

2. Domestication and Protection of Plants

2.1. The Beginning of Agriculture

The Quaternary is the shortest of all the geological periods which commenced about a million years ago. It is subdivided into the Pleistocene (the glacial age) and the Holocene or Recent (the post-glacial age). The Holocene began about 10,000 years before present. The vegetation came under human influence during the post glacial period when the Neolithic people commenced agriculture. The successive shifts in the plant populations in response to climatic changes gradually resulted in the present pattern of plant life. The main centre of Neolithic revolution was western Asia and it is in this region that the wild ancestors of two vital cereals wheat and barley are found.¹ A very interesting history of cultivated plants has been reconstructed by the discovery of carbonized seeds and impressions on potsherds found in the archaeological areas of Indus civilization.

In India, the recorded history of agriculture begins with the agricultural practices of the Indus people. That the entire civilization flowered forth as a result of surplus agricultural economy² cannot be doubted. The Harappans cultivated bread-wheat, barley, sesame, peas, melons, bananas, date palm and species of *Brassica*. In a number of Chalcolithic sites in India, both rice and wheat have been discovered. Rice has been found in Ahar in Rajasthan and Navdatoli in Madhya Pradesh. Sorghum has been recorded from Ahar and pea from Madhya Pradesh, carbonised seeds of mung, urd, lentil and bean have also been recorded from Navadatoli.

The earliest direct evidence of the use of rice in India as shown by Chowdhury is from Hastinapur, a Chalcolithic settlement (about 3,000 years ago)³.

The Harappans, wore cotton garment and the history of cotton, a commercially important product from plant can be traced back to the Indus valley civilization. From the sites of the Mahenjodaro cotton cloth and string have been recovered. so, it goes without argument that the Indus valley civilization flourished as a result of brisk agriculture and plant utilization. The economy of the people was based on agricultural produce. Though we have scarce archaeological evidence to make an idea about their agricultural implements or about their agricultural knowledge, Kosambi's opinion is that the Indus people did not have the plough (which is depicted on Mesopotamian seals) but only a toothed harrow which may be recognised as one of their Indus script ideograms.⁴

The intensive excavations at Kalibangan, one of the important pre-Harappan sites in Rajasthan, located on the southern bank of the Ghaggar which is now dry, have laid bare a furrowed field. In the words of Lal⁵ "about a hundred metres to the south of the settlement were identified the remains of an agricultural field, with some of the ploughed furrow-marks still intact. And no less interesting is the fact that the pattern of ploughing the field continues to be the same even now in that region". Sankalia's (referred by Chattopadhyay)⁶ suggestion is that the furrowed field proves the existence of a plough. In this context Chakraborty's opinion is worth mentioning that the terracotta model of a plough at Banawali sets at rest all the hypothesis about the use or non-use of plough in the Harappan civilization. Probably this plough was a wooden one.⁶

Whether this type of plough was tipped with metal could not be determined. The furrowed field at Kalibangan indisputably indicate that even in the third millennium B.C. The technique of agriculture was sufficiently a developed type and "this finding" comment the Allchins,⁷ "therefore, provides a dramatic suggestion that an agricultural practice was already in use during early Indus times which has survived locally till today". It can hardly be denied that before reaching the "Mature Indus style" the pre-Harappans introduced ploughs for cultivation in their formative stage. The Indus people knew the technique of flood irrigation. They could exploit the flood water of the Indus for a successful agriculture and thus by irrigated farming and use of ploughs they produced huge agricultural surplus without which the flowering of such an urban civilization like that of the Indus could not have been possible. As Marshall⁸ truly observes, "Great cities with teeming populations like Mohenjodaro and Harappa could never have come into being save in a country which was capable of producing food on a big scale, and where the presence of a great river made transport, irrigation and trade easy". The transformation of the early Indus culture into the "Mature Indus style" resulted in all probability from the tremendously productive agricultural potentialities of the alluvial soil of the Indus.

The querns have been found in various excavated areas of the Indus. These querns have beyond doubt that the grinding of the grains were carried on a large scale.

The Allchins are prone to give emphasis on the observation of Lambrick about the way of their production and their method of utilization of the flood water of the Indus. The Indus people took the opportunity of the yearly inundation of the river by sowing the cereals like wheat and barley i.e., the rabi crops just at the end of

flood. The area which went under flood water acquired much fertility and gave return on a large scale. The rabi crops were reaped in March and April.

Cotton and sesame were sown at the beginning of inundation and harvested in the autumn as autumn or Kharif crops. The alluvial soil of the Indus yielded large return in lieu of minimum human effort. The vast granaries of the Indus settlement were filled with these huge produce.

"As a matter of fact", comments Chattopadhyaya, "the agricultural products that filled the granaries of the Harappan cities did not presuppose a great deal of skill or improved implements. These presupposed, on the contrary, an understanding and control of annual inundation of the rivers."

The Indus people so can be credited with the knowledge they gathered for exploiting the flood water at its optimum level feasible at that time. The secret of the success in creating a vast agricultural surplus lies in their perfect utilization of the environment created by annual inundation, conducive to agriculture.

The existence of irrigation canals in the Harappan sites indicates their deep interest in improving agricultural technique.

The oldest evidences of the use of wood in the Indian region have been recorded from Harappa proper and from the sites of Harappan culture in Gujrat. For the manufacture of coffin they used rose-wood. It was a particular genus of tall tree. Deodar wood was

22 NOV 2012

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also used for coffin. Both are good for their scent. Further, use of wood is also evident from wooden mortar. The selection of a particular type of wood for a specific purpose indicates that the Harappans were well aware of the different qualities of timber species. Among the old wood, the most interesting is the discovery of wooden tools and implements found at Burzahom in Kashmir valley and Chirand in Bihar. Both the sites belonged to Neolithic culture.³ A thorough analysis of the wood remains proves that the people of that period, gathered sufficient knowledge about different utilities and properties of wood and used them accordingly.

There are other plant remains found at Hastinapur, a Chalcolithic site. Chowdhury and Ghosh⁴ have identified these woods as *Dalbergia sissoo Roxb.* and *Holarrhena antidysenterica Wall.* These were used as fire woods.

The Indus settlement was built up of huge brick construction. The quality of the bricks used in different types of construction is really amazing. Mackay's⁹ observation here, is very clear. He says, "well burnt bricks and those of Mohenjodaro are of excellent quality, are practically indestructible and can be used over and over again, provided that a moderate amount of care is taken in removing them from the old walls".

