

BACKGROUND TO SCIENCE AND TECHNOLOGY DURING PRE-COLONIAL TIMES IN BRITISH GUJARAT

British Gujarat: General Understanding

The term ‘British Gujarat’ seldom finds attention from the historians¹ working on the colonial history of Gujarat. In place of British Gujarat, term like ‘Bombay Gujarat’ is often found in use. To place British Gujarat in simplest sense one can identify it with the Northern Division of the Bombay Presidency. The formation of British Gujarat had been a long journey but at the same time had been a complex and constructive process (**my emphasis**).

It is difficult to comprehend the making of British Gujarat as its making was a long process and cannot be binded in fixed time frame, i.e., when did British Gujarat came into existence. British control over Gujarat region evolved in stages. In fact, it was the net product of political dynamism between Mughals, Marathas, English East India Company (EEIC) and local potentates. It comprised of five districts namely Surat, Broach (now known as Bharuch), Kaira (now known as Kheda), Ahmedabad and Panch Mahals. These pockets of Gujarat remained directly administered territories under the EEIC in beginning and gradually transferred under the hegemony of Britain and the British Government. The journey of the making of British Gujarat starts in 1750s as the British presence had been felt adequately in the sub-regions of the central and south Gujarat. These five districts territories did not made a single land mass. Ahmedabad and Panch Mahals were disjointed sub-regions. (**see Map I**) These districts overlapped with other areas under the sovereignty of various princely states like Devgarh Baria, Baroda, Sachin, Bansda, Dharampur, etc.

¹ Neera Desai (1978), *Social Change in Gujarat*, Bombay: Vora Pub.; R. D. Choksey (1968), *Economic Life in the Bombay Gujarat, 1800-1939*, Bombay: Asia Pub. House and Brahama Nand (2004), *Fields and Farmers in Western India, 1850-1950*, New Delhi: Bibliomatrix.

Physical Features of Gujarat (see Map II)

Like any other region, Gujarat is blessed with moderate climate, rich variety of soils, annual rivers, long coastline and thick forest pockets.

Soils

In Gujarat sub-regions, different types of soil are found. The soils near the coastal areas of Ahmedabad, Broach and Surat are noted not fit for the agriculture and, therefore, the inhabitants evolved the sea culture. The principle soil in the region is *Goradu*. *Kali* or black as it is called because of its colour. It can be located in different zones with variation. *Goradu* soil is found in arable pockets of Ahmedabad, Kaira, Panch Mahals, Bardoli *taluka* and Valod *mahal* of Surat. Similarly, it is found in the *Bhal* region of Kaira, Broach and land north of Navsari in Surat. Another variety of soil called *Bhatha*² is found in the beds of Narmada, Tapti and Sabarmati Rivers.

Rivers

The rivers of Gujarat are known for enriching the plains as these irrigated the arable pockets and enhanced the agrarian potentialities of the sub-region. The four pioneer rivers of Gujarat are Sabarmati, Mahi, Narmada and Tapti. Besides these rivers, their tributaries and other small rivers; water springs, lakes and ponds watered the region for agrarian and other purposes.

Rainfall

The State is blessed with adequate rainfall, but it is not uniformly distributed in some pockets. Forest trap of Panch Mahals and hilly tracts in south Gujarat receives abundant rainfall. Other sub-regions are reported with moderate rainfall. Based on the pattern of rainfall, there are chiefly two seasons for cropping called *kharif* (monsoon month's crops) and *rabi* (winter season crops). *Arud*, *chowla*, *toor*,

² *Goraroo* soil is light colour and its fertility depends upon manuring. *Bhata* or *Bhatha* is a very fertile class of *Goraroo* soil (alluvial soil). *Goraroo* is good for sugarcane, chilly and tobacco cultivation. See Renu Saxena (1989), "Ahmedabad from *circa* 1750-1850-A Review of It's Society, Economy and Institutions", Unpublished Ph. D. Thesis, Vadodara: The M. S. University of Baroda, 8-9.

rice, *botwa*, *banti*, *mug*, *math*, etc., are the important *kharif* crops. Some of the valuable *rabi* crops are wheat, gram, cotton, tobacco, ginger, chillies, etc.³

Demography

There was steady rise in the population during the period from 1881 to 1951. As per the estimate of Brahma Nand⁴, the trend in the population increase in British Gujarat was haphazard. According to *Census Reports* from 1881 to 1951, British Gujarat districts registered slow growth rate in terms of human population. From the survey of the data, it can be ascertained that the rate of growth was not continuous. During some decades in the British Gujarat districts, there was decline owing to famines, epidemics and other calamities.⁵

Following estimate is provided by Brahma Nand about the population trend of British Gujarat districts as follows:

District	1881	1891	1901	1911	1921	1931	1941	1951
Ahmedabad	103	111	96	99	107	120	236	202
Kaira	102	111	91	88	91	95	117	206
Panch Mahals	106	130	108	134	155	188	217	477
Broach	93	97	83	87	88	95	114	201
Surat	101	107	105	108	111	114	145	301

Source: Brahma Nand (2004), *Fields and Farmers in Western India, 1850-1950*, 29.

Districts of British Gujarat

Broach

Broach district was lying between 21° 25' 45" and 22° 15' 16" North Latitude and 72° 34' 19" and 73° 12' 15" East Longitude with a total area of 1458 square miles. According to the *Gazetteer of Surat and Broach* (1877), the district was divided into five *talukas* namely Jambusar, Amod, Wagra, Broach and Ankleshwar. Narmada, Dhadhar and Kim were the important rivers along with creeks and offsprings. It was reported that the rain usually began in June and ended in October. The sub-region of the district was deficient in mineral resources and also in forest

³ *Ibid.*, 23.

⁴ Brahma Nand (2004), *Fields and Farmers in Western India, 1850-1950*, 28-30.

⁵ *Ibid.*

tracts. Cows, buffaloes, oxen, camel, horses, etc., were the domestic animals. Agriculture was the most important activity in the district. The soils were of two types: the light and the black. The staple crops were rice, cotton, wheat and millet.⁶

Surat

Surat District was laying between 20° 15' 0" and 21° 28' 0" North Latitude and 72° 38' 0" and 73° 30' 30" East Longitude. As per the estimate of *Gazetteer of Surat and Broach* (1877), the total area of the district was 1669 square miles. It was divided into eight *talukas* namely Olpad, Mandvi, Chikli, Bulsar, Pardi, Chorasi, Jalalpur and Bardoli. Surat had rich alluvial soil in north-west and the poorer tract existed in the south-east, these were furrowed in some places by the channels of quick-flowing streams. Kim and Tapti were the main rivers along with Purna, Ambika, and other smaller ones. The climate of Surat could be divided under two categories namely equable temperature under the influence of sea-breeze and other one influenced by the action of heat and cold. The soils of the district were alluvial in character under three classes namely black or cotton soil called *kali*; the light soil called *gorat* and the *besur* which was a mixture of both.⁷ The staple crops were rice, wheat, *bajri*, *kodra*, *banti*, etc.⁸

Ahmedabad

Ahmedabad District was lying between 21° 25' 18" and 23° 37' North Latitude and 71° 21' and 73° 28' East Longitude with a total area of 3854 square miles.⁹

According to the *Gazetteer of India* (1984), *Gujarat State, Ahmedabad District*, Ahmedabad was divided into seven *talukas* namely Prantij, Daskroi, Viramgam, Sanand, Dholka, Dhandhuka and Ghogha. Besides Sabarmati, the other important rivers were Ghela, Shelwa, Andhli, Chatori, Omarkar, Bhogavo, etc. Chandola and Kankaria were the major water bodies and categorised as lakes in the district. The soils in this district could be classified as black, medium black, *goradu*, *kyari* and

⁶ GBP (1877), *Surat and Broach*, 337-56, 367.

⁷ *Ibid.*, 1-37.

⁸ *Ibid.*, 63.

