted a broad inquiry into the existing standard of cultivation in the Punjab between 1851 and 1853. A mass of valuable data concerning the staple products of the Punjab with

reference to the varieties of crops, lands, modes of irrigation, modes of cultivation, implements, use of manure, systems of rotation, etc., was collected.<sup>38</sup> In the early 1850s experiments were made in various districts with Egyptian wheat, New Orleans cotton, Otacheite sugarcane, flax, tobacco, marigold, turnips, clover, etc. The aid of the government was solicited and obtained for the procuring of seeds from England of all the above named products. For the furthering of their ends the Society communicated not only in England and America but also in Florence, Turin, Naples, Cadiz and Sydney.<sup>39</sup> The introduction of the new varieties of crops was coloured with the economic interests of the British. They gave more stress on those crops which were needed either for the industries in England like cotton and flax, or for the markets of the Europe like wheat or for the Europeans in India like the English vegetables. Besides these two more steps for the furthering of the cause of the new varieties of crops were taken in the 1870s. They were the creation of Imperial Department of Agriculture and the establishment of agricultural farms. But these attempts could not get much success in the advancement of agriculture due to the non-co-operation of the provincial governments.

More success, however, was achieved in the field of tea, cotton, potatoes, flax, sugarcane, indigo, maize and vegetables. The cultivation of tea was introduced in the Himalayan valleys to supply tea for Indian and European markets. Successful experiments were made in the Kangra district. In 1848 two small plantations were established in the Kangra valley. In 1852 Governor-General visited Dharamsala and encouraged the further undertaking of this experiment. Accordingly a third plantation named Holta was started in 1852.<sup>40</sup> The area planted with tea in Kangra district in 1872 was 3,257 acres.<sup>41</sup> The cultivation of tea spread from Kangra to Kulu which had three tea gardens in 1883.<sup>42</sup> A number of Egyptian and American varieties of cotton were sown in the Punjab.<sup>43</sup> The American cotton had a staple of greater length. The plant produced more flowers and each flower was a larger pod with smaller seed easy to be separated from the fibre.<sup>44</sup> The cultivation of potatoes was more successful in the submontane areas. In 1872 in Kangra district the area under the crop was 118 acres.<sup>45</sup> Elsewhere they were grown around the big cities. By 1892 considerable quantity of potatoes were grown round the city of Lahore but they were less sweet in taste.<sup>46</sup> Successful experiments were made in flax growing and government gave rewards for its cultivation.<sup>47</sup> Five varieties of sugarcane were widely grown in the Punjab. Of these Saharanpuri *ponā* which was introduced here in the late nineteenth century and *kāo* were the superior and superseded the other varieties.<sup>48</sup> The cultivation of indigo started in Punjab with the commencement of the British rule. It occupied 61,439 acres in 1870-71 and 90,788 acres in 1900-01.<sup>49</sup> The cultivation of American cotton was much successful in the submontane areas.<sup>50</sup> In other districts local variety was preferred to it.<sup>51</sup> Among the English vegetables cabbages, cauliflowers, lettuces, beet-roots, peas were sown with great success.<sup>52</sup> Some of new varieties of the crops like cotton, oilseeds, wheat, sugarcane, etc., became very popular but in the nineteenth century they could not replace the native varieties everywhere. The people cultivated them only when they were assured of their benefits,

The increasing manufacture and use of sophisticated and more efficient implements, particularly made of iron, marked the beginning of the mechanisation of agriculture in the Punjab. The more important among the new iron implements were the sugarcane crushers, Persian wheels and ploughs. The new iron sugarcane crusher fastly superseded the native press called *velna* which was a cumbersome arrangement of cogged wooden wheels.<sup>53</sup> The new mill was more sophisticated than the old clumsy wasteful press, required one pair of bullocks to work instead of three and was light and portable. Not only it shortened, cheapened and facilitated the work of pressing sugarcane but also crushed 1.3 times more quantity and its yield was 20 per cent higher than the old press.<sup>54</sup> Introduced in the last quarter of the nineteenth century it had almost ousted the old wooden press everywhere by the turn of the century.<sup>55</sup> More progress in sugar industry was made in Gurdaspur district where apart from the wider popularity of Behia Mills the sugar refineries known as *kanchis* were set up to prepare better qualities of sugar.<sup>56</sup>