These bricks were exceptionally well baked and ranged from straw colour to bright red. What a perfect technique for burning the bricks had to be attained, and how huge amount of wood were to be fired for this purpose can be easily imagined.

The informations regarding the Kiln are very scanty, still it may not be an untenable inference that there was evidently no difficulty

about fuel. The earthen potteries and vessels were also to be burnt with wood.

Flood defence probably became a vital problem to the people of the Indus site. The mud bricks were easily soluble and would have been destroyed by heavy rain and flood. To quote here the observation of the Allchins⁶ will not be out of context that "a vital necessity of settlement in the Indus plain itself would have been flood defence, and here it seems that burnt bricks must have played an important role" in the defence.

Though the mud bricks were generally used by the pre-Harappan people, the process of baking the brick by fire had already set in. The sites of Kalibangan and Banawali of the formative period of the Harappan culture may be cited as instances. Burnt bricks were used to safeguard the cities from the natural calamities of heavy rain and flood.

The conjecture that the Indus valley could not have produced sufficient timber for this task of burning the bricks has been set aside by the Allchins. They give emphasis on the opinion of Lambrick that presently the timber grown along the riverine tracts in the Sind is sufficient for burning all the bricks made in the province. In the Harappan times the timber could not have been less abundant. Thus, the plentiful of wood facilitated their process of burning the bricks. It would not be logical to think that an urban settlement with huge construction of bricks could have flourished by importing innumerable ready-made burnt bricks from contemporary settlement of far off countries like Mesopotamia. It is equally illogical to believe that certain part of a territory having no timber and plant resources

of its own could project itself as nucleus of a civilization like that of the Indus.

The picture of the animals of prehistoric India built up from their actual remains and representations on potteries and as figurines claim that the Indus people were well acquainted with the wild animals like tiger, elephant, rhinoceros, and buffalo. The existence of such animals is possible only in thick forest covers. thus, it strengthens the idea that the Indus people had their own timber resource for burning the bricks.

The observation of Mughal in 1972 can help us to have an idea of the extent of the civilization flourished at the dawn of Indian history - "Starting from the borders of Afghanistan, in northern Baluchistan (at Periano Ghundai), and the Iranian border on the Makran coast (at Sulkegan-Dor) it extended east and south east and covered the entire Makran coast, the Greater Indus valley and Gujrat. The remains of the Indus culture have also been found near Delhi in the Ganges-Yamuna Doab".¹⁰

The Allchins in 1983 estimated the area covered by the Harappan culture to be a little less than half a million square miles. Further references are not essential to stir up the imagination of modern people of this day for making an idea about the extent of this urban development.

Such a vast stretch of human settlement with brick works required almost an astronomical number of bricks. Initial foundation an subsequent expansion of such an advanced civilization can be thought of on those days, only when two resources are available :

good soil for agriculture and adequate timber for using as fuel and firing the bricks.

Fertile soil must contain minerals, compost organic fertilizer and soil water.

All these are contributed by a good forest cover in the nearby. Further, the retention of ground water also depends on forest tracts. Forest tracts maintain a good humid climate favourable for adequate rainfall. Rainwater while flowing through the forest-bed faces obstruction allowing seepage into the ground. This provides soil moisture for agriculture as well as ground water for domestic purposes.

Being animal, human life is associated with vegetation. An area devoid of vegetation is subject to soil erosion causing repetitive flood. A flood prone area cannot be chosen for human settlement. The destruction of Indus civilization because of recurrent flood as emphasised by some historians might have been due to rampant depletion of forests by the Indus people.

Thus, it is imperative that the existence of timber source in the nearby area of the civilization cannot be mooted. According to Wheeler.¹¹, widespread deforestation of the surrounding region was caused by the Harappan people to meet the demands of firewood for brick and pottery production, for domestic fuel and for smelting metal. That the Indus people reached a considerable height of knowledge about agriculture and botany is proved beyond doubt. They used to live in villages, cities and towns, wore clothes, cultivated crops other fruits and cotton, worshipped trees, glazed their pottery

with the juice of plants and painted them with plant designs. It is justified to believe that they knew quite a lot about the characteristics of plants which grew in their surroundings.

But as archaeology alone provides us with the surest information about their achievements, we are not in a position to comment on their perception on nature's balance contributed by the plants. In the absence of any written document and as the scripts are not yet deciphered, the Indus people fail to bear any message to the posterity, regarding their awareness of nature.

2.2 Utilization of Plant Resources and Simultaneous Study of Indian Flora by the Aryans.

The Aryans migrated to India from the west. They poured into this country in batches and opened a new vista in the history of India. The dates of the Indus culture are a matter of dispute. It has been ascertained that the Aryan migration to this country occurred between 2300 and 1750 B.C. It seems relatively certain that the decline of the Harappan civilization began in about 1750 B.C. and that this decline was in some way connected with the coming of the Aryans from the North-west. That the Aryans were careful observers of nature, is proved from their rich literature. They began to study the flora and fauna of this new country from the dawn of civilization.

The Vedic Aryans were mainly an agricultural people. In the Vedic period agriculture became an important vocation for people. The vedic people attached great importance to agricultural practices which is evinced from several hymns in the *R̥gveda*.¹² A vedic hymn says, 'with the master of the field, our friend, we triumph; may he bestow upon us cattle, horses, nourishment, for by such (gifts) he makes us happy May the herbs (of the field) be sweet for us; may the heavens, the waters, the firmament be kind to us; may the Lord of the field be gracious to us May the oxen (draw) happily; the men (labour) happily; the plough furrow happily Auspicious Sita (furrow), be present, we glorify thee: that though mayst be propitious to us; that thou mayst yield us abundant fruit May the ploughshares break upon land happily; may the ploughman go happily with the oxen; may parjanya (water) the earth) with sweet showers happily (R.V., IV, 57.1-3).

The Aryans had good many reasons to acquire working knowledge of plants and plant life.

After coming to the land of 'Saptasindhavas' the Aryans engaged themselves to the task of studying the details of the Indian plants and thereby finding out properly their utility. There are sufficient indications to show that the vedic people acquired a great deal of knowledge about agriculture, the general life history of plants, their medicinal properties and also Arbo-Horticulture. At that early stage, knowledge of rudimentary plant physiology became necessary for successful cultivation.