⁹ GBP (1879), *Ahmedabad*, 1-2.

rocky. The black soil tract consisted of the southern half of Dholka *taluka* and eastern half of Dhandhuka *taluka*, popularly known as *Bhal* tract where cotton was grown. The medium black soil was found in Viramgam, Sanand and Dholka *talukas* where *bajri*, *jowar* and cotton were grown. The *goradu* soil was found in Dahegam, Daskroi and parts of Sanand, Dholka and Viramgam *talukas*. This soil was noted for its fertility and all kinds of crops could be grown on this soil. The *kyari* soil was found in Daskroi, Sanand, Dholka and Viramgam *talukas*. Well known varieties of rice such as *pankhali*, *kamod*, *jirasar*, *sukhvel*, *sutarsal* and *basmati* were grown on this soil. The rocky soil found in parts of Dhandhuka *talukas* was known as *kaner* tract. It was shallow, light in texture and fit for early maturing crops like cotton, *bajri*, *jowar* and *math*.¹⁰

Kaira

The district of Kaira was lying between 22° 15' 25" and 23° 10' North Latitude and 72° 33' 40" and 73° 27' East Longitude and had a total area of 1600 square miles. The seven *talukas* of the district were Kapadvanj, Thasra, Mehmabad, Nadiad, Matar, Anand and Borsad. Mahi and Sabarmati were the important rivers along with channels of Shedhi and Vatrak.¹¹

In Kaira, four chief types of soil were found namely *gorat* (light), *besar* (medium), *kali* (medium) and alluvial (*bhatha*) soils. Irrigation was carried chiefly from ponds and wells. *Ramia* was deep well and *sundra* was a shallow one. *Bajri* was most important crop besides rice, wheat, tobacco, etc.¹²

Panch Mahals

Panch Mahals was lying between 22° 30' and 23° 10' North Latitude and 73° 35' and 74° 10' East Longitude with an area of 1595 square miles. The five *talukas* of Panch Mahals District formed two groups separated by a hilly and forest-clad strip. The western groups, the larger of the two comprised the *taluka* of Halol in the south. The eastern group was composed of Dohad *taluka* within the north, the petty

¹⁰ *Gazetteer of India* (1984), *Gujarat State, Ahmedabad District*, 4, 8-13 & 273.

¹¹ *GBP* (1879), *Kaira and Panch Mahals*, 1.

¹² *Ibid.*, 42-47.

division of Jhalod. Godhra, Kalol and Dohad were the three *talukas*. Maize was the staple crop of the district.¹³

Agriculture in Pre-British Gujarat

Sanskrit, Persian and indigenous sources amply bears testimony to continuous activity in agrarian sector during pre-British period in the present Gujarat region.¹⁴ Due to the availability of black soil in Gujarat, it is reported that the region not only produced food crops but immensely contributed to the growth of commercial crops as well. Cotton is one such example. H. K. Naqvi¹⁵ provides details of the crops produced in the north India for the Delhi Sultanate period; whereas *Ain-i-Akbari*¹⁶, *Tabqat-i-Akbari*¹⁷, *Khulasat-ut-Tawarikh*¹⁸ and *Mirat-i-Ahmadi*¹⁹ document copious information on the extent of cultivation, agricultural implements, yield and crop pattern. This is clearly comprehended by Irfan Habib in his doctoral dissertation published as book entitled *The Agrarian System of Mughal India, 1556-1707*²⁰.

A number of Persian and Sanskrit texts written over the centuries on agrarian activity do indicate about the techniques employed in agriculture are not seen by me; but there references in scholarly articles have helped me develop understanding on agrarian practices in pre-British period. *Krishiparasara*, *Nuskha Dar Fanni-i-Falahat*, *Risala Dar Falahat* are most referred one. Some of these are taken into

¹³ *Ibid.*, 183, 230.

¹⁴ One of the earliest surviving Sanskrit source on early medieval agricultural practices is *Krishi-Parasara* probably written by Parasara. Persian documents like *Risala Dar Falahat* (anonymous) and *Nuskha Dar Fanni-i-Falahat* by Amanullah Husaini (written c. 1693, attributed to Dara Shikoh but written by Husaini who was son of Mahabat Khan, famous noble during the Jahangir's rule) do provide information on techniques of agriculture; and *Lekhapaddhati*, an indigenous source material focuses on local practices employed by the cultivators. See Nalini Sadhale (tr.) (1999), *Krishi-Parasara*, Michigan: Asian Agri-History Foundation; and Pushpa Prasad (2008), *Lekhapaddhati: Documents of State and Everyday Life from Ancient and Medieval Gujarat*, Delhi: OUP.

¹⁵ Hamida Khatoon Naqvi (1984), "Cultivation Under the Sultans of Delhi, c. 1206-1555", *IJHS*, 19 (4), 329-40.

¹⁶ See Abul Fazl, *Ain-i Akbari*, (tr.) by H. Blochmann (2008), Vols. I & II+III, Delhi: LPP.

¹⁷ See Nizamuddin Ahmad (1593), *Tabaqat-i-Akbari*, ed. B. De (1913-35) (Vol. III partly edited and revised by M. Hidayat Hosain), 3 Vols., Calcutta: Bibliotheca Indica.

¹⁸ See Sujana Rai Bhandari, *Khulasat-ut-Tawarikh*, ed. Zafar Hasan (1918), Delhi, parts of it is published in *India of Aurangzeb*, (tr.) by J. N. Sarkar, 2007.

¹⁹ See Ali Muhammad Khan, *Mirat-i-Ahmadi: Supplement*, (tr.) by Syed Nawab Ali and Charles Norman Seddon (1928), Baroda: Oriental Institute.

²⁰ Irfan Habib (1999), *The Agrarian System of Mughal India, 1556-1707*, 2nd Edn, New Delhi: OUP; *idem* (2008), *A People History of India: Technology in Medieval India, c. 650-1750*, New Delhi: Tulika Books.

account in order to understand the techniques in the acquirement of arable land; enhancing its yield; agricultural apparatus; protection of crops; knowledge related to sowing and harvesting; seasons and adoption of crop-pattern.

Amanullah Husanini's, '*Nuskha Dar Fanni-i-Falahat*' is an important manuscript on medieval agriculture.²¹ This text registers name of various crops belonging to *rabi* and *kharif* seasons; vegetables and fruits; herbs, shrubs and trees. It also gives direction regarding the preparation of soil, water requirements for various crops, techniques and time for harvesting; manure requirement and its making. For grafting of fruits, he says that precautions should be taken regarding the age of the plant at which the grafting should be carried out so that desired quality of plant or tree can be cultivated.²² For instance, he refers to Egyptian beans which have potentiality to increase the productivity of the barren land. Text also informs us about sowing methods to save the seeds from diseases, mixed-cropping to increase the yield, etc.²³ He illustrates by giving example of grafting. For instance, pomegranate and myrtle could to be sown together.²⁴ Pomegranate tree covered with leaves and branches of gourd would remain protected against cold and frost-bite.²⁵ The almond and pistachio, if planted together, yield a better crop.²⁶ It also documents about the skill and inherent knowledge of Indian peasants about astronomical knowledge used in planting and harvesting.²⁷ For example, best time for planting the trees was when sun was in the sign of Libra or at the end of Pisces or the beginning of the Aries. Plants grown in spring season had long branches and roots. Further, he also suggests that vegetables should be planted in soft soil.²⁸

Gujarat region is largely known for its trade and commercial potentiality nonetheless the agrarian aspect had been extremely visible because throughout the

²¹ A. Rahman (1984), "Science and Technology in Medieval India", in A. Rahaman (ed.), *Science and Technology in Indian Culture: A Historical Perspective*, New Delhi: NISTADS, 125.

²² *Ibid.*, 126.

²³ *Ibid.*

²⁴ *Ibid.*

²⁵ *Ibid.*

²⁶ *Ibid.*

²⁷ *Ibid.*

²⁸ *Ibid.*

historical period varieties of crops are documented.²⁹ Cotton was cultivated on a wider scale and its finished products were highly demanded within and outside Gujarat. It was further blessed with annual rivers like Sabarmati, Mahi, Narmada and Tapi. The European travellers were impressed with the skills of the people of land in the art of cultivation for production of varieties of crops. The traditional knowledge was inherited from their forefathers since antiquity and these techniques were successfully exploited for the cultivation of food and cash crops. Gujarat was also a land of animals and especially milk yielding cattle, for instance, cows and buffalos were highly appreciated; however, the camels and sheep also remained the milching folk.³⁰ Therefore, one also notes the rich animal husbandry practices. A brief summary is provided regarding agricultural produce, implements and production method.

Food Crop

For Gujarat region in the line of food crops, we find ample evidences for rice, barley, maize, and other millets being cultivated in different pockets of Gujarat. Wheat, rice, *jowari*, *bajra*, maize, barley, gram, *moth*, peas, oilseeds, etc., remained in vogue during the period of the Delhi Sultanate.³¹ Similarly, for the Mughal period, *Ain-i-Akbari*³² documents spring harvest (*rabi* crop) namely wheat, Kabul and black gram, lentils, millets, etc. For autumnal harvest (*kharif* crop), it enlists varieties of rice, *mung*, *mash*, barley, others pulses and millets.