The improved Persian wheel was designed. The Agri-Horticultural Society had its working model in operation at Lahore by December 1851. The wheel worked well and increased the water flow.<sup>57</sup> The improved Persian wheel required little human and cattle labour.<sup>58</sup> The iron vessels called *tinds* or *dols* were gaining popularity on the Persian wheels and were made in large quantities in the cities like Amritsar.<sup>59</sup> In many districts by the turn of the century iron Persian wheels replaced the old wooden wheels. Two of the new iron wheels could be used on a well where there was only room for one old fashioned wheel.<sup>60</sup> The Kaiser plough was a new type of iron plough introduced for better tillage.<sup>61</sup>

Improvements were also made in the threshing implements. The old threshing practice was either to have the grain trodden out by oxen on a prepared floor in the open or to have a weighted branch of some thorny tree harnessed to bullocks and driven over the outspread stalks.<sup>62</sup> Now a threshing implement called *phalla* made by the ordinary village carpenter was gaining currency. A threshing machine supplied by Messers Thomson and Mylne Behia and a new reaper were introduced in the Punjab in the closing years of the nineteenth century.<sup>63</sup>

New techniques of cultivation concerning the sowing of crops their rotation, use of manure, etc., were evolved and their value came to be highly recognised. In most of the Punjab districts the use of drills for sowing seed greatly increased. Drill was a hollow tube being fixed in the shaft of the plough through which the ploughman dropped the seed grain into the furrow in a better condition. For more valuable crops like wheat it was practised as far as possible. The people came to recognise that the sooner the seed is in the ground the better the crop will be.<sup>64</sup> In the Punjab the crops were sown by rotation. By the middle of nineteenth century there was no regular system of changes for the renovation of the soil and the same crops succeeded each other every year. It was very largely due to the lack of artificial irrigation. With the development of irrigation by canals and wells separate rotation system came



into being for each category of irrigated land.<sup>65</sup> At places rotation of crops became a matter of supreme importance. In parts of Bannu district, for instance, the cultivators classified all plants as either heating or cooling to the soil. When one of the farmer has imparted too much heat they substituted one of the latter and so renovated the soil.<sup>66</sup> The use of manure to increase the productivity of the soil was highly recognised. All substances collected like the dung and its ashes, ashes of other things, litter, vegetable refuse, rubbish, sweepings of houses and of yards were kept in heaps outside the village and after some time were spread over the fields usually after harvesting *rabi*.<sup>67</sup> By 1879 the percentage of irrigated land constantly manured in Jhelam district was 34, Karnal 31 and Gurdaspur 27.<sup>68</sup> On irrigated lands more attention was paid towards the vegetative growth of crops. On such lands weeding was frequently done throughout the season up to the time of harvest.<sup>69</sup>

Efforts were made on a wider scale to improve the live-stock throughout the province. The Board of Administration gave attention to improve the condition of the live-stock to produce a powerful race of drought cattle here. The most important improvement was the importation of bulls from Hissar and Hansi. Up to 1853 for various districts thirty bulls were imported.<sup>70</sup> Veterinary Assistants and *hakims* were kept in various districts. In 1883 there was one *hakim* in Gurdaspur district<sup>71</sup>. By 1890 Ferozpur district had four Veterinary Assistants.<sup>72</sup> More success was achieved with the establishment of Veterinary Department in India in 1891. It opened a Veterinary College at Lahore to meet the provincial requirements.<sup>73</sup> In 1897-98 there were nine permanent veterinary dispensaries in the Punjab and eight internments. These institutions did a good work and were increasing in popularity. In this year sixty-four Veterinary Assistants were at work throughout the year.<sup>74</sup> Cattle fairs, moreover, were held every year or twice a year at important places. The better breed of cattle were exhibited to induce the people to improve the live-stock.<sup>75</sup>

These scientific and technological innovations introduced in the Punjab combined with the development of transport and communications, particularly the railways which placed the agricultural produce of the Punjab in the markets of India and Europe and brought handsome profits to the cultivators, commercialised the character of agriculture in the province which in turn had a far reaching effect on the economy of the region. Commercialisation here means a change from the cultivation for local consumption to the cultivation for the market. With the passage of time the cultivation of more remunerative and specialised crops gained a wider currency. In the Punjab particularly with the spread of irrigation the cultivation of more valuable crops such as wheat, oil seeds, cotton, etc., showed a large rate of development and that of the inferior crops decreased and of the moderate showed little development as illustrated in the Table (p. 200).<sup>76</sup>