The Vedic people knew the art of manuring the soil and cowdung was used as manure. In later period cowdung was found to give better result when dried before application. This shows that

they understood the value of natural manure of animals in the field. Of the important grains so far known of the vedic period are wheat, rice and barley. Barley is still considered by the Hindus as a sacred grain and used in various rituals, though it ceased to be a principal good food grains to the Indian people. It is interesting to note that the *R̥gveda* makes no mention about rice and in all probability it was still a wild growth. Auboyer's¹³ observation is that rice was not yet cultivated in the area where the *R̥gveda* was compiled. The references to rice are found in the *Taittirīya Samhitā*¹⁴ (VII, 2.10.2) and the *Atharva Veda*¹⁵ (VI, 140, 2; VIII, 7.20 ; IX, 6.14).

The Vedic farmers knew the method of increasing the productivity of the soil by what is now known as the rotation of crops in the same plot of land. In the *R̥gvedic* period, the rotation by fallowing land was practised. But the rotation of crops, rice in summer and pulses in the winter in the same field was recommended in the *Taittirīya Samhitā* (V, 1.7.3) Rotation of crops was thus familiar to the Indians. Dr. Roxburgh, the Father of Indian Botany believes, 'the Western World is to be indebted to India for this system of sowing'. In the '*Satapatha Brāhmana*¹⁶ a detailed description of the agricultural activities are given. Among the cereals which were regularly cultivated were *yava*, *vṛ̥hi*, *upavāka*, *anu*, *godhuma*, *n̄ivāra*, *priyaṅgu*, *syāmāka* and the pulses were *mudga*, *māsa* and *masūra*. The vedic farmers could understand the importance of irrigation for improving the quantity of production and protection of plants. In the dry weather of the area of Punjab water could not be retained in reservoir. So, they used to carry water through canals from catchment hilly areas. Besides, the *R̥gveda* mentions *asmacakra* which was a wheel of stone and water was lifted with the help of this wheel. There was also a *ghatajaṅtra* or *udghātana*. From the hymn in the *R̥gveda* it appears that the then people had to recourse to artificial water supply. In the *Atharvaveda* (IV, 15) we find the hymn which

conveys a beautiful tribute to Rain which is an indispensable factor in the prolific development of herbs and plants. "Let the mighty liberal ones cause to be hold together; let the juices of the waters attach themselves to the herbs; let gushes of rain gladden the earth, let herbs of all forms be born here and there ; let the herbs become full of delight with the coming of the rainy season."

The Aryans were conscious of the natural enemies of the crops. The *Kauśika-Sutra* of the *Atharvaveda* enumerates the animal enemies of corn and prays to the Divine power for their destruction. The locust, the rat, the devourers of corn and the borers are mentioned and these animals and insects are very familiar enemies of the corn even now.

The vedic hymns indicate very clearly that the Aryan people of this period looked to the agricultural profession as the most venerable and by their keen observation they perfected the job with brilliant success.

As because the plants and trees were intimately associated with the life of the Aryans a spirit of enquiry spontaneously grew among them as to the effect of natural vegetation growing near their dwelling places. To the community of the Aryans, the study of plants and plant life of this new country of India became a self imposed job as because the most part of the country still remained unexplored. The growing acquaintance with plant life is further reflected in the appreciation of the herbs bearing medicinal properties. The *R̥gveda* gives a broad classification of plants, *Vrkṣa*, *oṣadhi* and *vīrudhs*. There are further subdivisions e.g. *viśākhā* (shrubs), *sasa* (herbs), *vratatī* (climbers), *pratānavatī* (creepers) and *alāsāā* (spreading on the ground). There are some trees called Phalini which are luxuriant

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with fruits. There are some *aphala* i.e. fruitless trees. The plants devoid of flowers are called *apuṣpā*, and the *puṣpinis* are plants with flowers. In *R̥gveda* we find the hymns which in the words of G.P.Majumdar¹⁷ are 'the first medical utterance of man'. It is mentioned in the *Auṣadhi sūkta* of the 10th *Mandala* of the *R̥gveda*.

Some of the hymns are as follows :

1. Mother (of mankind) a hundred are your applications, a thousand fold is your growth; to you who fulfil a hundred functions make this my people free from disease.

2. "Plants" ! thus I hail you, the divine mother (of mankind). I will give to thee, Oh physician, a horse, a cow, a garment - yea, even myself (Sūkta VII, 97). There are several other hymns which indicate that the Aryans were aware of the medicinal properties hidden in herbs and plants and knew the methods of their application against innumerable diseases. But a more concrete and compact knowledge can be gathered from the detailed account of the medicinal plants and their application against various maladies described in the *Atharvaveda*. The Aryans were even particular to get the best out of the medicinal herbs and plants and in order to get the best they chose the peep of dawn for their application.

The plants were used for remedies from various physical diseases like leprosy, urinary problem, fever, eye diseases, head disease, physical injury and other common problems of health. Plants were used against snake bite. The vedic physician also used plants for prolongation of life. The most important plants used were "*aparājita*, *parṇa*, *palāśa*, *aśvattha*, *tālīśa pāthā*, *svādhā*, *khadira* and *simśāpā*"¹⁷, According to G.P.Mazumdar hymns in *Atharvaveda*

indicate very interestingly that even in those years of infancy of the medical science (?) in India the vedic Aryans took note of the importance of cosmetic for the purpose of improvement of appearance. The *Atharvedic* hymns mention *Sami* as the plant, very much conducive to the health and growth of the hair.

In the vedic literature we find references describing the external as well as internal features of plants. The ancient Aryans were highly inquisitive of external morphology and stray references of which we get from the *R̥gveda*. The *Atharvaveda* embodies the knowledge of external morphology in a hymn (VII.7) The *Vajāsaneyī Sam̐hitā*¹⁸ (XXX 28) and the *Taittirīya Sam̐hitā* (VIII, 3. 15.1) state the different parts of a plant body. The plants comprise of *mūla* (root), the *tula* (shoot), the *kāṇḍa* (stem), the *valsā* (twig), the *puṣpa* (flower) and the *phala* (fruit). Besides these, a tree has *skandha* (corona), *śākhā* (branch), *parṇa* (leaf).