Agrarian historians like S. P. Gupta³³, Dilbagh Singh³⁴, Shireen Moosvi³⁵, etc., on medieval agrarian history of India, further, substantiate the numerous food crops mentioned in the Rajasthani and Persian sources. For south Gujarat sub-region adjoining Surat, some sixteen crops were cultivated. Rice, wheat, barley and millets

²⁹ Habib, Irfan (1986), *An Atlas of the Mughal Empire: Political and Economic Maps with Detailed Notes, Bibliography and Index*, New Delhi: OUP, Sheet No. 7B, Gujarat-Economic, 24-25.

³⁰ *Ibid.*, 25-26.

³¹ Hamida Khatoon Naqvi (1984), "Cultivations Under the Sultans of Delhi, c. 1206-1555", 333-35.

³² Abul Fazl, *Ain-i Akbari*, tr. by H. Blochmann (2008), Vol. II, Delhi: LPP, 65-71.

³³ See S. P. Gupta (1986), *The Agrarian System of Eastern Rajasthan*, Delhi: Manohar.

³⁴ See Dilbagh Singh (1990), *The State, Landlords and Peasants: Rajasthan in the 18th Century*, Delhi: Manohar.

³⁵ See Shireen Moosvi (1987), *The Economy of the Mughal Empire, c. 1595*, Delhi: OUP.

cultivation is registered in Gujarat on a wider scale. In nutshell, it can be stated that Gujarat region observed multi-crop pattern.³⁶

Cash Crop

Naqvi enlists sugarcane, cotton, hemp and indigo as cash crops cultivated during the reign of Delhi Sultans.³⁷ Similarly, cash crops like sugarcane, cotton, rapeseed, castor, linseed, groundnuts, sun-hemp, indigo, opium and tobacco were cultivated during the Mughal period.³⁸

Cotton

Shantha Hariharan³⁹ reports about the production of cotton with seed or raw cotton popularly known as *kapas*. Broach region produced *laria* and *jaria* varieties. In addition to these, there were two other varieties which are termed as *roji* and *narma*. The *roji* was inferior in quality and was grown in Baroda *talukas* to be mixed with the regular Broach cotton as an adulterant. *Narma* or *dev kapas* (*Gopssipium Reloigiosm*) was a perennial plant lasting for five or more years and used for making thread and was grown in small quantities near temples or dwelling of ascetics.

Indigo

Tentoria, the indigo plant provided the dark blue dye. It is a well-known fact that Sarkhej in Ahmedabad was one of the important centres for indigo cultivation and its manufacture was for commercial demand.⁴⁰ It attracted number of Europeans namely Dutch and English.⁴¹ Towards the end of the 16th century, indigo became important in the Western Europe, as the blue dye was required for the woollen industry and the Portuguese started carrying indigo in moderate quantities to Lisbon.⁴² The Dutch factors⁴³ at Surat in 1601 wrote of it as the most important local

³⁶ Irfan Habib (1999), *The Agrarian System of Mughal India, 1556-1707*, 39-42.

³⁷ Hamida Khatoon Naqvi (1984), "Cultivations Under the Sultans of Delhi, c. 1206-1555", 335-36.

³⁸ Irfan Habib (1999), *The Agrarian System of Mughal India, 1556-1707*, 43-50.

³⁹ Shantha Hariharan (2002), *Cotton Textiles and Corporate Buyers in Cottonopolis: A Study of Purchases in Gujarat, 1600-1800*, Delhi: Manek Pub., 206-07.

⁴⁰ *Ibid.*, 231.

⁴¹ *Ibid.*

⁴² *Ibid.*

⁴³ *Ibid.*

product. The Commissions from the Governors of the EEIC to their merchants in 1607 asked them to buy indigo from Gujarat.⁴⁴

Bayana (near Agra) indigo was most preferred because it was pure and free from impurities. Indigo dye is completely different from the other natural dyes. It is insoluble and deposited on the fibers of the fabric as microscopic particle which gives cloth strength of colour, without the need to form a chemical bond with them. This characteristic made it uniquely suitable for dyeing to any type of fiber.⁴⁵

Pelsaert explains about three cuttings from the indigo plant which gives three qualities of indigo called '*nauti*', '*zairie*' (*jarhi*) and '*katel*'. The *zairie* (second cutting) was superior in quality to the *nauti*, first cutting gave a violet infusion. Its quality can be easily judged even without examining the inside of it, for it is much lighter in the hand than the *nauti*.⁴⁶

Sugarcane

Sugarcane and its products seems to be the effort of Indian peasants as we find term *Iksu*, mentioned in *Atharvaveda*, *Vajasneji*, *Maitrayani*, and few other texts for early India.⁴⁷ *Indica* of Magasthenes does record the production in the times of Chandragupta Maurya.⁴⁸ It is also mentioned in the medicinal works of Charaka (*Charaka-Samhita*) and Susruta (*Susruta-Samhita*).⁴⁹ The sugarcane and allied instruments were known as *mahajanta* or *kolluka*.⁵⁰ Susruta mentions twelve varieties of sugarcane namely *paundraka*, *bhiruka*, *vamsaka*, *sataporake*, *tapaseksu*, *kasteksu*, *sucipatraka*, *naipala*, *dirghaparta*, *nilapora* and *kosakrt*.⁵¹ Chinese Buddhist pilgrim Fa-Hien and Hiuen-Tsang also inform about sugarcane and its products consumption by the inhabitants of India.⁵² In 1498, Vasco da Gama

⁴⁴ *Ibid.*

⁴⁵ *Ibid.*, 232.

⁴⁶ *Ibid.*, 247.

⁴⁷ Adya Prasad Pandey (2007), "Indian Sugar Industry: A Strong Industrial Base for Rural India", *Munich Personal RePEc Archive*, Paper No. 6065, 3-4.

⁴⁸ *Ibid.*

⁴⁹ *Ibid.*

⁵⁰ *Ibid.*

⁵¹ *Ibid.*, 5-6.

⁵² *Ibid.*

observed its cultivation at Calicut.⁵³ *Ain-i-Akbari* describes the two varieties of sugarcane, called *ikh* and *paunda*.⁵⁴ It was introduced in Europe by the Arabs.⁵⁵ Sugarcane became familiar to Europeans only during the 10th and 12th centuries.⁵⁶ The Europeans preferred its usage as medicine. It is noteworthy that sugarcane among Europeans was also used as candid sugar and as a luxury product. It became more popular during the 19th century.⁵⁷

Tobacco

B. G. Gokhale⁵⁸ provides impressions related to tobacco production and its consumption during the 17th century on the basis of Persian and European travellers account.

The best account of the introduction of tobacco and the subsequent growth of its consumption comes from two Persian sources: Memoir of Asad Beg (*Wikaya-i-Asad Beg*) and Sujan Rai Bhandari's *Khulasat-ut-Tawarikh* for the 17th century in *India of Aurangzeb* (tr.) by J. N. Sarkar.⁵⁹ It was cultivated in Bijapur during the 17th century. It is reported that Asad Beg brought a costly hubble-bubble with a *chilim* from Bijapur for Akbar. He also stated that tobacco was once presented to Akbar in late 16th century by a physician who brought it from Mecca and Medina. Presence of tobacco at the Mughal court generated debate about its usage between Asad Beg and Hakim Ali. In due course, increase in demand of tobacco resulted in the rapid extension of its cultivation.⁶⁰ One can easily make it out that during post-Akbar period it was cultivated in India extensively and used for smoking and chewing.⁶¹ Under such circumstances, Jahangir was forced to issue a decree forbidding the smoking of tobacco. W. H. Moreland observed in *India at the Death of Akbar* that

⁵³ *Ibid.*, 3-4.

⁵⁴ *Ibid.*

⁵⁵ John Daniels and Christian Daniels (1988), "The Origin of the Sugarcane Roller Mill", *Technology and Culture*, 29 (3), 498.

⁵⁶ Adya Prasad Pandey (2007), "Indian Sugar Industry: A Strong Industrial Base for Rural India", 8.

⁵⁷ *Ibid.*, 3-8.

⁵⁸ B. G. Gokhale (1974), "Tobacco in 17th Century India", *Agriculture History*, 48 (4), 484-92.

⁵⁹ See Sujan Rai Bhandari, *Khulasat-ut-Tawarikh*, ed. Zafar Hasan (1918), Delhi, parts of it are published in *India of Aurangzeb*, (tr.) by J. N. Sarkar, 2007.

⁶⁰ A. J. Qaiser (1982), *Indian Response to European Technology and Culture, 1498-1707*, New Delhi: OUP, 118-19.

