Artificial irrigation is of fundamental importance in the economy of a predominantly agricultural country like India.\(^1\) Primitive man had known water-deficient areas since time immemorial. But so long as he was mainly a food gatherer, he had little need for planned water-supply for irrigation. Pastoral nomads frequently supplemented their economy by agriculture, but as they had to move their herds, from place to place, they paid only casual attention to whatever crops they grew near their camping-sites.\(^2\) Their migratory way of life prevented them from constructing permanent irrigation works, which form the basis of settled agricultural economy. It was only when man became an intentional food-producer that he began to appreciate the agricultural possibilities of dry areas that contained sources of water-supply other than on-the-spot rainfall.

\(^{\text{1. Sir Charles Travelyan rightly points out that}}\) irrigation is every thing in India. Water is more valuable in India than land, because when water is applied to land it increases its productivity at least six-fold and generally a great deal more; and it renders great extent of land productive'. See Indian Rural Economy, p. 165. Also see M.H. Gopal, Mauryan Public Finance, p. 185.

\(^{\text{2. Karl A. Wittfogal, Oriental Despotism, New Haven, 1957, p. 204.}}\)
In India, the prehistoric food-gatherer had turned an ‘intentional food producer’ at an early stage.¹

The rulers of the Nile and the Tigris valleys encouraged artificial irrigation.² Agriculture on those lands was practically based on artificial irrigation, though the engineering skill was not of a high order.³ The Indus economy like the Egyptian and the Babylonian also rested on irrigation farming.⁴ The people of the ‘Harappa Culture’, who by their technical skill developed the system of town-

1. V.D. Krishnaswamy, ‘Neolithic Pattern of India’, Presidential Address, Indian Science Congress, Delhi, 1959, p. 1. Mortimer Wheeler states that the change from parasitic to productive life can be definitely seen much earlier in western Asia. In lower Mesopotamia, the great achievements of the Ubaid period (4400 B.C. - 3950 B.C.) were the creation of rural economy, the maintenance of canals, rational utilization of land and water. See Early India and Pakistan, London, 1959, p. 108.


planning along with underground drainage schemes as early as the third millennium B.C., must have had a thorough knowledge of artificial means of irrigation. Recent excavations at Lothal (Gujarat) have brought to light traces of a canal.¹ But we have no clear evidence to prove that the canal water was used for irrigation purposes. It seems that the agrarian economy of these people was sustained by various minor irrigation works.² Besides the use of wells and periodic floodings, the construction of short-length canals in order to increase the flooded area that could serve small land-holdings appears to have been the usual mode of irrigation.³ This is suggested by the discovery of dams at Amri and in the Las Bela region.⁴


In the fertile plains of Ganga, only artificial irrigation could secure good crops.\(^1\) There are numerous references in our sources which prove that artificial means of irrigation were employed by the early settlers in the Ganga plains.\(^2\) We have evidence to the fact that the Dravidians of northern India were acquainted with the construction of 'tanks' for irrigation.\(^3\)

The importance of rains to agriculture was fully realised during the *Rigvedic* period.\(^4\) The hymns in the *Rigveda* dilate less on the human struggle with nature than on prayers directed to Indra, the rain-god.\(^5\) In the *Mahābhārata* also, we have references to the importance of

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1. 'The government of ancient Egypt and Indostan', states Adam Smith, 'were particularly attentive to the interests of agriculture. The works constructed by the ancient sovereigns of Egypt for the proper distribution of waters of the Nile were famous in antiquity, and the ruined remains of some of them are still the admiration of travellers. Those of the same kind, which were constructed by the ancient sovereigns of Indostan for the proper distribution of waters of the Ganges --- though they have been less celebrated, seem to have been equally great'. See *The Wealth of Nations*, Vol. II, London, 1950, p. 179.


5. *Ibid.*, III, 8 ; VIII, 118.55 ; X, 42.
rains to agriculture. The monsoon regions are particularly liable to famines, since the prosperity of agriculture depends upon a short season of abundant rainfall in summer. When the rain is scanty or delayed, famine conditions develop. There are numerous references to famine in the Buddhist literature. "Sakka, for the space of three years, stopped rain from falling in the kingdom of Kasi, and the country became as it were scorched up and no crop came to perfection ---." There was a drought in the land of Kosala and the crops withered. In the Rāmāyaṇa, we read of a famine in the kingdom of Aṅga. Similarly, in the Mahābhārata, there is reference to drought that occurred due to the failure of monsoons. Diodorus, relying on the account of Megasthenes, states that "famine has never visited India and that there has never been a general