Osadhibhyaḥ svāhā mūlebhyaḥ svāhā tūlebhyaḥ svāhā kāṇḍebhyaḥ svāhā valśebhyaḥ svāhā puṣpebhyaḥ svāhā phalebhyaḥ svāhā/ vanaspatibhyaḥ svāhā mūlebhyaḥ svāhā tūlebhyaḥ svāhā skandhobhyaḥ svāhā śākhābhyaḥ svāhā parṇebhyaḥ svāhā puṣpebhyaḥ svāhā (Taitt, S. viii, 3, 19-20).

Pāṇini¹⁹ in his *Aṣṭādhyāyī* mentions the different parts of a tree. Patañjali describes different parts of a plant as *mūla* (root), *skandha* (trunk), *phala* (fruit), *palāśa* (leaf). The *Viṣṇu Purāṇa*²⁰ mentions various parts of trees. Plants growing on other plants i.e. the *pargachā* was not unknown in ancient India. The weak stemmed plants or creepers were called *valli*, *vrataī*, or *lata*.

Mazumdar¹⁷ observes that the ancient Indians differentiated the stem of a tree broadly into two parts, the peripheral part called the *tvac*, *Valkala* (rind, skin) and the inner part, the *sāra*.

In the *Vṛhat Ārṇyaka Upaniṣad* (Chap-III, 9th *Brāhmaṇa*, Lotus Library Edition)²¹ the plants are regarded as animate being and analogy has been drawn between plant body and human body. The analogy runs thus : "The body of the plant is exactly like the body of man; the hairs of man corresponding to the leaves of plants and his skin corresponding to the dry exterior bark of the plants. Thus, a sort of animation was ascribed to the plants which Sir, J.C.Bose established scientifically only in recent period. So, we find that the people of ancient India made a fascinating advance in acquiring knowledge on plant life. The modern people are making conscious efforts for protection of trees and plants as they are aware of the various utility of trees and plants in human life. They are also conscious of the fact that human life would be at stake if there is no plant on the earth. The trees and plants maintain the ecological balance. So, the plants should be protected. But this thinking is not a recent and a new concept in India. This developed in the mind of the ancient Indians from their empirical knowledge, and in course of time their inquisitiveness resulted in the flourishing of plant science in India.

The *Agṇipurāṇa*²², the *Arthaśāstra*^{23,24,25} and the *Brhatsamhitā*²⁶ have each a distinct section dealing with plant science (*Vṛkṣāyurveda*). The meaning of the term *Vṛkṣāyurveda* is 'The knowledge of tree-life'. In the *Adhyakṣyapracārah Adhyāya* Kauṭilya says that the Director of Agriculture, himself is conversant with the practice of agriculture, water-divining and the science of rearing plants or assisted by experts in these, should collect in the proper seasons,

seeds of all kinds of grains, flowers, fruits, vegetables, bulbous roots, roots, creeper fruits, flax and cotton. (*Sītādhyakṣa kṛṣitantra-gulma vṛkṣāyurvedajñastajñasakho bā sarvadhānya puṣpaphalaśāka kandamūla bāllikyakṣouma kārṇāsabijāni yathā kalām gr̥ṇhīyāt*) .

Shamasāstry in his translation used the term *Kṛṣitantra-gulma vṛkṣāyurveda*.²⁴ Mazumdar referring to the translation of Shamasāstry suggests that from the construction of the sentence it is clear that *Kṛṣitantra* and the *Gulma-Vṛkṣāyurveda* were the two disciplines of knowledge. His opinion is that these two branches of knowledge were possibly interdependent. A treatise of agriculture will be incomplete without a section dealing with plant science. That the plant science or the botanical science existed in those years is corroborated from the information embodied in the *Kāmasūtra* of *Vātsāyana*.²⁵ The *Kāmasūtra* regards the *Vṛkṣāyurveda* as one of the 64 kalās or arts which developed in India. A branch of knowledge is to be recognised as an art only when it stands on a long historical background and is tested against times. But Dr. R.G. Basak²⁶ prefers the word *Kṛṣitantra - Sulvaṛkṣāyurveda*. He translates these terms as *Kṛṣiśāstra* and '*Sulvaśāstra*'.

There may be some differences of opinion among the scholars regarding the interpretation of some terms of the literature, but there is little doubt that the ancient people of India went far in developing their knowledge of agricultural science as well as plant science.

The point which is noticeable in the *Arthaśāstra* is that these two sections of knowledge were complementary to each other. Agricultural knowledge cannot be complete without botanical knowledge because successful agriculture depends on the art of

plantation, cultivation, art of manuring and others, based on the science of plant life. In *Śukranīti*²⁸, the knowledge of plant life is regarded essential in case of *Ārāmādhīpati* whose position corresponds to the superintendents of botanical gardens of modern times. Śukra's advice in this regard is "the superintendent of parks and forests is he who knows of the causes of growth and development of flowers and fruits, who knows how to plant and cure the trees by administering proper soil and water at the suitable time, and who knows of their medicinal properties" (Śu.11. 317-319).

The knowledge and consciousness of the ancient people regarding plants and trees which formed their immediate environment were not concentrated only to the limit of practical necessity. That they were much more involved with the nature by heart is revealed from the relation of Śakuntalā with the natural surrounding of Tapovan, as depicted in the *Abhijñāna Śakuntalā* by Kālidāsa.²⁹ The parting scene of Śakuntalā from the hermitage of Kaṇva, where she had resided so long and where every creeper and plant were bound by the tie of love, stirs our imagination. Nature plays an indispensable part in human life. When Śakuntalā was proceeding for her husband's abode with a grief stricken heart leaving behind her old hermitage, the nature also echoed in the same tune. Priyamvaḍā says, 'it is not that our friend alone is agrieved at the separation from the penance-grove. Just behold the (troubled) condition of the penance-wood whose separation from you is impending. The deer have dribbled adown the mouthful of Kuśa-grass; the pea-fouls have given up their dance, creepers with their brown leafage falling, are shedding tears, as it were'. *Udgalita-darva-Kabalā mṛgaḥ Parityakta - narttanā mayūrāḥ aparṣta pāṇḍu-patra muñc antyaśruṇīva latāḥ*. The glorious life of nature and the equally glorious life of man balance themselves in the composition of this

ancient Indian poet. Indeed, this faith of life in Nature must have been so living and dynamic in the minds of the people of India, of those days that a unique creation like 'Śakuntalā could have been possible by our great poet. This perception of life in nature by the old Indians is a great achievement of the Indian cultural tradition.