In conclusion, agriculture in the nineteenth century was the chief industry of the Punjab and agricultural policy of the government was to maintain its status. Considerable efforts were made for the development of agricultural science and technology

*Area under various crops in thousands of acres*

Crop	Year	
	1876	1921
Wheat	6,609	8,951
Cotton	668	1,540
Oilseeds	118	1,172
Rice	708	829
Barley	1,874	1,099

in the province. This development was the two sided process of continuity and change in which the old modes and practices continued to exist and were modified along with the new innovations. On the whole, in the first half of the nineteenth century very largely the traditional mode of cultivation was followed. In the second half the Western technology was introduced successfully which contributed greatly towards agricultural development. These new scientific and technological innovations went a long way in the mechanisation of agriculture and transformed the medieval character of agriculture in the Punjab into a modern one.

#### NOTES AND REFERENCES

<sup>1</sup>The Punjab here means the territory which came to be known by the name of the Punjab on 9th February, 1858 with the transfer of Delhi and Hissar divisions from the North-Western Provinces to the Punjab. The British Punjab had an area of 101,829 square miles and a population of 17,611,498 souls: *Report on the Census of the Punjab 1868*, paras 28-31. pp. 7-8. With its thirty-six feudatory states, it covered an area of 144,436 square miles, and spread between 27° 39' and 35° 2' north latitude and 69° 35' and 78° 35' east longitude. In the early 1880's, it embraced a population of 22,712,120 souls or one-eleventh of the total population of the Indian Empire: *Gazetteer of the Punjab Provincial Volume 1888-89*, p. 1. In the nineteenth century various powers ruled over the different parts of this territory. They were the British, the Lahore Darbar (Ranjit Singh and his successors) and a large number of feudatory chiefs. Of these the British and the Lahore Darbar were most important.

<sup>2</sup>For further details see H.L.O. Garret (tr. & ed.). *The Punjab A Hundred Years Ago: As described by V. Jacquement (1831) & A. Soltykoff (1842)*. Languages Department, Punjab, Patiala, 1971 (reprint). pp. 5-6, 90; *Report on the Administration of the Punjab for the Years 1849-50 and 1850-51*, Calcutta 1853. Selections from the Records of the Government of India (Foreign Department), No. II, paras 5-7, pp. 2-4. H.A. Rose. *A Glossary of the Tribes and Castes of the Punjab and North-West Frontier Province*, Vol. I. Languages Department, Punjab, Patiala 1970 (reprint). pp. 9-18, *Gazetteer of the Punjab Provincial Volume 1888-89*. pp. 13-21; and David Ross. *The Land of the Five Rivers and Sindh*, Languages Department, Punjab, Patiala 1970 (reprint), pp. 102-03.

<sup>3</sup>*Report on the Census of the Punjab 1868*. para 75. p. 16; *Report on the Census of India 1911*. Vol. XIV. part I, p. 51.

<sup>4</sup>In the first half of the nineteenth century the Punjab remained a platform of quintuple warfare and struggle among the British, the Lahore Darbar, the Afghans, the Marathas and the petty feudal chiefs for the occupation of its suzerainty and sovereignty. During this period no single

power ruled it as a whole but it was divided in the dominions of many small and big powers. The Marathas went out of the struggle in the first decade of the nineteenth century while the small chiefs of the Punjab fought up to the end of the second decade and Ranjit Singh continued fighting till the fourth and after his death in 1839 the Sikhs and the British till 1849 in the two Anglo-Sikh Wars in the late 1840's which made the way for the annexation of the Lahore Kingdom in March, 1849 and establishment of the British rule on the whole Punjab.