1. 'Without rains, however, O son of Kunti, it never yieldeth crops'. Indeed, in the absence of rains, people speak of an artificial irrigation --- but even then --- the water, artificially let in, is dried up in consequence of a providential drought. See Udyogāṇa, V, 78.
2. In the itayah of the Mahābhārata and the daivapīdanams (providential calamities) of the Arthaśāstra, flood by excessive rains also figures as the forerunner of famine. Mbh., V, 60.17 ; AS., VIII, 4.
3. Mahāvagga, VI, 23.10 ff ; Jāt., V, 193 f ; I, 331 ; II, 149 ; VI, 487.
5. Ibid., I, 75.
6. Rām., I, 8.
7. Mbh., Śaanti Parva, 141.
scarcity of nourishing food".¹ This sweeping statement, however, does not fit in well with the available evidence.² There is a clear mention of famines in the Arthaśāstra.³ The Jain tradition also refers to a famine during the reign of Chandragupta Maurya.⁴ The most severe impact of the famine was felt in the Ganga plains.⁵ This fact is borne out by two Mauryan inscriptions at Mahāsthan and Sohgaura, which refer to the measures adopted to ameliorate famine conditions in the Ganga valley.⁶ In the Jātakas, we find reference to a famine caused by drought in the Kalinga country.⁷ Kauṭilya has listed detailed measures for famine-relief.⁸

The climatic conditions in the Ganga plains --- uneven rainfall, violent overflow of rivers during the period of monsoons, abrupt changes in temperature --- all called

1. Diod., II, 36 ; J.W. McCrindle, Ancient India As Described by Megasthenes and Arrian, Calcutta, 1877, p. 32.
2. Vinaya, I, 211, 213 ; III, 220 fn. 1 ; Jāt., I, 329 ; II, 135, 149, 367 ; V, 193 ; VI, 487.
3. AS', IV, 3.
5. For details, see M.D.N. Sahi, 'Famine in the Ganga Valley ---'. Proc.IHC, Jabalpur, 1970.
7. Jāt., II, 276 ; VI, 547.
8. AS', IV, III.
for artificial irrigation. Words like 'kulyā' meaning canal, 'khanitrima' produced by digging', in the Rigveda refer to artificial channels used for irrigation.  
Similarly, in the Yajurveda, words like 'sarasi' and 'kulyā' are referred to as meaning dam or reservoir and canal, respectively.2 The Atharvaveda, while describing the digging of canal from river, allegorises the former as a calf and the latter as a cow.3 In the Rigveda, reference is also made to the wells.4 On the basis of these references, Romila Thapar inferred that artificial means of irrigation were used in the watershed area and the upper Ganga plain during the Rigvedic period.5 In the Epic, Rama praises the land of Kosala as adevamāṛkāḥ, i.e., relying on irrigation and not on rainfall.6 In the Mahābhārata, Narada's anxiety to know from Yudhishtira whether irrigation works are built at proper distance, without leaving agriculture at the mercy of rains, indicates the importance attached to artificial irrigation.7 In the same context, he adds that to provide

1. Rigveda, III, 45.3 ; VII, 49.2 ; X, 43.7 ; Macdonell and Keith, Vedic Index, Delhi, 1967, Vol. I, p. 173.
3. Ibid., p. 214.
5. Romila Thapar, From Lineage to State, Bombay, 1984, p. 29.
6. Rām., II, 100. 45.
7. Mbh., Sabhā Parva, 5.77
irrigation facilities to cultivators should be the duty of a righteous king.¹

The Buddhist sources refer to the builders of canals and the measures for regulating the inlet of water to fields after sowing.² In his commentary on Sāṁyutta-Nikāya, Buddha-ghosha mentions that the fields in Magadha were divided into plots of a regular shape and were irrigated.³ The Milinda Pañho refers to wells and artificial lakes which served the purpose of irrigation.⁴ Due attention was paid to irrigation works in the monarchies and in the republics. Buddhaghosha, in his commentary on Dīgha-Nikāya, mentions a dam on the river Honini built by the Koliyas and the Sakyas for irrigation purposes.⁵ Although irrigation works are reported far back in remote antiquity, yet they became widespread under the Mauryas when the State began to take active interest in agriculture.⁶

In the Ganga plains, early cultivation was probably confined to the immediate vicinity of rivers, where the

¹. *Ibid.*, Sjānti Parva, 43. 7 ; 86. 15.
². *Dhammapada*, 80, 145 (*udakaṁ hi nayanti nettikē*); Cūḷavagga, V, 17. 2 ; VII, 1.2.
³. On *Sāmyutta Nikāya*, I, 1127. Also see *Vinaya*, I, 287.
soil was moist, and where wells, if used at all for irrigation, would have been mere pits in the soft soil.\textsuperscript{1} When people learnt to cut canals inland from the rivers or to sink deeper wells and lift water by some mechanical devices, cultivation spread to wider areas. Though most of the Painted Grey Ware (PGW) settlements were situated closer to the river banks, yet there is an evidence of some similar settlements located away from the perennial source of water-supply. Subsistence of these settlements could not have been possible unless the artificial sources of water were tapped, not only for the daily needs of the people but also for irrigation of land.\textsuperscript{2}