2.3. Protection of Plants by Growing Healthy Plants through Scientific Methods.

The hymns of the Vedas, Upaniṣads, the Epics, the Purāṇas, the medical treatises, *Bṛhat Saṁhitā*, *Amora-kośa*²⁸ and such other works provide convincing indications that throughout the ages in the past, the people of India had remained engaged in developing a branch of knowledge about plant kingdom. Their untiring efforts for unveiling the mysteries of plant domain not by laboratory tests but by empirical knowledge resulted in the formation of a distinct science which was named by them as *Ṛkṣāyurveda*. The discovery of the manuscript of the *Ṛkṣāyurveda* of Parāśara³¹ by Vaidyasastri Jogendranath Visagratna of Nabadwip, Bengal and its presentation with notes by his son N.N.Sircar in the Journal of the Royal Asiatic Society of Bengal (1950) bring to the notice of the present world lots of scientific information on plant life. Parāśara was contemporary of Agniveśa. Agniveśa and Parāśara are found mention in the *Sūtrasthāna* of *Caraka-saṁhitā*.³² Caraka's date is uncertain, though tradition makes him the physician of the great king Kaniska. Kaniska should be ascribed to a date not earlier than the last quarter of the first century A.D.³³ If Caraka's chronology is fixed during the period of Kaniska, the date of Parāśara can be further pushed back. In this botanical treatise there is a distinct section called *Bijotpatti kāṇḍa*. Besides, there are other sections such as *Vanaspati Kāṇḍa*, *Vānaspatya Kāṇḍa*, *Virūda Valli Kāṇḍa*, *Gulmakṣupa Kāṇḍa* and *Cikitsita Kāṇḍa*.

The *Bījotpatti Kāṇḍa* is again sub-divided into eight chapters. The portion which is named as *Cikitsita Kāṇḍa*, is missing. But the information regarding diseases and treatment of plants can be gathered from a number of texts like *Bṛhatsamhitā*, *Agnipurāṇa* and *Upabana-Vinoda*.³⁴ It is evident that the ancient Indian people did know the process of germination of seeds, internal and external morphology of plants, physiology of plants and gathered knowledge about their nourishment, manuring and medical treatment.

The plants are vulnerable not only to natural diseases but also to the assault of human community. As the plants are living beings they are bound to take birth, to grow with the passage of time and to succumb to death after the span of life is over. The span of life differs from species to species, but the death is the final end of plant life as that of any animal being. Our ancestors conceived this eternal truth about plant life.

The propagators of plant science in India took the job of developing a system of medical treatment of the plants as a distinct section of *Vṛkṣāyurveda*. That the science of plant life came to be regarded as a full fledged department of knowledge is evident from the *Arthasāstra* (11.24.1) The Director of Agriculture, it is said, must possess the knowledge of science of agriculture dealing with the plantation of bushes and trees and he should have got the assistance of those who have adept in this science.

The concept that the prevention is better than cure was not unknown to our ancestors. We find that the first task of the Director of Agriculture was to collect the proper seeds to be sown in properly prepared soil in proper season (KA. 11.24.1,2).

For getting the optimum return from healthy plants, the Head of the Department of Agriculture had to keep watch over many matters relating to better success in cultivation. The *Arthaśāstra* prescribes many times ploughing of soil (KA.11. 24.2) and some treatment of seeds before sowing.

2.3.1 Collection, Selection and Treatment of Seeds for Good Germination and for Vigorous Seedlings.

According to *Arthaśāstra*, the seeds of rice, wheat and barley should be kept in the dew at night and in sunshine during the day time for a week. The similar treatment of seeds of pulses should be done for three to five days and nights. Honey, ghee, pig's fat cowdung etc. were recommended for treating various seeds (KA II. 24, 24). Thus, we find that the act of preparing the seeds for best germination was the matter of utmost importance, so that any unwanted crisis could be avoided in stages of continuous development.

The small chapter, *Upavana-Vinoda* as a branch of *Vṛkṣāyurveda* in the *Śārangadhara Paddhati* treats of arboriculture. In this chapter some definite instructions regarding the planting, watering and protection of plants are discussed. This encyclopaedic work was compiled by Śārangadhara under the Royal instruction probably in the thirteenth century (Majumdar).

In the *Vijoptividhi* section of *Upavana-Vinoda* there are some prescribed rules for the sowing of seeds. The purpose of this section is to give the people proper guidance in the task of treating of the seeds before sowing. The instructions are :

1. First of all one should take well-mature seeds of the season, sprinkle milk and clarified butter over them, keep them for five days (in this condition) and then fumigate them with frankincense, or

2. One should besmear these seeds thus sprinkled with milk, with powder of vrhati and sesamum mixed with ghee, dry them and besmear them again with cowdung, and then fumigate with fat of some animal. If the seeds, thus prepared, are sown they sprout in a single night.

3. After besmearing with cowdung the seeds sprinkled with milk, one should dry them and besmear them again many times with powders of viḍaṅga mixed with honey and sow them; and they will sprout very soon.

4. The seeds of jambū, panasa, cūṭa, sarala, lakuca should be treated with milk and sown with ghee, cowdung and viḍaṅga dust mixed herewith.

5. A person (the master of the household) after taking ablution and putting on well-washed cloths and after worshiping the gods, and making obeisance to his Guru (spiritual preceptor) and giving away earth or money to a qualified Brahmin and making obeisance again to the presiding diety of foundation (*vāstupuruṣa*) should himself sow seeds. His attendants should follow suit.

6. One should first of all sow seeds in the seed bed, spread

grass over it and sprinke milk and water, and then when the seeds germinate, remove the grass, dry the earth a little and transplant these sprouts together with this roots and earth attached thereto.

The above quoted instructions of upavanvinoda give considerable stress on the task of preparing the seeds. The seeds of treated according to the sastric guidance would sprout with full vigour.

2.3.2 Schedules for Seed Sowing

Much attention was paid to the factor of maintaining the specified distance between plant and plant so that each and every plant could suck their optimum amount of nutrients from the earth-bed and could maintain its vigour. The measured density of plants allow them to acquire maximum solar energy and air component for food production. According to *Bṛhat-Saṁhitā*, it is best to plant trees at intervals of 20 cubits, next at 16 and 12 cubits,' interval in the minimum that can be prescribed.