<sup>5</sup>It does not mean that there were no canals in the Punjab prior to the nineteenth century. But their purpose primarily was to serve the imperial requirements and not to irrigate the lands under common cultivation in general. The Punjab plains, in fact, witnessed the inauguration of the canal irrigation in the mid-fourteenth century when Feroz Shah Tughlaq excavated five canals from various rivers in the Sutlej-Jamna Divide. One of these canals taken from the Jamna was the forerunner of the Western Jamna Canal. It was re-excavated and turned into a perennial canal by Akbar in 1568. The engineer Ali Mardan during the reign of Shah Jahan extended it to Delhi to serve the needs of Imperial palace at Delhi. About two centuries later its remains were restored and enlarged by the British engineers and was re-named as Western Jamna Canal. Ali Mardan in 1633 excavated another canal called Shah Nahar from the Ravi to irrigate the Royal (Shalimar) Gardens at Lahore. It was later on renovated and extended to Amritsar by Ranjit Singh and was named as Hasli. For further details see R.S. Jauhri. "A few Canals of Medieval Punjab"—*Punjab History Conference Proceedings*, Punjabi University, Patiala 1965, pp. 83-85; *Gurdaspur District Gazetteer 1883-84*, p. 7; *Hissar District Gazetteer 1883-84*, p. 4; *Report on the Administration of the Punjab for the Year 1849-50 and 1850-51*, para 355, p. 135; James Douie. *The Panjab. North-West Frontier Province and Kashmir*. Seems Publications, 1974 (reprints), pp. 132 & 135. Many other inundation canals were also excavated in the south-eastern districts of the Punjab in the late eighteenth century. See, for instance Captain C. Minchin. *Memorandum on the Biloch Tribes of Dera Ghazi Khan District: Selections From the Records of the Government of the Punjab and its Dependencies. New Series. No. III*, Punjab Printing Company Limited. 1869, p. 48

<sup>6</sup>*General Report on the Administration of Punjab Territories Comprising of the Punjab Proper and the Cis- and Trans-Satluj States for the Years 1851-52 and 1852-53* (cited hereafter as the *Report on the Administration of the Punjab 1851-52 and 1852-53*), Calcutta 1854, Selections from the Records of the Government of India (Foreign Department), paras 425, p. 170.

<sup>7</sup>*Ibid.*, paras 429-30, pp. 171-72.

<sup>8</sup>See, for instance, *Report on the Administration of the Punjab for the Years 1849-50 and 1850-51*, para 258, p. 90; *Ferozepore District Gazetteer 1883-84*, p. 66; Gurdit Singh. "Irrigation in the Punjab During the Maharaja's Time", *Maharaja Ranjit Singh: First Death Centenary Memorial*, (ed. Teja Singh and Ganda Singh), Languages Department, Punjab, Patiala 1970 (reprint), pp. 144 & 152.

<sup>9</sup>See *Gazetteer of the Punjab Provincial Volume 1888-89*, p. 249; Himadri Banerjee, *Agrarian Society of the Punjab 1849-1901*. Ph.D. Thesis, University of Calcutta, 1976, pp. 112-13; and *Hissar District Gazetteer 1883-84*, pp. 4-5.

<sup>10</sup>*Baree Doab Canal Project 1850*, para 1, p. 15.

<sup>11</sup>*Ibid.*, para 2, pp. 15-16.

<sup>12</sup>*Ibid.*, paras 3-15, pp. 16-18. These engineers were Lieutenant Colonel Napier, Civil Engineer and Lieutenant J. H. Dyas, Executive Engineer for Bari Doab Canal, see also *Report on the Administration of the Punjab for the Years 1849-50 and 1850-51*, para 355, pp. 135-36; *Report on the Administration of the Punjab 1851-52 and 1852-53*, para 432, p. 142; and *Gurdaspur District Gazetteer 1883-84*, pp. 7-8.

<sup>13</sup>Indu Banga, *Agrarian System of the Sikhs*. Manohar Publications, Delhi, 1978, p. 84.

The *zaildars* and *lambardars* of the British were the counterpart of *Chaudharies* and *muqaddams* of Ranjit Singh: See Sita Ram Kohli, "Land Revenue Administration Under Maharaja Ranjit Singh", *Journal of the Punjab Historical Society*, Vol. VII, No. 1, 1918, p. 85.

<sup>14</sup>See, for instance, Gurdit Singh, "Irrigation in the Punjab During Maharaja's Time," p. 151. The region called the Doaba was covered by the Jullundur and Hoshiarpur districts; Riarki was

used for the most of Gurdaspur and a part of Amritsar district while the district of Sialkot and a part of Gujranwala district formed the tract called Darap.