⁶¹ B. G. Gokhale (1974), "Tobacco in 17th Century India", 484.

probably it reached India through Portuguese and was established first in the province of Gujarat, where leaf was obtainable in the year 1613, but the process of manufacture is however, not spelt then.⁶² Gradually, it gained importance and became important cash crop as it fetched more wealth to the state as revenue. In 1612, Robert Clarkson was employed by the Surat Factory for curing tobacco. In the western India, the principal producing area was Gujarat with Surat as its major market and the port city as destination of dissemination and collection. Surat received its tobacco from the areas surrounding the city especially from Dandipur, Gandevi, Bulsar and Dandi.⁶³ The western India export then destined was mainly to Gombroon and major urban ports of the Persian Gulf and the Red Sea.⁶⁴

As early as c. 1613, the English factors recorded that this crop was grown on a large scale in Surat. Edward Terry⁶⁵ speaks of its cultivation in abundance at Agra and Surat. Similarly in 1670, a European traveler noticed the production of both sugarcane and tobacco around Surat.⁶⁶ John Fryer mentions many flourishing fields of tobacco at Broach located above Surat.⁶⁷ It is reported that during the early 19th century the Brahmins in Bombay remained engaged in tobacco trade.⁶⁸ For example, three Brahmins who hailed from Bandra were given sureties for tenders by four Portuguese of Mahim.⁶⁹

Tools and Implements

According to H. K. Naqvi⁷⁰, during the Delhi Sultanate, “the heavy ploughs used in early historic period were ‘discarded’, simple and relatively light weight ones were brought to use by the cultivators”. It was used to dig and break clodded soil. Plough fitted with metal projections was especially used for the land containing stones and weeds. Wheat and cotton needed more elaborate ploughing whereas some

⁶² *Ibid.*

⁶³ *Ibid.*, 488.

⁶⁴ *Ibid.*, 487-89.

⁶⁵ W. Foster (ed.), *Early Travels in India, 1583-1619*, Delhi, 299.

⁶⁶ A. J. Qaiser (1982), *Indian Response to European Technology and Culture, 1498-1707*, 120.

⁶⁷ B. G. Gokhale (1974), “Tobacco in 17th Century India”, 485.

⁶⁸ *Ibid.*, 490-91.

⁶⁹ *Ibid.*

⁷⁰ Hamida Khatoon Naqvi (1986), *Agricultural, Industrial and Urban Dynamism Under the Sultans of Delhi, 1206-1555*, New Delhi, 14-15.

crops like barley, and other millets and rice required simple ploughing. She refers to the usage of sickle through which thorny weeds were removed.⁷¹

Irfan Habib⁷² also provides details about the tools used by the Indian peasants for the Mughal period. These were local needs friendly. For example, the hump of Indian ox gave an advantage to plough compared to the European one, in which the harness had often to be fixed to the horns of the beast. The hump lessened the danger of yoke slippage which was so serious with the hump less European ox, necessitating the use of a wheel to secure smooth movement for the plough. Indian agriculture was far from primitive because drill-sowing, rice transplantation was common practice and usage of bone manure was not used frequently except Gujarat. Fish manure was used for sugarcane cultivation in Surat.⁷³ Europeans were impressed by the cultivation of more than one crop during single harvest season. Plough was made locally and supported cultivation efficiently. It was made of local wood to maintain its lightness so that it did not go below the fertile top soil. Iron tip was used as coulter in the lower part of plough. Indian top soil was fertile enough to support crop nourishment. European top layer soil was not fertile and it needed deeper ploughing. *Noria* and *saqiya* (gear and ungeared) were used for drawing water from well, tank, etc. Usage of *noria* can be documented since the 4th century B. C., but the full-fledged *saqiya* (Persian wheel) based on gear mechanism and drawn by animal power was brought to use somewhere in the late 15th century.⁷⁴ Persian wheel and other means of techniques were utilised for artificial irrigation; water being drawn from tanks, wells and rivers. Water storage systems were eco-friendly but their upkeep depended on the monsoon rain. It could be brought to use for only nine to ten months as water used to get bitter. Yogesh Sharma⁷⁵ records that sometimes onion was used

⁷¹ *Ibid.*

⁷² Irfan Habib (1999), *The Agrarian System of Mughal India, 1556-1707*, 26; *idem* (2008), *A People History of India: Technology in Medieval India, c. 650-1750*, 3-5; *idem* (2000), "Joseph Needham and the History of Indian Technology", *IJHS*, 35 (3), 257.

⁷³ Irfan Habib, *A People History of India: Technology in Medieval India, c. 650-1750*, 2008, 5.

⁷⁴ Irfan Habib (2000), "Joseph Needham and the History of Indian Technology", 257. H. C. Verma does not agree with Habib observation. According to him, Persian wheels were used in Rajasthan, Bengal and Awadh regions along with its use in Samarqand in the Central Asia. See H. C. Verma (2001), *Harvesting Water and Rationalisation of Agriculture in North Medieval India: 13th-16th Centuries*, New Delhi: Anamika Pub.

⁷⁵ Yogesh Sharma (2009), "The Circuit of Life: Water and Water Reservoirs in Pre-Modern India", *SH*, 25 (1), 80.

to correct its unsavoriness. The use of the draw-bar and circular track of the oxen for trashing and milling spread to different parts of India between 5th to 10th centuries. Seed-drill was probably diffused from China during the 16th century.⁷⁶ Another method of sowing to prevent waste of seed called dibbling was recorded by Amanullah Husaini.⁷⁷ Referring to cotton cultivation, he says: “In some places they push down a pointed peg into the ground, put the seed into the hole and cover it with earth. It grows better.”⁷⁸

Manure

Varahamihira in *Brihatsamhita*⁷⁹ documents about the methods for manure making: “To promote inflorescence and fructification, a mixture of one *adhaka* of sesame, two *adhaka* of excreta of goats or sheep, one *prastha* of barley powder, one *tula* of beef thrown into one *drone* of water and standing over seven nights shall be poured round the roots of the plant. Further, the sprinkling of the washing of fish increases the productivity of the manure”.⁸⁰

Ranabir Chakravarti further provides information from another contemporary Sanskrit text *Krsi-Parasara* about the manure making process. According to the text: “In the month of January-February, dung heap is collected with the help of spade. Small balls are made when it is dried in the sun. These dried balls are scattered over the field at the time of sowing. The benefit of this process is that the undistributed dung heap minimised the loss of nitrogen. Drying of the dung into balls further reduces the accumulation of ammonia which was considered injurious to plants”.⁸¹ It was also reported that the dung balls in the pits augmented humus which enhanced the fertility of the soil”.⁸²

⁷⁶ Irfan Habib (2008), *A People History of India: Technology in Medieval India, c. 650-1750*, 5.

⁷⁷ *Ibid.*

⁷⁸ *Ibid.*

⁷⁹ Ranabir Chakravarti (2008), “Agricultural Technology in Early Medieval India (c. A. D. 500-1300)”, *The Medieval History Journal*, 11 (2), 236.

⁸⁰ *Ibid.*

⁸¹ *Ibid.*, 236-37.

⁸² *Ibid.*, 237.

We have information regarding the usage of manure from Naqvi.⁸³ She refers to dropping of animals like cow, buffalo and birds were also used as manure. Ash of wood fuel was mixed with manure heap to prevent the breeding for wooly worms. Farmers were well aware about the seed cultivation. Yellowish pink coloured wheat seed yielded large size and tasty crop. Bean, gram and other seeds were soaked in water before their sowing in the field.

Season and Rainfall

Indian peasants were well aware of seasons and position of stars, sun and deep observation about clouds. For example, *Dakar Bachan* and *Khanar Bachan* (ancient Bengali texts) are still used for agricultural knowledge by the peasants in Bengal.

These texts record:⁸⁴

If it rains in the month of *Agrahayan* (November-December) the king goes a bagging. If it rains in the month of *Paush* (December-January) money may be had even by selling the chaff. If it rains at the end of *Magh* (January-February) the king and his country become blessed. If it rains in *Phalgun* (February-March), the millet *chinakaon* (*Pennisetum polystachyon*) grows abundantly.

Khana (daughter-in-law of astronomer Varahamihira) says that the paddy thrives in the sun and the betel in the shade. If the paddy gets profuse sunshine by days and showers by night, it develops rapidly. He says the drizzling rain in the month of *Kartik* (October-November) does immense good to paddy. Here, O son of ploughman put some smut of paddy in the bamboo-bush; if you do so near the root of the shrubs, they will soon cover two *kudas* (about 174 square cubits) of land. O son of ploughman, plant *patol* (*Trichosanthis dioeca*) in a sandy soil, your expectations will be fulfilled.