Same is the suggestion in the *Agnipurāna*. It is best to plant trees at intervals of 20 cubits, an interval of 16 cubits is next, and worst is the interval of 12 cubits. Closely planted trees become fruitless (*uttamaṁ bimśatirhastā madhyamaṁ soḍasāntaram Sthānāt sthānāntaram kāryyam vṛkṣānāṁdvādasābaram biphalāḥ syurghanā vṛkṣaḥ* chap. 282, 8-9). Śukrācārya gives a slightly different advice : the king should have the domestic plant planted in villages and the wild trees in the forests - the good ones at a distance of

twenty cubits from one another, the middling at a distance of fifteen cubits and the ordinary ones at a distance of ten cubits and the youngest at a distance of five cubits (Śu. Chap. IV, 91-93).

In the section of *Upavana Vinoda* called, '*Roṣṇa vidham*' (the process of planting) some rules are given. These rules are laid down because if the trees are not planted according to these guidance, the growth of the plants would be hampered. The plants if planted irregularly, they lose their beauty and vigour. It is said that (i) one should plant trees at an interval of 10 cubits in the lower level of the garden, and at 20 cubits in the higher and at 16 cubits in the middle, but if the surface of the garden be plane, one should plant grass like plants at an interval of 2 cubits, trees at 4 and gulmas at 3 cubits apart.

(2) Trees if thickly sown are hindered in their growth and if sown very sparsely they are in danger of falling down even consequence of mild winds; hence for lean plants in the laying out a garden, planting after the method described above is wise. From the above verses, the natural inference is that ancients had a pretty good knowledge of the fact that the plant can get the essential nutrient from the soil if each plant has a comfortable peripheral space.

2.3.3. Watering

For the vigorous growth of trees and plants, proper watering was necessary. *Bṛhatsaṁhitā's* instruction is that after the trees are planted, one should water them in the morning and evening during the summer, at the end of the day in the cold season and during the rainy season, watering should be done only when the earth is dried due to want of rain.

Śukra's opinion is that 'the trees are to be watered in the morning and evening in summer, every alternate day in winter, in the fifth part of the day (i.e., afternoon) in spring, never in the rainy season' (Śu.Chap. IV 105-106).

Upavana-Vinoda also gives an instruction for watering of plants. The trees which are newly planted should be watered regularly in the morning and evening and should be systematically protected from bad effects created by cold and strong wind.

The rules for watering the plants as advised in this work are:

1. One should water the plants every alternate day in autumn and in winter, everyday in spring and twice a day during the summer, i.e. once in the morning and once in the afternoon.
2. During the rainy and autumn seasons when it does not rain one should fill the circular ditch under the tree with water.
3. One should go on applying water till the earth attached to the roots of the tree becomes wet; one should not measure the quantity of water applied to this purpose.
4. Trees suffer from indigestion if the water in the ditches is not dried up, hence one should not pour fresh water in it till that is the case.
5. A person versed in the laws should not hesitate, in the interest of trees, to extirpate the weeds, creepers and shrubs

which grow beside them. Though these rules were framed with a view to making the people aware of the necessary preliminaries for successful arbori-horticulture, yet these rules are equally applicable for the purpose of rearing and caring of almost all the trees in general.

2.3.4 Manuring

The use of fertiliser was quite familiar to the ancient people. Lots of instructions have been given in *Bṛhatsamhitā* and *Agnipurāṇa*. In *Agnipurāṇa* it is said that to increase the production of flowers and fruits one should sprinkle ghee with cold milk, also a mixture of sesame, excreta of goats and sheep, barley powder and beef, thrown into water, and standing over for 7 nights should be poured round the roots of the plant. (*Ghr̥taśītapayaḥsekaḥ phalapuṣpāyasarvadā. Ābikājasakreṭūrṇam̐ yava cūrṇam̐ tilāni ca Gomāṁsamudakañcaiva saptarātraṁ nidhāpayet utsekaḥ sarvavr̥kṣānām̐ phalapuṣpādi vṛddhidaḥ* (Ag. 282. 11-12).

Instruction for manuring in the *Bṛhatsamhitā* is as follows : "To promote influence and fructification a mixture of one adhaka (64 palas of sesame, two adhakas of excreta of goats or sheep, one prastha (16 palas) of barley powder, one tula (100 palas) of beef, thrown into one droṇa (256 palas) of water and standing over, for 7 nights, should be poured round the roots of the plant. The measure is for all kinds of plants."

For nourishment *Śukraṇīti* also suggests the use of excreta of goats, sheep and cows, water as well as meat. All these combinations after a definite span of time decompose into an ideal compost fertilizer

suitable for healthy growth of plants of all kinds.

2.4 Plantation of Trees : A Sacred Act

The job of plantation of trees were regarded as sacred job. Both the *Bṛhatsaṁhitā* and the *Agnipurāṇa* advise to perform the job with sacred body and mind. In *Bṛhatsaṁhitā* (Br.S. Chap. 54, vol.11) it is said "one should plant the tree after oneself being pure and after worshipping the tree with a bath and anointment, and the result will be that the tree will be graced with luxuriant growth of leaves". What an attitude of reverence was borne by the ancient Indians towards the trees and plants and what sort of eagerness they had, can be easily visualised from these lines quoted above :

We notice the same attitude in the verses of *Agnipurāṇa* : "one should perform the work (of plantation) after worshipping *varuṇa*, *viṣṇu* and *parjjanya* ---- the rain God."

From the foregoing references it is abundantly clear that by means of botanical knowledge the growth and healthiness of trees and plants could be ascertained to a great extent. The treatment of seeds according to sastric method leads to the growth of flowering trees.

All the aspects of knowledge as stated above are crucial for the maintenance of sound vigour of plants. Modern agricultural science really concerns all these aspects. The ancient Indian people acquired these knowledge from their empirical judgement which they applied in agricultural practices so that the vigorous plants could resist the environmental adversities and pathogens.

2.5 Protection of Plants from Diseases by Proper Treatments.

Plant diseases and their treatment received careful attention of the ancient Indians. In spite of all prophylactic measures, the green world is subject to the attack of varieties of diseases. The science of the treatment of plants which in the opinion of Majumdar³⁵ does not exist in the occidental countries, developed as an important section of *Vrksāyurveda* in ancient India. In *Brhatsamhitā* and in *Agnipurana* separate chapters are given dealing with the diseases and their remedies by means of medical appliances. Gunaratna in his commentary has drawn an analogy between a human body and a plant body". Just as the human body is subject to jaundice, dropsy, shofa (?) emaciation and defects (dwarfness) of finger, nose etc., so also plants suffer from similar diseases such as inception of disease, displacement or dislocation of flower, fruit, leaves bark.