With the clearance of forests and increase in population, famine became a major agrarian problem and both the rulers and the ruled turned to mechanical devices against flood and drought. Irrigation works were undertaken and also encouraged by the State.\textsuperscript{3} Megasthenes refers to an extensive system of irrigation in the Ganga plains; 'The greater part of the soil is under irrigation and consequently bears two crops in the course of a year'.\textsuperscript{4}

\begin{enumerate}
\item Baden Powell, \textit{The Indian Village Community}, p. 51.
\item See M. H. Gopal, \textit{Mauryan Public Finance}, p. 185.
\item Diod., II, 35 ; Strabo, XV, 1.20.
\end{enumerate}
Large areas in the Ganga plains were watered by the river and its tributaries.¹

The general pattern of artificial irrigation in the Ganga plains seems to have been by wells and tanks. The water from the rivers and canals also served the purposes of irrigation. The Buddhist texts often refer to the ponds which were formed by rain water, and were used for irrigating the gardens and fields close to them.² Kauṭilya says that irrigation works (setubandha) having perennial supply of water are better than those fed by water drawn from other sources.³ Manu enjoins that the boundary between two villages should be determined by tanks, ponds, channels and other reservoirs of water.⁴ Obviously, these water-works not only served as boundary marks but also supplied water for irrigating the adjacent fields.

A.L. Basham, while describing the general pattern of irrigation works in ancient India, states, 'In the flat plains, the land was cut by canals running from the great rivers and dotted with artificial reservoirs which were made

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1. Diod., II, 36-37; Strabo, XV, 1. 17; Dhamapada Commentary III, 254; Mahābhāṣya, III, 316; Milinda Pañho, p. 382; Ind. Ant., 1908, p. 233. The land irrigated by river water was called nadiṃatrika.


3. ASʾ, VII, 12.

by damming smaller streams or enlarging lakes by stopping their outlets'.\textsuperscript{1} Strabo refers to the embanked canals from which the water was distributed to channels so that wider areas could be irrigated for cultivation.\textsuperscript{2} He had evidently in view the perennial canals, which ensured water supply all the year round. The construction of a canal is beyond the means of an individual, and as such, a canal could be dug either by the co-operative efforts of the village community or by the State. Once the canal water was made available, larger areas could be irrigated with less labour.

A canal of the Maurya times has been discovered at Kumrahar, a village about three miles east of Patna railway station. It was linked with the river Son and through it, with the Ganga and was used for bringing monolithic pillars from the Chunar quarries.\textsuperscript{3} Whether it served the purposes of irrigation or not remains a matter of conjecture due to the lack of evidence on the point. D.R. Bhandarkar discovered traces of another canal at Besnagar in Madhya Pradesh. At the excavated site, it was seven feet broad and its walls were five feet six inches high. In Bhandarkar's opinion, the canal might have been Maurya or possibly pre-Maurya in origin and that it served the purpose

\begin{enumerate}
\item A.L. Basham, \textit{The Wonder That Was India}, p. 192.
\item Strabo, XV, 1. 50.
\end{enumerate}
of irrigation.\(^1\) Patanjali refers to canals used for irrigating rice-fields during the Sunga period.\(^2\) The Hathigumpha Cave Inscription (c. 1st Century B.C.) records that king Kharavela of Kalinga repaired and extended an old canal which was originally dug by the Nanda king three hundred years earlier.\(^3\) Obviously this canal greatly helped irrigation.\(^4\) The canals perhaps also helped in controlling inundation by rivers, for these are referred to as jalanirgamaḥ (drains) in the Amarakosha.\(^5\)

Tanks, wells and reservoirs seem to have received greater attention in early India than the major irrigation works. From the Rāmāyaṇa, we learn that the region of Ayodhya abounded in tanks and reservoirs.\(^6\) Similarly, wells are mentioned in the waterless places in the Kosala region.\(^7\) The Buddhist works frequently refer to the construction of tanks, wells and reservoirs by the rulers and the ruled in

4. B.M. Barua, Old Brahmi Inscriptions, pp. 43, 290.
7. Ibid., 80.
many parts of the Ganga valley.\textsuperscript{1} There are references to wells used for irrigation in early law-books.\textsuperscript{2} Kautilya says that tanks and wells should be built in barren and less fertile parts of the country.\textsuperscript{3} In the newly established villages, the king was expected to construct reservoirs with perennial water supply.\textsuperscript{4} The construction of irrigation works was considered an important form of charity.\textsuperscript{5} The inscriptions of Ashoka refer to the construction of wells.\textsuperscript{6} The tanks belonging to pre-Kushana and Kushana period have been excavated at Thanesar, Ahicchatra (near Bareilly), Kausambi, and Bhita near Allahabad.\textsuperscript{7} About half a dozen such tanks have been found in the Hastinapur area alone.\textsuperscript{8}