- <sup>14</sup>Herbert B. Edwardes and Herman Merivale, *Life of Sir Henry Lawrence*. Smith Elder, London, 1873, pp. 475-76.
- <sup>15</sup>*Report on the Census of the Punjab 1881*, para 119, p. 50; para 192, pp. 98-99.
- <sup>16</sup>Sethi, R. R. *John Lawrence As Commissioner of the Jullundur Doab 1846-49*. Punjab Government Record Office Publications, Monograph No. 10, pp. 17-18.
- <sup>17</sup>There is no direct evidence on this point and this statement is based on the probability of the circumstances. What is wellknown, however, is that the masonry wells worked with Persian wheels and therefore, the larger number of masonry wells meant the larger number of Persian wheels. Figures for wells in various districts for the year 1878 are recorded in the district gazetteer series of 1883-84. The number of masonry wells in use in 1878 in Amritsar district was 8,517, in Ambala 3,839 and in Gurdaspur 4,044 like the other districts: See *Amritsar District Gazetteer 1883-84*, p. 35; *Ambala District Gazetteer 1883*, p. 48; and *Gurdaspur District Gazetteer 1883-84*, p. 50. As the evidence does not suggest that even half of these wells were constructed under the British rule it is very probable that the bulk of these wells were in existence in the early nineteenth century and in this way the number of the Persian wheels in use was very high. It was observed in 1850 that well irrigation carried on by means of Persian wheels was everywhere of first rate. See *Report on the Administration of the Punjab for the Years 1849-50 and 1850-51*, para 19, p. 7.
- <sup>18</sup>Harbans Singh. "Agriculture in the Punjab During the Maharaja's Region": *Maharaja Ranjit Singh: First Death Centenary Memorial*. (ed. Teja Singh and Ganda Singh), Languages Department, Punjab, Patiala 1970 (reprint), p. 146 and F. S. Waheeduddin. *The Real Ranjit Singh* Oriental Publishers, Delhi, 1976, p. 120.
- <sup>19</sup>*Hissar District Gazetteer 1883-84*, pp. 49-50.
- <sup>20</sup>The Lower Chenab Canal was made into a perennial canal in 1889-90. In this year it irrigated only 39,308 acres: *Report on the Administration of the Punjab and its Dependencies 1889-90*, paras 458-61, pp. 142-43. In 1899, it irrigated 1,092,075 acres: *Report on the Census of India 1901*, Vol. XVII, Part I, p. 49. Within the next ten years, this area increased more than two fold: James Douie. *The Panjab, North-West Frontier Province and Kashmir*, p. 133.
- <sup>21</sup>*Third Report of Indian Territories From the Select Committee of the House of Lords, Session 1852-53*, Appendix C, p. 172.
- <sup>22</sup>*Baree Doab Canal Project 1850*, pp. 4-5.
- <sup>23</sup>For further details, see *Ibid*, pp. 1-4, 7, 11-13; *Baree Doab Canal Revised Estimate 1856*, paras 13-15, pp. 4-5; *Report on the Administration of the Punjab for the Years 1849-50 and 1850-51*, paras 356-60, 364, 367, pp. 136-40; *Report on the Administration of the Punjab 1851-52 and 1852-53*, paras 424, 434-37, pp. 169-70, 176-79; *Gurdaspur District Gazetteer 1883-84*, pp. 8-9; and *Gazetteer of the Punjab Provincial Volume 1888-89*, pp. 236-40.
- <sup>24</sup>*Report on the Administration of the Punjab and its Dependencies for 1897-98*, para 598, p. 225.
- <sup>25</sup>*Report on the Administration of the Punjab 1851-52 and 1852-53*, paras 426-27, pp. 170-71.
- <sup>26</sup>Captain C. Minchin, *Memorandum on the Biloch Tribes of Dera Ghazi Khan District*. pp. 11, 16, 20, 55-56.
- <sup>27</sup>*Ferozepore District Gazetteer 1883-84*, p. 9; *Ferozepore District Gazetteer 1915*, pp. 186-88.
- <sup>28</sup>*Report on the Administration of the Punjab and its Dependencies for 1897-98*, paras 631, 636, pp. 233-34.
- <sup>29</sup>*Karnal District Gazetteer 1918*, pp. 9. & 199.
- <sup>30</sup>Banerjee Himadri, *Agarian Society of the Punjab 1849-1901*, pp. 77-82.
- <sup>31</sup>Doule, James, *The Panjab, North-West Frontier Province and Kashmir*, pp. 48, 241.
- <sup>32</sup>Vij, B. Dass: *Co-operation in Punjab: A History of the Progress of the Co-operative Movement from 1904-05 to the Year of Grace*, Punjab Co-operative Union Ltd., Jullundur 1959, p. 41.
- <sup>33</sup>*Report on the Administration of the Punjab and its Dependencies for 1897-98*, para 464, p. 160.
- <sup>34</sup>*Gazetteer of the Punjab Provincial Volume 1888-89*, pp. 249-56.