And just, as by the application of the appropriate remedies unnatural growth, deterioration, wounds, fractures, etc. can be cured, so also in plants by application of proper drugs as prescribed in *Vrksāyurveda*".

According to Varāhamihir, plant diseases are caused by the extreme climatic conditions cold climate i.e. fall in temperature, wind i.e. dryness and high temperature generally affect the plants adversely. The weather-beaten plants generally fall prey to various types of diseases. The detection of a diseased plant can be done when the leaves of the plant become yellow, the buds are under developed and the growth arrested and the branches become dry, and the exudation of the sap occurs.

Kaśyapa's account quoted by Majumdar³⁵ is "those plants that have yellow leaves, that are fruitless and denuded of leaves and these caused by coldness, excessive heat, too much rain, dry wind and by the intermingling of roots of different plants are to be known as diseased, and are to be treated accordingly".

The texts like *Bṛhatsaṁhitā Agnipurāṇa* and others not only give the symptoms of a diseased plant but also prescribe both preventive and curative treatment to make them free from ailments. Varāhamihir says "as a sort of general prophylactic mud kneaded with ghee and *viḍaṅga* should be applied to the roots, after which milk diluted with water should be poured".

In *Agnipurāṇa*, almost the same treatment is prescribed : "Viḍaṅga mixed with rice, fish and flesh - and all these mixed together constitute a remedy invigorating to the plants and curative of their diseases. (*Matsyāmbhaśa tu sekena bṛddhirbhabati sākhiṇaḥ | Viḍaṅgatandulopetaṁ matsyaṁ māṁsaṁ hi dohadam | Sarbbe ṣāmbiśeṣeṇa vṛkṣānām rogamarddanaṁ*) (Ag Adhyaya 282 - 13).

A remedy is prescribed in the *Agnipurāṇa* for barrenness; "Viḍaṅgaghṛta paṁkāktān secayecchītabāriṇā || Phalanāśe kulatthaisca māsaïrmudgairyaabaistilaiḥ Ghṛtaśīta-payahsekaḥ phala-puṣpāya Sarvaḍā (Ag. 282.10) | "Viḍanga and ghee kneaded with mud and sprinkled with cold water together with Kulattha, Māsa, Mungo, Yava and Tila should be used in a case of barrenness.

Varāhamihir also prescribes treatment of barrenness of trees with a decoction prepared from the extracts of same ingredients.

Śukra suggests that in cases of miscarriage of fruits, the tree should be treated with cold water after being cooked together with kuluttha, Māsa (seeds), Mudga (pulse) yava (barley) and Tila (oilseed). This would lead to the growth of flowers and fruits (Śu. IV. 107-108).

The *Vṛkṣāyurveda* of Śurapāla is believed to have been composed by about the tenth century.³⁶ (The manuscript is available in the Bodleian Library Oxford). The exact translations of the relevant portion is given below from the *Concise History of Science in India*. There is also a reference of one Sureśvara or Śurapāla from Bengal, who was a court physician of Bhīmpāla in the eleventh century A.D. His father and grandfather are said to have been court physicians of Rampala and Gobinda Chandra respectively. This Śurapāla wrote *Śabdapradīpa* and *Vṛkṣāyurveda* on medical botanical terms, and *Lohapaddhati* or *Lohasarvasva* on the medical use and preparation of iron.³⁷ It is very difficult to establish whether these two Śurapālas were two different persons or the two names are of same person.

This *Vṛkṣāyurveda* of Śurapāla classified the diseases of all trees into two groups. (i) there are some diseases which develops from the body i.e. internal, and there are some ailments caused by external factor. The bodily diseases are said to develop from winds (Vāta), Phelgm (Kapha) and Bile (Pitta) while the entrances ailments are caused by vermin, frost etc. The treatment prescribed by Śurapāla for caring the plants from various types of ailments are as follows :

One should cure the diseases of wind disorders by the application of flesh, lymph, fat and ghee. Nutrient provided by these substances removes all wind troubles.

Liberal fumigations with oils in which soapberry, cows-horn, horse's hair, black pepper, ghee and porpoise have been boiled and the lymph of a hog added, quickly remove the diseases due to wind.

The trees are cured of bilious diseases by being watered with the decoctions of liquorice, honey and madhuka and with milk mixed with honey. All kinds of trees are relieved of bilious diseases if they are watered with the decoction (?) of the tree myrobalans in which ghee and honey have been mixed.

The problems of animal enemies of corn is a persistent problem of agriculture. Some remedial measures to safeguard the plants from the attacks of the insects have been devised in the Vrkṣāyurveda of Śurapāla.

Insects are destroyed by the administration of water containing milk, carcass, vacā and cowdung, and by the plaster prepared from white mustard, musta grass, vacā, kustha and ativia.

Fumigation of the tree with with fumes of white mustard, ramatha (?), viḍaṅga, vacā, black pepper, beef, ambu (a kind of Andropogan), horn of buffalo and flesh of a mixed with the powder of lodhra, at once destroys the colonies of insects infesting the trees.

Plastering with viḍaṅga mixed with ghee, irrigation with diluted milk for seven days and a poultice of beef, white mustard and sesamum are effective in destroying insects like Kandara (?). Injury caused by insects is healed by a plaster of viḍaṅga, sesamum, cow's

urine, ghee and white mustard and by watering with milk.

The broken trees are (healed and) restored to health if their fractures are filled with fertile soil, plastered with (the powder of) the barks of plakṣa and undumbara mixed with ghee, honey, wine and milk and then tightly tied with ropes and sprinkled with buffalo's milk and, finally, watered copiously at the roots.

The trees, whose branches have fallen off would grow branches so abundantly that they would obstruct the view of the sky, if the broken ends of these branches are plastered with honey and ghee and they are watered with diluted milk and fumigated.

Trees damaged by fire would cover the sky with foliage, if they are plastered all over with the paste of the lotus - plants and fed with carcass water.

Trees struck by lightning would bear beautiful leaves, if they are plastered with vidara, sugar, red, arsenic and sesamum and watered with diluted milk.