Sow the mustard seeds close, but those of rye at some distance from one another. Cotton plants should be put at the distance of a lap from one another and jute should by no means be planted near them, for cotton plants will perish if they come in contact with water from the field. If the sky is covered by mist in *Chaitra* (March-April) and there are plenty of paddies in *Bhadra* (August-September), the earth is afflicted with plague and other disasters of that sort. If a southern wind blows in the month of *Ashadh* (June-July), there will be a flood in the year. If in *Push*, there is heat in the atmosphere and cold (April-May) in that year heavy rainfall will commence from the first part of *Ashadh*.

If the clouds take the form as if cut by spade and axe and the wind blows off and on, it shadows be understand that rainfall will commence in a day or two. O my peasants friend, do not waste time in such weather but busy you with the water. If in the night the clouds cover the sky and there be rain throughout the day, O brother farmer, it will be in vain for you to go to your field for work.

⁸³ Hamida Khatoon Naqvi (1984), "Cultivations Under the Sultans of Delhi, c. 1206-1555", 331-32.

⁸⁴ Upinder Singh (2009), *A History of Ancient and Early Medieval India: From the Stone Age to the 12th Century*, New Delhi: Pearson, 581.

Appropriate knowledge of rainfall was very important for the good crops yield. Four types of clouds were recognised: *Avarta* produced local rain, *Samvarta* rain everywhere; *Puskara* indicated drought and *Drouna* produced abundant rainfall. Movement of winds, further, enabled a farmer to predict about rain. Wind from north and west meant rainfall and south and east brought drought. Absence of winds could lead to erratic rain. With the help of flag, the direction of the wind should be observed. One such easy method was to fix a pole in the river bed to know about the rise and fall of the rain.⁸⁵

According to *Krsi-Parasara*, the following signs indicated immediate rainfall.⁸⁶

- White ants with wings rushing out of their holes
- Dancing of peacock
- Sudden croaking of frogs
- Snakes coming out of their holes and taking shelter on tree
- Water fowls drying their wings in the sun
- Rheumatic people belonging to have aches and pains all over their body.

Similarly, *Risala Dar Falahat* also provides information about the tests which determined the suitability of the soil, seasons, fruits cultivation, food preservation of seeds, storage, control of insects and pests, harvesting and so on.⁸⁷ The details of the processes and practices are provided in the **Appendix I**.

Animal Husbandry

Numerous texts on early India namely *Sukraniti*, *Asvavaidyakam*, *Agni Purana*, *Vishnu Purana*, *Matsya Purana*, *Arthasastra* and *Mahabharata* reveals that peasants were proficient in animal management. These texts provide classification of animals, breeding knowledge and methods for recording their population. For breeding of cattle, its strong stature, free from disease and deformity, etc., were taken into account at the time of mating. From the skin of a cow, one could even predict about its milk quality. For example, good colour of the pigment of the skin meant cow should yield nutritious milk. Milk of black cow was best, red one was medium

⁸⁵ Kafil Ahmed Chowdhary (1992), “*Krsi-Parasara*”, *IJHS*, 27 (1), 37.

⁸⁶ *Ibid.*, 37-38.

⁸⁷ M. Majumdar (1984), “*Risala Dar Falahat*”, *IJHS*, 19 (4), 341-60.

and whites an average.⁸⁸ For their good health, cowsheds were regularly smoked to drive out mosquitoes and other insects. Further, piece of hot irons were used on the bodies of cows and its hair from the tail trimmed off. This operation made the cows healthy and saved them from diseases.⁸⁹

Pre-Colonial Non-Agrarian Environment

Historiographical survey of pre-colonial India suggests the process of continuity and change in almost all productive sectors as obvious in case of agrarian activities. Having known the potentiality, availability of the production in far off lands of Gujarat, I would like to lay stress on the tools and implements and techniques used in the production of commodities. The survey of historical writing on craft production shows that a number of crafts were practiced in different parts of Gujarat.⁹⁰ Some of these crafts products were highly appreciated within Gujarat and across the region. Cotton was the most priced product with its ready varieties of goods. These attracted European travellers to venture in the interiors of Gujarat. Surendra Gopal⁹¹ informs us about the varieties of cotton textile manufactured at different centres of Gujarat namely *bafta*, *calicoes*, *chader*, *cuttaine* and *chintz*. The Dutch and the British records are full of praise for the commodities quality and give reason that the quality and variety of textile products became the vital reason for purchase of cotton made products. Cotton products were ably assisted by a number of natural dyes which was manufactured from vegetable plants. Paper making, work

⁸⁸ Usha V. Mandokhot (1987), "Breeding Practices and Selection Criteria for Domestication of Animals", *IJHS*, 22 (2), 128-29.

⁸⁹ Kafil Ahmed Chowdhary (1992), "*Krsi-Parasara*", 43.

⁹⁰ The non-agrarian products made with traditional skills were appreciated and purchased by traders of the northern and southern India. Muslims merchants of Central Asia especially Arabs were other important groups. Cotton fabrics were even popular in Africa and South-East Asian regions. This was the reason which forced the European traders to venture for its successful exploitation in Gujarat. See Tripta Verma (2002), *Karkhanas Under the Mughals from Akbar to Aurangzeb: A Study in Economic Development*, New Delhi: Pragati Pub.; Shantha Hariharan (2002), *Cotton Textiles and Corporate Buyers in Cottonopolis: A Study of Purchases in Gujarat, 1600-1800*; Surendra Gopal (1975), *Commerce and Crafts of the Gujarat in the Sixteenth and Seventeenth Century*, New Delhi; Dharampal (1971), *Indian Science and Technology in the Eighteenth Century: Some Contemporary European Accounts*, Delhi: Impex; B. G. Gokhale (1978), *Surat in the Seventeenth Century: A Study in Urban History of Pre-Modern India*, Bombay: Popular Prakashan and V. A. Janaki (1974), *Some Aspects of the Historical Geography of Surat*, Geography Research Paper Series, No. 7, The M. S. University of Baroda, Vadodara.

⁹¹ Surendra Gopal (1975), *Commerce and Crafts of the Gujarat in the Sixteenth and Seventeenth Century*, 196-98.

in metals, leather products, navigation and so on was able to fulfil the demands of the society.

Cotton Textile Manufacture

Varieties of cotton made finished articles were in high demand in Indian Ocean markets since antiquity. One such interesting case is documented by Shantha Hariharan.⁹² The king of Achin was presented in 1615, with pieces of fine Broach *baftas* to procure license for the English to trade at Priaman, Tecoe and Barouse. The said example establishes the predominance of Indian / *Gujarati* merchant because the *Gujarati* merchants were particularly used by the colonial authorities to sustain their influence on other countries. *Gujarati* merchant was elected as *Shah-i-Bandar* along the Swahili coast and in South East Asia by general acceptance of entire merchant community in the western and eastern Indian Ocean during the 18th century.

The excellency in both quality and quantity of cotton textiles was possible because of number of instruments which were used by the natives for the making of cloth products from raw cotton. The techniques employed were easy and simple. For instance, Irfan Habib⁹³ refers to cotton gin which was an invention of the India's weavers. This device later on got diffused to China. It was used to remove seed from cotton. Similarly, the other tool was scutch-bow which was used to separate and loosen the cotton fiber. Another instrument called spinning wheel was used for making yarn. According to Irfan Habib: "It was based on crucial mechanical principles of belt transmission of power and the stabilising of rotation through fly-wheel. It had also another characteristic of a machine, namely, a radical in output. In comparison with the hand spindle or distaff in use before it, it was estimated to increase production by six times, even in its simplest (one-spindle) form. Besides this, it freed the spinner from the intolerable pressure on her thumb and fingers which she had to bear while hand-rotating the spindle".⁹⁴

⁹² Shantha Hariharan (2002), *Cotton Textiles and Corporate Buyers in Cottonopolis: A Study of Purchases in Gujarat, 1600-1800*, 142.

⁹³ Irfan Habib (2008), *A People History of India: Technology in Medieval India, c. 650-1750*, 37-38.

⁹⁴ *Ibid.*, 39-40.