\begin{enumerate}
\item Jāt., I, 99 ; II, 70 ; III, 216, 270 ; V, 106.
\item Baud., II, 6. 11. 25 ; II, 3.5.6 ; II 3.6.27 ; Gaut., IX, 10.
\item Aś, II, 34.
\item Ibid., II, 1, (sahōdakamaharyōdakam vā sētum bandhayēt)\textsuperscript{7}
\item Baud., II, 3-6 ; Vas., XVII, 8. The digging of tank was considered to be one of the seven great meritorious acts a man was expected to perform during his lifetime, the other acts being the procreation of a son, the marriage of a girl, the hoarding of treasure, the composition of a poem, the planting of grove, and the consecration of a temple. See Ep. Ind., III, pp. 88 ff.\textsuperscript{8}
\item Pillar Edict No VII ; Rock Edict No II. See R.G. Basak, Asokan Inscriptions, Calcutta, 1959, p. 111.
\item See Ancient India, No. 4, p. 125 ; Nos. 10 & 11, pp. 18, 19 ; IHQ, vol. 31 ; pp. 307-308.
\item Ancient India, Nos. 10 & 11, p. 16.
\end{enumerate}
The ring-wells first appeared under the Mauryas in the Ganga plains. Some ring-wells and numerous kaccā-wells are found in small plots of land in the Patna and Muzaffarpur areas.1 Similar discoveries have also been made at New Delhi, Mathura and Ujjain.2 In the post-Maurya period irrigation by means of wells had become more common.3 At Sringaverpur in the upper Ganga plain, a large tank ascribable to around the first century A.D. has been excavated.4 Tanks and wells are frequently mentioned in the inscriptions of Śaka-Kushana period.5 The Mathura Stone Inscription mentions that a brāhmaṇa treasurer of Śoḍāsa (C. 10-25 A.D.) donated a tank, a reservoir and a plot of land which shows the desire of the donor to supply water both for irrigation and drinking purposes.6 The Ara Inscription of Kanishka II belonging to Ist half of the second century A.D., refers to the sinking

6. LL. No. 82 ; H. Chakravorti, Early Brahmi Records of India, p. 50 ; Sel.Inscr., p. 119 ; Ep.Ind., IX, p. 141 ff.
of wells by some persons known as dasavharas. In the later part of the second century A.D., Rudrabhūti, the general of Rudrasimha the Śaka ruler of Ujjain, caused a tank to be dug in a village of Rasopadra near Kathaiwad for the welfare and comfort of all living beings. The Sanchi Inscription, belonging to the third century A.D., records the digging of a well by a Śaka chief for the perennial supply of water for all. The Mandara Hill Rock Inscription of Adityasena, assignable to the seventh century A.D., records the construction of a tank in Bhagalpur area by Konadevi, wife of Adityasena. In some Gupta inscriptions, we come across the term vāpi meaning water tanks which were used both for irrigation and drinking purposes in central India and Gujarat. The tanks and wells were dug by individuals to increase religious merit.

The State in early India took initiative, though on a limited scale, to provide irrigation facilities to the 

2. Ibid., XVI, pp. 16 & 232; Sel. Inscr., pp. 154-55.
3. A.N. Bose, Social and Rural Economy, p. 103.
4. CII., III, No. 44, pp. 211-12.
5. Ibid., III, pp. 75, 166, 199; Ep. Ind., XI, pp. 107, 111, 113.
peasants. In addition to canals, wells and tanks were also
dug by the State for irrigation purposes. The Junagarh Rock
Inscription of Rudradaman dated C. 150 A.D. furnishes an
evidence of the concern which the Mauryan rulers showed
towards the construction of irrigation works in the most
distant regions of their empire. Pushyagupta, the
provincial governor of Ujjain, thought that by constructing
a dam on a small stream, a reservoir of great value for
irrigation could be provided. Accordingly, he developed a
lake, but could not complete the necessary supplementary
channels for irrigation purposes. These were completed in
the reign of Ashoka. From this evidence, we can infer that
many more such works must have been undertaken by the State
in the Ganga plains which formed the core area of the
Mauryan empire.

In addition to the State constructing and repairing
both major and minor irrigation works, individuals were also


p. 27. The Sudarsana lake in Saurastra marks the
beginning of the recorded history of tank and bund
irrigation. See Irfan Habib, 'The Peasant in History',

3. The beneficial work undertaken by the Maurya ruler
lasted for about four hundred years. In c.150 A.D.,
the dam bursted due to heavy rains, but was repaired by
Rudradaman, the Saka ruler. See *Ep. Ind.*, VIII, 6. It
again bursted during the reign of Skandagupta and was
repaired by the State. See CII., III, No. 14, p. 56 ff.
encouraged to build and restore the same. People constructing new irrigation works and repairing the old ones were provided with many facilities by the State. The sites, roads, timber and other necessary materials for construction were made available to them.\(^1\) In such undertakings people from the neighbouring areas were required to co-operate and send bullocks to carry on the work.\(^2\) The State remitted taxes for some years on those who constructed and repaired wells, tanks, and reservoirs.\(^3\) By the first and second centuries A.D., many towns had developed in the Ganga plains.\(^4\) As foodgrains could not be easily brought from long distances, intensive cultivation became necessary in the countryside surrounding the towns. It could have been possible only if irrigation facilities were made available to the cultivators. That individual initiative played a considerable role in the construction of irrigation works in such areas is borne out by a number of inscriptions