- <sup>35</sup>See for instance *Rohtak District Gazetteer 1910*, p. 99.
- <sup>36</sup>Amritsar District had an efficient drainage system. See *Amritsar District Gazetteer 1947*, pp. 6-9.
- <sup>37</sup>*Imperial Gazetteer of India, Provincial Series, Punjab*, Vol. I, p. 62.
- <sup>38</sup>Kerr, Ian J, "The Agri-Horticultural Society of the Punjab, 1851-71", *Essays in Honour of Dr. Ganda Singh; Punjab Past and Present*. (ed. N. G. Barrier and Harbans Singh), Punjabi University, Patiala 1976, pp. 252-72. The Agri-Horticultural Society of the Punjab was organized on 16 May, 1851 at Lahore with Henry Lawrence as President. It was primarily a body of the European officers.
- <sup>39</sup>*Report on the Administration of the Punjab 1851-52 and 1852-53*, para 470, p. 192.
- <sup>40</sup>*Ibid*, para 471, pp. 193-94.
- <sup>41</sup>*Report on the Land Revenue Settlement of Kangra District 1865-72*, para 16, p. viii.
- <sup>42</sup>*Kangra District Gazetteer 1883-84*, Vol. II. pp. 60-61.
- <sup>43</sup>See *Report on the Administration of the Punjab and its Dependencies 1897-98*, para 464, pp. 159-60; and *Bannu District Gazetteer 1907*, p. 65.
- <sup>44</sup>*Third Report of Indian Territories From Select Committee of the House of Lords Session 1852-53*, Appendix C, p. 161. The distribution of superior cotton seeds in India was commenced by the East India Company as early as 1788. In 1813 the services of Americans were obtained to improve its cultivation. Again in 1818 and 1831 in the Maratha country and Gujarat experimental farms were established. But in the early nineteenth century these efforts remained limited to south India. The main varieties of foreign cotton which suited well to the soil and climate of India were Bourbon, Egyptian and New Orleans; *loc. cit.*, also, *First Report of Indian Territories From the Select Committee of the House of Lords Session 1852-53*, question nos. 1865-66, p. 179.
- <sup>45</sup>*Report on the Land Revenue Settlement of Kangra District, 1865-72*, para 15, p. viii.
- <sup>46</sup>Latif, Sayad Muhammad, *Lahore: Its History, Architectural Remains and Antiquities*, New Imperial Press, Lahore 1892, p. 257.
- <sup>47</sup>See *Report on the Administration of the Punjab 1851-52 and 1852-53*, para 470, p. 192; and *Gujaranwala District Gazetteer 1883-84*, p. 53.
- <sup>48</sup>See for instance *Amritsar District Gazetteer 1892-93*, pp. 94-95; *Shahpur District Gazetteer 1897*, p. 171; and *Attock District Gazetteer 1907*, pp. 158-59.
- <sup>49</sup>*Imperial Gazetteer of India Provincial Series, Punjab*, Vol. I, pp. 61-62.
- <sup>50</sup>*Ibid*, p. 62.
- <sup>51</sup>See for instance *Bannu District Gazetteer 1907*, p. 81.
- <sup>52</sup>See Sayad, Muhammad Latif, *Lahore: Its History, Architectural Remains and Antiquities*, pp. 257-58; and *Bannu District Gazetteer 1907*, p. 84.
- <sup>53</sup>See *Amritsar District Gazetteer 1892-93*, p. 94; and *Karnal District Gazetteer 1883-84*, p. 162.
- <sup>54</sup>Banerjee, Himadri, *Agrarian Society of the Punjab 1849-1901*, pp. 91-93.
- <sup>55</sup>See *Imperial Gazetteer of India Provincial Series, Punjab*, Vol. I, p. 59. Its wider popularity is evident from the case of Karnal district. In this district only four Bahia Mills were sold in 1881 but in 1883 the figure rose to 395. See *Karnal District Gazetteer 1883-84*, p. 163. Similar was the case of many other districts. See for instance *Report on the Administration of the Punjab and its Dependencies for 1897-98*. para 464, p. 159.
- <sup>56</sup>*Gurdaspur District Gazetteer 1883-84* p. 62. Another landmark in this field was the establishment of Sujampur Sugar Works in May, 1877 which commenced working in November, 1878; *Ibid*, pp. 56-57.
- <sup>57</sup>Kerr, Ian J, *The Agri-Horticultural Society of the Punjab 1851-71*, p. 262.
- <sup>58</sup>The labour of Persian wheel was much easier as expressed in the saying "*Harat ek ankh se chalta*". One eye was enough for a *harat*, for the driver (*gaderia*) who sat on the beam to which the yoke was tied may be blind and the *panlara* (who directed the water to the field) only needs one eye. See *Karnal District Gazetteer 1918*, pp. 107-09.
- <sup>59</sup>*Amritsar District Gazetteer 1883-84*, p. 44.
- <sup>60</sup>*Ferozepore District Gazetteer 1915*, p. 160.
- <sup>61</sup>Banerjee, Himadri, *Agrarian Society of the Punjab 1849-1901*, pp. 98-99.