Irfan Habib further explains: “After the yarn was spun, weaving was next step. Cotton weaving had traditionally been done in India on horizontal loom. The weaver’s hands were now left free to handle the shuttle, while the shed opened and closed by the alternating movements of his feet. This naturally enabled him to get the cloth woven much faster—even ten times faster. If, then, the efficiency of the spinner increased due to the spinning wheel, first attested in 1350, the weaver too was now, through his treadles, able to keep pace with the increased amount of spun yarn that he was called upon to weave. On the horizontal loom, flowered patterns were achieved generally by two weavers. They passed the weft thread under different set up of warp threads at each stroke according to the envisioned pattern. Most intricate and beautiful patterns could be woven”.⁹⁵

According to one of the observations of Irfan Habib, Indian cloth-printing industry inspired English craftsmen to undertake cloth-printing by themselves during the early 18th century.⁹⁶

In context to Gujarat, we find mention to two types of cotton cleaning machines, the foot roller (*pauvatna*) and the *charkha*. Former was adapted to hard seeded cotton and was simply an iron rod, thick in the centre and tapering towards the extremities. It was rolled by wooden soled-feet over a smooth flat stone. K. L. Tuteja observes: “Cotton came in a continuous web from the stone like a broad tape leaving the seeds behind”.⁹⁷ The use of the foot-roller was generally confined to women and children. Tuteja states that this process was slow and laborious, but the fibre was not injured. Using a foot roller, a capable worker could turn out from four to six pounds a day.⁹⁸

H. K. Naqvi⁹⁹ gives a vivid example of process of cotton manufacture in the northern India especially employed at the various centres of Lucknow. It can be

⁹⁵ *Ibid.*

⁹⁶ *Ibid.*, 46.

⁹⁷ K. L. Tuteja (1990-91), “Agricultural Technology in Gujarat: A Study of Exotic Seeds and Saw Gins, 1800-50”, *IHR*, XVII (1-2), 139.

⁹⁸ *Ibid.*

⁹⁹ Hamida Khatoon Naqvi (1982), “Technology and Process of Some of the Principal Industries of 18th Century Hindustan”, *IJHS*, 17 (1), 65-66.

presumed that this method was operated in Gujarat as well. However, the European travellers like Ralph Finch, Palsaert and others do mention the process of making of cloth in sub-regions of Gujarat. *Sembhal* and *kapas* were the two cotton yielding sources. Former could not be twisted, and therefore, discarded for making fabric; latter was well suited for the purpose of making cloth and was chiefly used for fabric manufacture.¹⁰⁰ Collected *kapas* from the field were cleaned from dirt manually and wooden bow was used to make it free from other unwanted materials and dust. Next step was making of the yarn with the help of spinning instrument. For spinning the yarn *charkha* was employed for coarse yarn and the other one called *takli* for making fine yarn.¹⁰¹ After the making of yarns, the next step was fabric manufacture through weaving largely done by male weavers. For weaving, yarn was wind on a wooden bobbin (*nar*) which was hollow from the inside. Yarn was moistened to prevent its frequent breakage during the weaving process. After moistening the yarn it was inserted in the shuttle, which on operation was to constitute the woof of the fabric.¹⁰² The warp was laid out on a fabric length frame to which *narkul* stalks were stuck upright from the ground at certain intervals along with two *naris* which were fixed by wedges on the ends of long reeds. A person walking along round the uprights dropped by a skilful movement of his hands, the two threads, one from each *nari*, so as to lap on the alternate uprights. When the warp was stretched out, it was dressed with a paste of flour and dried. It was then taken to a loom and each alternate thread was drawn through a hole in one *rachch* and the other thread was drawn through the interstices of the *hatta* or batten.¹⁰³ The ends were finally fastened to the beam. The other end of the warp was attached to a hook or a peg or any other contrivance swung from or fastened to the ceiling. There was one beam in the loom. The place of the second was taken up by the three reeds which were so disposed as to prevent the threads from becoming entangled behind the *rachch*. To the *rachch* were attached treadles and by their movement the shed was produced through which the shuttle flew. Fabric was thus obtained after this operation.¹⁰⁴

¹⁰⁰ *Ibid.*, 65.

¹⁰¹ *Ibid.*

¹⁰² *Ibid.*

¹⁰³ *Ibid.*, 66.

¹⁰⁴ *Ibid.*

Dyers during the medieval India had sound botanical knowledge of various dye plants. They further knew that citrus crops producing areas lent greater luster to the colour washed in it. According to Naqvi, Thatta-Burhanpur belt was best example as numerous localities in the belt was known for dyeing of different varieties of cloth.¹⁰⁵

According to Surendra Gopal: “The Gujarat bleachers were famous even outside the province. In 1642, their presence is mentioned in Java. In 1669, Bombay requested the English factory at Surat to send some bleachers. Dyeing was considered so important by the English that in 1646, they decided to open a dyeing house of their own at Ahmedabad. For this purpose they purchased land where 36 vats could be constructed. Small workshops privately owned began to emerge. Workers were hired and were to be paid wages. The tools belonged to the master. The significance of this development lies in the fact that the traditional mode of production wherein the craftsmen combined in him the functions of owner, worker and seller was slowly disintegrating”.¹⁰⁶

Broach was known for bleaching of cotton cloth owing to excellent quality of water available, wide space on the route of Bombay and Agra, close to Surat and Swalley and large quantities of lemons growing in Broach. Its juice was important for the bleaching process.¹⁰⁷

According to Shantha Hariharan: “The *baftas* of Gujarat being less beaten and starched than cloth from Agra was better liked in England for the uses desired in England. In Manila, people disliked the curing of the Indian cloth with *kanji* or rice water”.¹⁰⁸

According to Surendra Gopal: “The English preferred to get cloths, purchased in north India, bleached in Gujarat because of the fine results achieved. *Gujarati*

¹⁰⁵ Hamida Khatoon Naqvi (1991), “Dyeing Agents in India, 1200-1800”, *IJHS*, 26 (2), 160.

¹⁰⁶ Surendra Gopal (1975), *Commerce and Crafts of the Gujarat in the Sixteenth and Seventeenth Century*, 210.

¹⁰⁷ Shantha Hariharan (2002), *Cotton Textiles and Corporate Buyers in Cottonopolis: A Study of Purchases in Gujarat, 1600-1800*, 172.

¹⁰⁸ *Ibid.*, 172-73.

bleachers were so famous that evidence is available of their migration to such far off places as Bentham in Indonesia”.¹⁰⁹

According to Shantha Hariharan: “Bleaching is a seasonal process and, by and large, the period between October and May is the most productive and best season when the rain is over and the water in the river is clean, sunshine is in abundance and the climate is free from gales and gushes of wind carrying dust, which interfere with dyeing”.¹¹⁰

Hariharan do provide a comparison between the methods employed by the bleachers in India and Europe.¹¹¹ The Dutch were noted as best bleachers in Europe in the 18th century. The Dutch bleachers buck the cloth by steeping it in hot waste lye and followed by fresh lye for eight days.¹¹² It was then washed with black soap and wring dry. The washed cloth was put in a vat for one to three weeks. It was again washed and kept in the sun. Thereafter, it was regularly wetted. The operations of bucking souring and crafting, i.e., spreading on grass in the sun was repeated five to six times. The process was time consuming.¹¹³ In 1756, with the discovery of sulphuric acid, it became possible to bleach the cloth in short duration. In contrast, the cloths in India were steeped in alkaline dye composed of soap and *sajee matte* or impure carbonate of soda.¹¹⁴ The half dry fabric was sent to the boiling house to be steamed. The steam allowed the alkali to penetrate deeper into the threads for effective bleaching. The process of bucking, steaming and grassing was repeated for ten to twelve days.¹¹⁵ After the cloth went through the following steps, it was steeped in clear filtered water acidulated with lime juice and bleaching was completed. The cloths were sized, dressed and pressed. It was estimated that the delivering of

¹⁰⁹ Surendra Gopal (1975), *Commerce and Crafts of the Gujarat in the Sixteenth and Seventeenth Century*, 221.

¹¹⁰ Shantha Hariharan (2002), *Cotton Textiles and Corporate Buyers in Cottonopolis: A Study of Purchases in Gujarat, 1600-1800*, 174.

¹¹¹ *Ibid.*, 177-78.

¹¹² *Ibid.*, 177.

¹¹³ *Ibid.*, 178.

¹¹⁴ *Ibid.*

¹¹⁵ *Ibid.*, 177.

finished cloth in Gujarat was only about three months, while in Europe; the bleaching of cloth usually took six to eight months.¹¹⁶

For curing of the cloth and to give it a whitish effect, indigo was used, while for stretching and sizing of cloth, *kanji* or rice water was used.¹¹⁷

Like Bayana near Agra, Ahmedabad also benefited from its proximity to the indigo producing area of Sarkhej. Broach was also advantageously placed in regard to its dyeing industry by virtue of large cultivation of indigo in Jambusar just thirty miles from it.¹¹⁸

According to B. C. Mohanty, et. al.: “Flowers of different kinds like *cossumba*, *dawarry*, *suringj*, *kissury*, etc., were grown in Broach region and Jambusar *taluka* yielded dyes of different colours. Dried flowers of *cossumba* or safflower plant (*Carthamus tinctorinus*) provided the real dye and it was used for making red cloth. It was further supplemented with redwood, *chayaver* which was brought to Broach in large quantities by the traders from Malabar Coast. Indigo use was slightly different from other natural vegetable dyes. Indigo dyeing required special skill to dissolve and reduce the insoluble dye stuff in a warm (up to 50° Celsius) alkaline solution in the vat. This transformed the indigo into a colourless derivate, which attached itself to the fibers immersed in the vat, with a yellowish green colour and turned blue only after several minutes’ exposure to the air. Those who mastered it were treated as specialized and the secret was passed on to the next generation”.¹¹⁹

The season of the year played an equally important role in dyeing as in weaving. The best season for both was during the rains, when cloth proved to be close woven and dyeing of colours proved good. Chemical interaction between salts contained in the water of a particular place and various dyes stuffs locally procured

¹¹⁶ *Ibid.*, 178.