\begin{enumerate}
\item AS\(^.\), II, 1. (anyēṣham vā bondhatam bhūmi margavṛk shōpa karaṇāṇūgraham kuryāt)
\item Ibid., II, 1.
\item When irrigation works were newly constructed by individuals, taxes on their lands below such works were remitted for five years; when ruined and neglected works were repaired, the taxes were remitted for four years; and for improving and restoring the irrigation works overgrown with weeds, taxes were remitted for two years. See AS\(^.\), III, 9.
\item R.S. Sharma, Perspectives in Social and Economic History of Early India, p. 168.
\end{enumerate}

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belonging to the Saka-Kushāna period.1 Dion Chrysostom (C.A.D. 50-17) also states that in order to carry water from large and small rivers to their fields, the local inhabitants made many channels.2 The Ara Inscription of Kanishka II alludes to a well dug by an individual for the welfare of all beings.3

Manu lays down that seizure of houses, tanks, orchards and fields by others is a crime of great magnitude.4 The reference to tanks in the list shows that these were constructed and owned by individuals for irrigation purposes. At another place, amongst other things, selling one’s tank, garden, wife or child is declared a sin to be expiated by penance.5 Nārada states that when a man repaired a dyke without the permission of its owner, he would not be entitled to any profit out of it.6 Thus, the law-books suggest some kind of individual ownership of irrigation works. Moreover, in the absence of much evidence about large irrigation works undertaken by the State, it seems that irrigation was mostly an individual enterprise.

2. J.W. McCrindle, Ancient India as Described in Classical Literature, p. 175.
5. Ibid., XI, 62.
during the post-Maurya period.

The ideal of religious toleration and co-operation has always been a living force in India. Buddhism with its principles of liberty and equality gave a powerful impetus to this ideal in the Ganga plains at a very early stage, and it was reflected in the sphere of irrigation as well.\(^1\) We have references in our sources where all members of the village community co-operated in constructing irrigation works. The Jātakas refer to villagers digging water reservoirs and making dykes.\(^2\) In the Jātakas, there is also reference to fields which were separated from one another by channels dug for co-operative irrigation.\(^3\) Kautilya lays down that in case a peasant could not participate in the construction of co-operative irrigation works, he should bear his share of the expenses.\(^4\) Manu lays down that if a

\(^1\) According to D.A.L. Stede, 'irrigation is one of the strongest agencies in promoting civilization, for it encourages providence and care, and by teaching people to live in peace and submit to the will of the majority, fosters communal existence and co-operation without which progress is impossible'. See 'The Importance of the physical features of India for the understanding of her History', Indian Culture, vol. II, Calcutta, July 1935, p. 7.

\(^2\) Ibid., I, 99, 336.

\(^3\) Ibid., I, 336; IV, 167; V, 412. The cultivated fields of Magadha, which were thus divided by channels rectangular and curvilinear, bore the appearance of the patched robe of a member of the Buddhist Saṅga. Rhys Davids, Buddhist India, p. 24.

\(^4\) AŚ., II, 1.
villager does not co-operate with others in case of breach in the embankment of watercourses, the king should expel him from the village.\(^1\) Brihaspati says that the various guilds should look after the irrigation dams.\(^2\) All this shows that the irrigation works were mostly constructed and repaired by the collective endeavour of the villagers.\(^3\) Moreover, as the land grants, which became a common feature of the land system from the Gupta period onwards, led to the rise of local units of production, it seems that to provide irrigation facilities had become a local responsibility in such areas.\(^4\)

Various methods were employed for lifting water from wells, rivers and reservoirs for irrigating the fields. In the Rigveda, mention is made of wells from which water was drawn by means of strong ropes, and it flowed through channels into the fields.\(^5\) In the Cûlava Ga Jâtaka, the

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1. Manu, IX, 272 & 274.
3. The small irrigation works like wells, tanks and river channels all required local co-operation rather than State organisation. See Romila Thapar, The Past and Prejudice, p. 59.
5. Rigveda, VIII, 9. 12. X, 101. 6; Also see S.P. Raychaudhuri et al. (ed.), Agriculture in Ancient India, New Delhi, 1964, pp. 353-54. The water was raised from the wells by a wheel of stone (chakra) to which was fastened a strap (varatra) with a bucket (kosha) attached to it. See Rigveda, X, 101. 5-7.
lever (tulum), bullocks (karakaṭaka, karakaṭanka, karakaḍaka), the wheel and axle (cakkavattakam), are referred to as the means of drawing water from irrigation sources.\(^1\) Pāṇini mentions a leather basket for lifting water (uddāncana) and the yoke (yugavaratra) put on oxen for drawing up the leather basket.\(^2\) Kautilya describes different methods used for lifting water from water reservoirs.\(^3\) These included drawing water by manual labour (hastapravartiman), by the water-lifts worked by bullocks and by means of wind power (vātapravartima), etc. The term ‘hastapravartiman’ is not very clear. Perhaps, it implied the system of irrigation in which two persons standing on opposite sides and holding the ropes attached to a leather basket throw water from a low level to a higher level.\(^4\) In the Nāsik Buddhist Cave Inscription of the time of Raja Maṭhairiṣṭhīra Iśvarasena, the Abhira ruler (c. 248 A.D.), there occurs the term ‘odayantrikas’, which has been explained by Senart as a guild of workers manufacturing some kind of hydraulic engines.\(^5\) It can not be said with certainty whether these engines were used for lifting water for irrigation purposes or not. R.S. Sharma, however,