- <sup>62</sup>*Bannu District Gazetteer 1907*, p. 76.
- <sup>63</sup>*Report on the Administration of the Punjab and its Dependencies for 1897-98*, para 464, p. 159.
- <sup>64</sup>See *Ferozepore District Gazetteer 1883-84*, p. 67; and *Bannu District Gazetteer 1907*, p. 79.
- <sup>65</sup>A good description of various crops grown on lands irrigated from canals, wells and dependable on rainfall separately is given in *Gujranwala District Gazetteer 1935*, pp. 142-52.
- <sup>66</sup>*Bannu District Gazetteer 1907*, p. 77.
- <sup>67</sup>See *Imperial Gazetteer of India Provincial Series, Punjab*, Vol. I, pp. 58-59; J. M. Douie, *Punjab Settlement Manual*, Civil & Military Gazetteer Press, Lahore, 1909, para 261, p. 126.
- <sup>68</sup>See *Jhelam District Gazetteer 1883-84*, p. 96; *Karnal District Gazetteer 1883-84*, pp. 161-62; and *Gurdaspur District Gazetteer 1883-84*, p. 50. Increase in the value of manure increased its price. For instance in Bannu district manure at the outset of the twentieth century was sold in the villages at from rupees 7 to 10 per hundred donkey loads equivalent to roughly 150 maunds per rupee. See *Bannu District Gazetteer 1907*, p. 77.
- <sup>69</sup>*Sialkot District Gazetteer 1920*, pp. 79-80.
- <sup>70</sup>*Report on the Administration of the Punjab 1851-52 and 1852-53*, para 465, p. 188.
- <sup>71</sup>*Gurdaspur District Gazetteer 1853-84*, p. 52.
- <sup>72</sup>*Ferozepore District Gazetteer 1915*, p. 177.
- <sup>73</sup>See *Report on the Census of India 1931*, Vol. XVII, part I, pp. 35-37; and M. L. Darling, *The Punjab Peasant in Prosperity and Debt*, Manohar Publications, Delhi 1977 (reprint), p. 149.
- <sup>74</sup>*Report on the Administration of the Punjab and Its Dependencies for 1897-98*, para 478, p. 166.
- <sup>75</sup>*Ibid*, para 476, p. 165; and *Report on the Administration of the Punjab and its Dependencies for 1877-78*, para 266, p. 104.
- <sup>76</sup>See *Report on the Administration of the Punjab and Its Dependencies for 1877-78*, paras 255, 257, pp. 101-02; and *Report on the Census of India 1921*, Vol. XV, part I, para 7, p. 10. This development is also noted in the Punjab District Gazetteers.