¹¹⁷ *Ibid.*

¹¹⁸ *Ibid.*, 184.

¹¹⁹ B. C. Mohanty, et. al. (1987), *Natural Dyeing Processes of India*, Ahmedabad, 29-30. Also see Shantha Hariharan (2002), *Cotton Textiles and Corporate Buyers in Cottonopolis: A Study of Purchases in Gujarat, 1600-1800*, 185.

or produced was undoubtedly an important aspect why certain towns and village were able to produce textiles involving dye fixing techniques of a better quality than others.¹²⁰

Care was necessary in calendaring the dyed cloth which involved gumming and rubbing processes. In the Calendaring process fabric was rubbed hard with a stone. At the same time these were gummed and every folding was beaten down with a stick. The cloth in this process was dried near the river to avoid dust should not fall upon fabric before they were completely dried.¹²¹

The fertile plain of Broach region, produced not only some of the finest cotton in Gujarat, but also grains like wheat and rice, dyes of sorts like *cossumba*, *dawary* flowers, oilseeds like *gingelly*, gram and other *dhals*, *jowar*, *bajra* and indigo in Jambusar. Butter, rice, wheat for making bread and biscuits, gram, *moong* and other fodder for horses etc., were generally in demand.¹²²

Paper Making

The making of paper from hemp goes back to China. By the 4th century A. D., paper in China replaced silk and bamboo was as the main material for writing. Before 10th century, the fundamentals of paper manufacture, including movable bamboo screen, mould and sizing had been perfected and silk, mulberry bark, and even wheat and barley stalks were used for manufacture paper. From here, it was introduced to the Islamic world. By 1223, Sanskrit manuscripts began to be written on paper in Gujarat.¹²³ This can be better assumed because of the region's close proximity to Sindh and the presence of Muslim mercantile communities in its ports.¹²⁴

According to S. A. Khan Ghori and A. Rahman: "Sultan Mahmud Begara of Gujarat sent some presents to Sultan Zainu 'l-'Abidin who reciprocated by sending

¹²⁰ *Ibid.*, 186.

¹²¹ *Ibid.*

¹²² *Ibid.*, 241-42.

¹²³ Irfan Habib (2008), *A People History of India: Technology in Medieval India, c. 650-1750*, 63.

¹²⁴ *Ibid.*

Kashmiri products and paper was one such item”.¹²⁵ Kashmir paper industry was developed by importing paper manufacturing technology from Samarqand and Khurasan of Central Asia. These regions received this knowledge when some Chinese prisoners were captured through whom this technique gradually came to known to the people. Over the period of time, it diffused to India and Europe. Probably, Gujarat brought this technology from Kashmir.¹²⁶ Ahmedabad, Cambay and Patan were the paper manufacturing centres in Gujarat.¹²⁷ Patan paper was famous for *Patani* paper. *Zarafshah* was a brown paper made especially for account work.¹²⁸ Paper manufacture in western India was brought by the Muslims. In eastern India, it got diffused from China via Nepal.¹²⁹ Besides this, there are evidences of paper manufacture even before the 8th century A. D. For instance, Macartney and Gilgit manuscripts found in *stupas* of Kuchar in central Asia belong to pre 8th century. Further, Jain repositories of the western India do not resemble with the paper of the eastern India.¹³⁰

According to Lt. Colonel Ironside: “*Sun* (Sun hemp) plant is used in the manufacture of paper. It is cultivated all over India in the month of July. Seeds are sown near to one another so that stem rose higher, erect with flower branches and to increase the produce. Native lady uses the seeds and powder it with oil on their hair. They believe that this would make the hair strong and long. It is further used for rope making, packing cloths, nets and uses as fertilisers for crop productivity”.¹³¹

Lt. Colonel Ironside¹³² also describes about the paper manufacture in India. According to him, the manufacturer purchased old ropes, cloths and nets made from *sun* plant and cut them into small pieces. These pieces were macerated in water for a few days, generally five, washed them in river in a lodged in the ground, the water was strongly impregnated with a lixivium of *sedgimutti* (it is an earth containing a

¹²⁵ S. A. Khan Ghorī and A. Rahman (1966), “Paper Technology in Medieval India,” *IJHS*, 1 (2), 136.

¹²⁶ *Ibid.*, 136.

¹²⁷ *Ibid.*, 137

¹²⁸ *Ibid.*, 137-39.

¹²⁹ Sita Ramaseshan (1989), “The History of Paper in India up to 1948”, *IJHS*, 24 (2), 103.

¹³⁰ *Ibid.*, 103-06.

¹³¹ Lt. Colonel Ironside, “Paper manufacture in India”, in Dharampal (1971), *Indian Science and Technology in the Eighteenth Century: Some Contemporary European Accounts*, 174.

¹³² *Ibid.*, 175-77.

large portion of fossil alkali, *natron* of the ancients. It is found in plenty in India and universally used in washing, bleaching, soap making and for various other purposes) six parts and quick lime seven parts.¹³³ After remaining in the state for eight or ten days, these were again washed and while wet, broken into fibers by the stamping leaver and then exposed to the sun upon a clean steeped in a fresh lixivium as before.¹³⁴ When these had undergone three operations of this kind, these were fit for making coarse brown paper after seven or eight operations. It was prepared for making paper of a tolerable whiteness.¹³⁵

Ahmedabad paper was reputed for the excellency for their durability, gloss and smoothness and was in demand in overseas market.¹³⁶ Bark, hemp, rag, waste paper were being used as the raw material for producing varieties of paper known as *hariri*, *shami*, *mansinghi*, art and ornamental paper, etc.¹³⁷

Leather

Leather work was an ancient industry in Surat. People working on leather and manufactured leather cushions and upholstery for carriages and saddles for horses. Surat made the most elegant targets of rhinoceros hide for which the skin was brought from Arabia and polished at Surat. It was then shed with silver nails about one inch in diameter.¹³⁸

This traditional industry could be located in villages on a small scale. Ahmedabad and Panch Mahals had large establishments. The industry was not well organised and each tanner or shoemaker worked for himself. Only in a few places one would find large tanneries. The *mochi* who made leather products used simple tools for manufacturing. He was neither a skilled nor a steady worker and was generally thriftless.

¹³³ *Ibid.*

¹³⁴ *Ibid.*, 177.

¹³⁵ *Ibid.*

¹³⁶ Hamida Khatoon Naqvi (1982), "Technology and Process of Some of the Principal Industries of 18th Century Hindustan", 66.

¹³⁷ *Ibid.*

¹³⁸ V. A. Janaki (1974), *Some Aspects of the Historical Geography of Surat*, 16.

Bombay, Ahmedabad, Godhara, etc., were the important centres based on leather. The tannery at Vegalpur in Surat was another one. The factory employed American process of chemical tanning instead of the bark method. A large market was found in Bombay for its products and exports were also sent to England. Leather from Panch Mahals was sent to Indore and other states of the central India agency. In Broach, by far, the most important branch of the leather trade was the manufacture of the gin rollers. During the ginning season, the cutting of leather washes alone was noticeable. The remainder of the year was spent in tanning a few hides for local consumption.¹³⁹

Turtle shells were used for making shields for soldiers and horn of the rhinoceros for medical value. Hides and skins were used for packing quicksilver and saltpeter and the English often sold hides in small numbers as a luxury article. The use of hides for packing use led to the growth of the *mumjama* or wax cloth industry, for this cloth was used to wrap the hides against moisture. The packaging needs also created another industry, that of the *dubba*, a kind of a tube of hides to hold butter or *ghee*.¹⁴⁰

Iron and Other Non-Agrarian Products Manufacture

Indian metal works were considered superior in terms of manufacture products during the pre-colonial period. They possessed proficiency in melting, refining and shaping of iron, steel (*wootz*), copper, zinc, gold and silver.¹⁴¹

According to Naqvi, following method was used in the manufacture of iron: “Iron ore is excavated from the earth and it is put into a furnace. The furnace has opening to allow the entry of air and to put coal to generate fire. Bellows are used to increase the intensity of the heat. Thus, one received molten iron which could be used for the manufacture of a number of articles. Lemon, Sambhar salt, varnish, etc., were used to prevent rusting of iron. Copper was added to make a good quality of

¹³⁹ R. D. Choksey (1968), *Economic Life in the Bombay Gujarat, 1800-1939*, 222-23.