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2. V.S.Agrawala, India As Known to Panini, p. 204.
3. AS\(c\), II, 24; III, 9.
4. See N.N.Kher, Agrarian and Fiscal Economy, p. 176.
5. Ep. Ind., VIII, p. 89; LL. No. 1137.

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suggests that these engines had some connection with raising water from different sources for irrigation. But we have no evidence of the use of such mechanical devices in the Ganga plains.

The term araghaṭṭa is mentioned in a number of inscriptions. It was a technique used for lifting water from wells and other water reservoirs by working at spokes. A series of earthen pots tied to the periphery of a wheel were driven by the water current in a stream. The pots were so inclined to the axis that they dipped and filled while in water, and emptied while passing a trough placed above the shaft. It was also called as ghaṭi-yantra, ghaṭa-chakra and udghāṭana. Bāṇa was perhaps referring to the same method of lifting water when he said that the farms were "watered by the pots of the Persian wheel".

1. See Perspectives in Social and Economic History of Early India, p. 169
3. The device udghaṭana consisted of a drum-shaped wheel turning in a vertical plane over water, round which went a pair of endless ropes with earthen pots tied to them at equal distances. The wheel had spokes at one end and worked like a capstan. See H. Chakravorti, 'History of Irrigation in Ancient India', Proc. IHC., Jabalpur, 1970, p. 153.
The water requirement of a crop is not consistent throughout its growing period; some crops need more water at early stages than in the later period, while the reverse is the case with some other crops. Only controlled water supply can prove most beneficial to the cultivators. The irrigation operations, therefore, were designed to regulate the inflow of water into the fields. The irrigation works were controlled by specialists who regulated the supply and distribution of water in a planned way so that every peasant had his share. Under the Mauryas, there was an official agency for supervising the proper distribution of canal water among the peasants, which was controlled through sluice-gates. Megasthenes observed, "some superintend the rivers -- and inspect the sluices, by which water is let out from the main channels into their branches --- to see that there is an equal supply of water to the people." Megasthenes makes it clear that the government was the distributing agent of irrigation water, but he does not provide organisational details. Strabo refers to a class


2. Dhammapada Comm., 80, 145. (udakam hi nayanti nettikā). "The nettikās, to judge from the commentary and from the general purport of the verse, are not simply water-carriers but builders of canals and aqueducts who force the water to go where it would not go by itself" --Max Muller's note on Dhammapada, SBE series.

of royal officers who supervised the canals. It seems that these functions were, to some extent, performed by the official called nadīpāla. But Kauṭilya states that the sītādhyaksha had the general control over state-owned irrigation works. His duties, among other things, consisted of letting in water to the fields from nādi (river), tāṭāka (tank or reservoirs), kūpa (wells), and saras (lakes) by regulating the sluice-gates. Romila Thapar holds the view that irrigation was controlled by the office of the rājūkas or agronomoi of Megasthenes.

The State considered it a duty to safeguard the rights of the cultivators to the use of irrigation works even if these lay in others’ fields. When Devendravarman, the Ganga king, granted a hala of land including the watercourse and the house site, the brāhmaṇa donee was clearly instructed to share the water during summer (grīshmodaka) 'equally with the (other) families'. The use of the irrigation works constructed by the State required the prior permission of the State authority. The brāhmaṇa donee of a plot of land in the village of Siddārthaka had to procure from the donor,

1. Ibid.
2. AŚ., II, 6.
3. Ibid., II, 24.
Indravarman II, the specific permission for using water from the nearby rājataṭaka for irrigation purposes.¹

In view of the importance of artificial irrigation, the State paid due attention to the protection of the irrigation works. Rules were framed by the law-givers for their protection. Heavy fines and severe punishments were imposed on those who caused damage to irrigation works.² Kautilya says, 'persons who cultivate the lands below tanks, etc., of others at a stipulated price (prakraya), or for annual rent (avakraya), or against some share of the crops grown (bhāga), or persons who are permitted to enjoy such land free of rent of any kind, shall keep the tanks, etc., in good repair; otherwise, they shall be punished with a fine of double the loss.'³ Moreover, the water of irrigation works could be let out only through the sluice-gates (apare) and any one attempting to hinder the flow of water from these outlets was punished with a fine.⁴

The damage to irrigation works was considered a heinous crime comparable to the destruction of a child in the womb and the culprit was liable to be punished by drowning with

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1. Ibid., III, pp. 127 ff.
2. AS', II, 1.
3. Ibid., III, 9.
4. Ibid.
a stone tied to his neck.\textsuperscript{1} Kautilya suggests similar punishments depending upon the nature of the crime committed.\textsuperscript{2} The law-givers also prescribe very stringent penalties for those who cause any damage to water reservoirs. Manu ordains that one who destroys the embankment of a reservoir shall be either drowned in water or put to death by beheading.\textsuperscript{3} He further lays down that if someone makes an unauthorised use of a tank or destroys a channel of water by raising embankments, he shall be punished with the heaviest fine.\textsuperscript{4} Vishnu prescribes death penalty to those who destroy embankments.\textsuperscript{5} Brihaspati lays down that he who causes any damage to irrigation works shall be fined hundred \textit{paṇas} or more depending upon the nature of the offence.\textsuperscript{6} For the purpose of maintaining the existing irrigational facilities, the \textit{Arthasastra} enjoins collective

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\item V.R.R. Dikshitar, 'A History of Irrigation in South India', \textit{Indian Culture}, vol. XII, 1945-46, p. 77.
\item According to Kautilya, when a person causes any damage to a tank full of water, he shall be drowned in the same tank. If a person causes any damage to a dry tank or to a tank which is in ruins owing to neglect, the culprit should be punished with a heavy fine or some punishment according to the crime committed. See \textit{As'.,} IV, 11.
\item Manu, IX, 279.
\item \textit{Ibid.}, IX, 281.
\item Vishṇu, V, 15.
\item Brih., XXIII, 5.
\end{enumerate
responsibility. The villagers themselves were also aware of the need of protecting the irrigation works. There are instances of agreements among villagers to the effect that they would not cause any damage to the irrigation works, any breach of the agreement being punishable with the confiscation of a portion of the land of the offender to the village temple. Sometimes, the village community engaged some persons to look after the communal water reservoirs.

There is a difference of opinion among the scholars regarding the imposition of irrigation tax by the State. Irrigation being so vital to agriculture, any tax on water by the State would mean its great control over the peasants. Bhattasvāmin, in the course of his commentary on a passage in the Arthaśāstra, observes that those well-versed in the Śāstras declared the king as the lord of both land and water. Kauṭilya distinctly mentions udakabhaga, which along with land revenue, was charged from the peasants in

1. AS., II, 1 ; IV, 10. Pāṇini refers to the cleaners of the village wells - VI, 3.60. As every member of the village community got his share of the water supply from the irrigation works, they were required to contribute towards the upkeep of these works.


the form of a share of the produce.\textsuperscript{1} He further lays down different rates of irrigation cess depending upon the methods employed in irrigating lands.\textsuperscript{2} Medhātithi, in his commentary on Manu, observes that the king could stop water supply to those villages that did not contribute something in return to the State.\textsuperscript{3} It implies that in return for the use of water for irrigation, the villages were expected to pay some tax to the State in one form or the other.

On the basis of the statements of Kautilya and Megasthenes, M.H. Gopal has arrived at the conclusion that an irrigation tax was charged by the State from the peasants.\textsuperscript{4} The same view has been expressed by A.N. Bose.\textsuperscript{5} Lallanji Gpoal, on the other hand, not agreeing with their views, concludes that the State in ancient India never

\begin{enumerate}
\item \textit{Ibid.}, II, 24.
\item Those who irrigate their lands by manual labour (hastaprāvartimam) shall pay one-fifth of the produce as irrigation cess; those who carry water on their shoulders for irrigation (skandhaprāvartimam), shall pay one-fourth of the produce; and those who employ some mechanical devices, shall pay one-third of the produce. Kautilya refers to general irrigation tax when he lays down that those who irrigated by raising water from the rivers, lakes, tanks and wells, shall pay one-fourth of the produce. See \textit{AS'}, II, 24.
\item On Manu, 1. 21.
\item M.H. Gopal, \textit{Mauryan Public Finance}, pp. 71 ff. Megasthenes states, ‘besides the land tribute, they (the husbandmen) pay into the royal treasury a fourth part of the produce’.
\item A.N. Bose, \textit{Social and Rural Economy}, p. 102.
\end{enumerate}

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derived any profit from irrigational works. But irrigation cess cannot be called profit. It could be a means of recovering the cost of construction as well as the maintenance and supervision of such irrigation works. Lallanji Gopal suggests that the irrigation tax was levied only on the crown lands, as it has been mentioned by Kauṭilya while dealing with crown lands. If this tax, he argues, was applicable even to non-crown lands, it would have been one of the chief sources of the State’s income deserving mention in other contexts as well. But its conspicuous absence in the two lists, one mentioning the taxes collected by samāharta among other revenues from rāśṭra and the other dealing with the charges collected by the Superintendent of the Storehouse from several departments, shows that it was a minor tax and a negligible source of income and hence, it has been referred to by Kauṭilya in the chapter dealing with crown lands.