¹⁴⁰ B. G. Gokhale (1978), *Surat in the Seventeenth Century: A Study in Urban History of Pre-Modern India*, 114.

¹⁴¹ Satpal Sangwan (1991), *Science, Technology and Colonisation: An Indian Experience, 1757-1857*, Delhi, 6.

steel which was highly recognised in the trading world”.¹⁴²

The modern metallurgical literature was not aware about the smelting of zinc ore to produce metallic zinc in India. Zinc manufactures in India was an ancient industry and there are references for its production as early as the 14th century. Commercial production of zinc metal in Europe did not take place until two centuries later, having been introduced to that continent by traders in the 16th century.¹⁴³

Wood carving was another important traditional industry. In the European travellers account, mention is made of articles of household furniture beautifully carved bedsteads of different colours and designs, writing desks most skillfully inlaid with mother of pearls, ivory, gold silver and precious stones. The houses of the rich had luxuriously carved pillars, doors and window brackets. The Jain temple, about which Narmada Shankar writes, has even now, the original carved pillars and some of the old houses in Gopi Pura *Chakla* in Surat have profusely carved wooden work supporting the pillars and windows. Cart making, wooden dolls and idols were popular industry.¹⁴⁴

Establishment of British rule definitely led to the decline in those non-agrarian sectors which were based on local demands. Pre-colonial India had a notable iron and steel industry. The quality of its iron was well regarded and its damascened stud was world famous.¹⁴⁵ According to Irfan Habib, the policy of British government was responsible for depletion of forest, which in turn, resulted into high cost of charcoal. Further, the native iron manufacture could not withstand the influx of British iron imports. A similar decline beset the hand paper industry as Charles Wood, Secretary of State for India ordered that all papers required for government purposes to be purchased only in Britain. The glass industry also suffered as cheap

¹⁴² Hamida Khatoon Naqvi (1982), “Technology and Process of Some of the Principal Industries of 18th Century Hisdustan”, 63-64.

¹⁴³ A. Rahman (1984), “Science and Technology in Medieval India”, in A. Rahaman (ed.), *Science and Technology in Indian Culture: A Historical Perspective*, New Delhi: NISTADS, 131.

¹⁴⁴ V. A. Janaki (1974), *Some Aspects of the Historical Geography of Surat*, 16.

¹⁴⁵ Irfan Habib (2007), *A People's History of India: Indian Economy, 1858-1914*, AHS, New Delhi: Tulika Books, 97.

imported glass bangles flooded the Indian market. These imports also hit the making of lac bangles in India, a widespread village industry.¹⁴⁶

Navigation

The pre-colonial knowledge in the field of navigation was based on systematic understanding of condition of stars, use of maps, knowledge about the nature of oceans and manufacturing of vessels which registered the Gujarat region prosperous in terms of exchange of commodities across the regions.

The country made vessels were largely employed for inter-coastal trade. The small frigates fit to row or sail, made with prows instead of beaks were more useful in rivers and creeks than high seas.¹⁴⁷ In contrast, though big ships were used extensively, it had its own limitation. For instance, big merchant ships such as ‘Fateh Mahmood’, ‘Gunj Swaie’, etc., belonging to Abdul Gaffar and Aurangzeb were captured by the English pirates namely Every, Kid and Green from Gujarat ports.¹⁴⁸

Radhakumud Mookerji refers to the potentiality of western India in the field of navigation. Ship industry in Gujarat was based on scientific understanding since antiquity. For construction of a vessel, following precautions were taken. Ships made of different classes of timbers rot fast in the water and liable to split at the slightest shock of the sea wave and would sink. Bottom of the vessels should not use iron which would attract the influence of magnetic rocks present in the sea. One of the European travellers observes that lower part of a vessel was constructed with triple planks to withstand the force of the tempests to which these were exposed. For deep channels of sea where anchors could not be laid, ships were built with prows at each end for turning about in channel of extreme narrowness. In case of no visibility of stars, birds were used to locate the nearest land by the mariners.¹⁴⁹

¹⁴⁶ 97-98.

¹⁴⁷ S. B. Rajyagor (1982), *History of Gujarat*, New Delhi, 337.

¹⁴⁸ *Ibid.*

¹⁴⁹ Radhakumud Mookerji (1912), *Indian Shipping: A History of the Sea-Borne Trade and Maritime Activity of the Indians from the Earliest Times*, Bombay, 21, 25, 46 & 103.

Radhakumud Mookerji further informs us about the sizes and quality of woods used. Ships were built of fir-timber; they were all doubled-planked, that was, they had a course of sheathing boards laid over the planking in every part. These were caulked with oakum either with or without, and were fastened with iron nails. The bottoms were smeared over with a preparation of quicklime and hemp, pounded together and mixed with oil procured from a certain tree, which made a kind of unguent that retain its viscous properties more firmly and was a better material than pitch. Some ships of the larger class had, besides the cabins, as many as thirteen bulkheads or divisions in the hold, formed of thick planks let into each other (rabbeted). The object of these was to guard against accidents which might make the vessel spring a leak, such as striking on a rock or receiving a stroke from a whale. For if water chanced to run in, it could not, in consequence of the boards being so well fitted, pass from one division to another, and the goods might be easily removed from the division affected by the water. In case of a ship needing repair, the practice was to give her a course of sheathing over the original boarding, thus forming a third course, and this, if she needed further repairs, was repeated even to the number of six layers, after which she was condemned as unserviceable and not seaworthy.¹⁵⁰

With reference to Gujarat, one can observe that the seafarers from Gujarat were good in cartography. National Museum, New Delhi houses one of such *Malam pothis*. One map is brought to the public sphere by Samira Sheikh traced from the St. John's College, Oxford, UK. The manual known as *pothi*, a form of book style, is in Gujarat along with Persian words which show that Indian sailors were benefitted by the map making technique from Arabs and traders of Indian Ocean Zone. This pilot manual tells us about location of various ports and directions to be used by the sailor.¹⁵¹

A detailed description of the ship building industry in Surat is given by Stavorinus.¹⁵² The yards he says were places like graving docks hollowed out on the banks of the river. An earthen dam was built to protect the water from entering the

¹⁵⁰ *Ibid.*, 191-93.

¹⁵¹ Samira Sheikh (2010), "A Gujarati Map and Pilot Book of the Indian Ocean, c.1750", *Imago Mundi: The International Journal for the History of Cartography*, 61 (1), 67.

¹⁵² V. A. Janaki (1974), *Some Aspects of the Historical Geography of Surat*, 17.

yard while the ships were being built and the yard was closed towards the river. The dam was removed when the ship was ready to be taken into the water.

Boats and ships of different sizes for different purposes were built in various parts of India. The local boats ranged from small crafts of five tons burthen to fair-sized scows of sixty tons. Some drew as little as eighteen inches of water and others as much as five feet. Ships were built at Surat, Bombay and Daman. Surat was famous for the construction of fine ships of all sizes and capacities over thousand tons. In fact, the carpenters of Surat ship wrights had become experts and many of their ships exceeded in shape those that come out of England or Holland. Indian ships were also superior on account of their durability. Ships made of Malabar teak in the Bombay dockyard were seaworthy even after fifty years of service, while English ships made of oak and elm, seldom lasted more than three voyages.¹⁵³

From the above discussion we can assume that pre-colonial India was not lagging in terms of both agrarian and non-agrarian production. The traditional process used by the peasants and the artisans' generated enough surplus to fulfill the demands not only for the local markets but across the Indian Ocean rim. The quality and quantity was excellent and it was well acknowledged by the European travellers too. They were impressed by the skills of natives about their understanding of manufacturing processes which were based on judicious use of indigenous ecology.

The discussion about the pre-British Gujarat agrarian scenario clearly establishes the potentiality of the sub-regions. The existing set up created an environment for the Britishers to impose the European technical skills employed in Europe. The next chapter will offer a discussion about the interaction between the indigenous and European agrarian mode of production and also about the emergence of "hybrid agriculture".

¹⁵³ Satpal Sangwan (1991), *Science, Technology and Colonisation: An Indian Experience, 1757-1857*, 6-7.