According to M.H. Gopal, the irrigation tax is mentioned by Kauṭilya while referring to crown lands and


2. AS., II, 24. In Lallanji’s view, no such tax was charged from the peasant proprietors in ancient India, and the practice of levying irrigation tax started only in the medieval period. See History of Agriculture in Ancient India, pp. 179-83.

3. For the two revenue lists mentioned in the Arthaśāstra, see AS., II, 6 & 50. For L. Gopal’s arguments, see ‘Irrigation-Tax in Ancient India’, IHQ, pp. 66 ff.
their cultivation, not because the tax applied to crown lands alone, but because it was very natural to enumerate it while treating agriculture and perhaps also because the cess might have been regulated by the Superintendent of Agriculture who was a royal officer. On the basis of Megasthenes' statement, he further states that the peasants paid the land revenue and also another tax, amounting to a fourth part of the produce, which proportion was about the average and more commonly paid amount of water cess. Kauṭilya's injunction that when waterworks are constructed by the people themselves, nothing should be charged from them until they realise profit twice the expenditure, shows that the irrigation tax was charged even when the land was irrigated from privately owned waterworks.

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1. To substantiate his view that irrigation tax was levied on non-crown lands as well, M.H. Gopal argues that as the tenants working on crown lands received one-half of the produce when they employed their own capital, and one-fourth or one-fifth of the produce when the State supplied the implements and other necessaries (AS, II, 24), and if, in addition to this, they paid the water charges, i.e., one-third, one-fourth or one-fifth part of the produce as the case was, then practically nothing would be left to them. See Mauryan Public Finance, p. 71.

2. As the statement of Megasthenes has been variously interpreted by Diodorus, Strabo and Arrian, the inference which M.H. Gopal has drawn does not seem to be very sound. For different interpretations of Megasthenes' statement, see F.J. Monahan, Early History of Bengal, pp. 142, 144, 149.

3. According to U.N Ghoshal, irrigation cess was charged at three distinct rates for lands irrigated by the State-owned irrigation works, and a uniform rate of one-fourth part of the produce for lands irrigated by rivers, lakes, tanks and wells. See Hindu Revenue System, p. 43.
It appears that under the Mauryas, the State charged irrigation tax from all the cultivators who benefitted from irrigation facilities. But in the post-Maurya period we do not come across any direct reference to udakabhaga as a separate tax levied by the State on cultivators. It does not occur in the long list of taxes mentioned in the land charters from which the beneficiaries were exempted. Perhaps, the State had relaxed its strict control over agriculture and took a limited initiative in the sphere of irrigation. That left the responsibility for providing irrigation facilities mainly to individual and co-operative hands, and, as such, there remained perhaps no justification for regular irrigation levy. It might be possible that the land revenue included the irrigation tax also as we have seen that the rates of land revenue differed depending upon the nature of land which covered the irrigation facilities as well. Karl Wittfogal, while referring to irrigation, states that the Muslim masters of India exhibited less hydraulic concern than their Hindu predecessors, and that they never fully restored the grandiose hydraulic economy that appears to have flourished in the Mauryan empire.¹

Irfan Habib, refuting the statement in totality, has expressed his opinion that India never possessed hydraulic agriculture on any scale. He also adds that the Muslim rulers of medieval India did not exhibit less hydraulic

concern than their predecessors but, in fact, showed the same indifference to it.\textsuperscript{1} R.S. Sharma, however, is of the view that in most parts of India, irrigation was neither badly needed nor always provided by the State.\textsuperscript{2} But most parts of India, because of climatic conditions, did need artificial irrigation. It is altogether a different matter how much initiative the State took in this respect. At least, the Maurya rulers were not indifferent to this vital aspect of agriculture. In the \textit{Arthasa\'stra}, we find that one of the duties of the Superintendent of Agriculture was to look after irrigation. In the post-Maurya period, though we have instances where the rulers constructed irrigation works, the initiative seems to have been left mostly in private hands.

\begin{itemize}
\item \textsuperscript{1} Ifran Habib, 'An Examination of Wittfogal's Theory of Oriental Despotism', \textit{Studies in Asian History} (ed.), K.S. Lal, Delhi, 1969, pp. 378 ff. Some Muslim rulers of medieval India, on the contrary, showed a considerable interest in the construction and maintenance of irrigation works. See B.N. Datta, \textit{Dialectics of Land Economics of India}, Calcutta, 1952; Elliot and Dawson, \textit{History of India}, Vol. VII, p. 56.
\item \textsuperscript{2} R.S. Sharma, 'Stages in Evolution of Early Indian Society', \textit{The Man and the Scientist} (ed.), G.P. Sinha, Delhi, 1979, p. 205.
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