There is a distinct section called 'Druma Rakṣā' in which rules for the protection of trees are categorically mentioned. One should carefully protect trees against (destructive influence of) dew, strong wind, smoke, fire and spiders.

Trees blessed with flowers should be placed in the middle of the row of trees; and the fruits of those which produce good fruits

should be kept covered, and all trees should be well protected with walls having ditches around them.

3. One should take up the ashes of trees struck by lightning, throw the same round other trees and this will ensure the latter against cold. These have the power to allay (extinguish) even the burning fire.

4. Throwing boiled Śāli rice of white variety mixed with curd and rock salt round trees ensures their protection against poisonous (harmful) rain injuries to them.

5. If one apprehends danger from mice, locusts, ants, etc. one should utter the following formula (mantra) 108 times, and write it down on the leaf of a tree.

Om Svasti kiṣkindhāsthita prakataparā kramāntarhitārkamaṇḍalopajivitasya caśrīhan umānājñāpayati mūṣaka pataṅgapipīlikā śalabha karabhānvakakītagandhikā ni vahairṇasthā tavyam. Ājñāmatikramamāṇasya śarīranigraha Samāvartayati. Tasya vānarasiṃhasya kramamānasya sāḡaram. Kakṣāntaragato vāyurjimūtaiva nardati. Hum phat namaḥ.

6. And after writing down the (above) formula on the leaf and reciting it one should burry it in the ground under the tree. This will lead to the destruction of locusts, mice and ants of the field.

In the *Vṛkṣāyurveda* of Śurapāla, there was a scientific attempts for controlling the insect pests. The application of

incantations for controlling the insect pests in *Upavana-Vinoda* though appears to be unscientific, it reveals the inherent desire of man for plant protection. The existence of both scientific and unscientific approaches to pest control might have been delimited by time and space.

In *Upavana-Vinoda*, the diseases of trees and their remedies have been discussed. Here, also trees are compared with human beings. As human body is vulnerable to diseases through the affections of vāta (wind), pitta (bile) and kapha (phlegm), the trees also are affected by diseases caused by the disorder of wind, phlegm and bile. So, the trees are to be treated without any delay after making correct detection of diseases. An operative measure is advised in case of damage in the body parts of trees caused by insects, fire, storm, thunder etc.

1. Thus, it is said, in *Tarucikitsā* section, when a tree is consumed by insects, burnt by fire, broken by storm, struck by thunderbolt, - one should cut away the affected parts ; but in case of diseases the operation is to be of different nature.

2. Tall, thin, short, sleepless or partly conscious trees are of windy humour. They do not bear flowers and fruits.

3. Trees of billious temper cannot bear the rays of the sun, are of yellow colour, and shed their branches over and over again, and bear premature fruits.

4. Trees of phlegmatic temper have their branches and leaves very glossy, flowers and fruits well shaped and of good appearance, trunks symmetrical, and all parts covered with creepers.

Some treatments are prescribed to save the trees from the ailments.

1. Substances of pungent, bitter or caustic tastes are destructive of the windy humour of trees ; and those having bitter, hot, salty and acid juice are destructive of the bile, and those with graceful, sweet, acid or salty juice are destructive of the phelgm.

2. The affectations of windy humour is alleviated through the application of the graceful things like clarified butter mixed with flesh juice. The affectation through the bile is alleviated through the application of things that are cold and graceful mixed with water, and the affectation through phelgm is mollified through the application of acid things mixed with hot water, or through pungent and bitter things.

3. Rudeness of appearance, tubercles (nodules over the body) both of large and small size are due to windy humour which may be overcome by the application of Lodhra flower, cowdung, fats and kunapa water.

4. One should do well to realise that worms (krmayo) are at roots of plants affected with tubercles, or of plants for the paleness of buds and flowers of which no other particular cause can be assigned; and one should do well to root out these worms with care.

If now fresh urine of cows, clarified butter, Vidanga, mustard and sesamum are mixed together and applied to the trunk, then fumigated and watered with milk and water, they (these plants) grow.

2.6 Social and Scriptural Injunctions for Conservation of Plants.

The human civilisation is entirely dependent upon the contributions of nature. The indebtedness of human civilization to plants and herbs is beyond estimation. Since Man settled down and started a pastoral life, he became very much dependent on the plant world. The beautiful nature supplied all the necessities of life. The march of human society created an ever increasing demand over soil and plants. People of ancient India showed their height of knowledge by introducing various injunctions and prohibitions against any unnecessary spoil of animal life and destruction of plant life. The purpose of these scriptural injunctions and social prohibitions was to create a congenial atmosphere to the world of animate being at large.

The continuous exploitation of nature actually drives the human civilization towards a total environmental collapse. As the economy of people was totally dependent on plant resources and agriculture in early period, any profligacy in using the nature's wealth could be perilous to the very existence of man himself.

To avoid any such fatal situation, the ancient Indian thinkers seriously took the job of creating an environment of social consciousness for the conservation of plants by implementing state prohibitions and social injunctions.

In the vedic hymns, we notice the inquisitiveness of the Aryans for trees and plants. Different herbs and plants have been mentioned by Ṛgveda and Atharva veda. Many of the hymns clearly express the inherent desire for rich growth of plant. Many hymns addressed to the Divine power, pray for luxuriant growth; protection of plants from animal enemies was simultaneously sought. But by the 4th century B.C. the art of agriculture and plantation became more organised and scientific. Attempts were made to save the plants from the assault of the people by implementing prohibition. In Kauṭilya's *Arthaśāstra* and other subsequent texts, clear cut provision of punishment for such misdeeds are mentioned.

By the time of Gautama Buddha some two thousand and five hundred years before, agriculture and pastoralism had covered a wider area of northern India. Buddhism and Jainism had played significant role in designing social conventions which promoted the conservation practice of nature. These religions extended their compassionate attitude towards all living creatures, imposed ban on killing of animals and suggested planting and protecting of trees. A widespread perception of the need of protecting the plants and trees reached perfection in that age. The first known attempts to protect trees from the greed of people are recorded in *Arthaśāstra*. By the 4th century B.C. the art of agriculture and plantation became more organised and scientific.

In *Arthaśāstra* we notice that there was a Department of Agriculture. The main qualification of the Director of Agriculture was his knowledge in *Vṛkṣāyurveda*.

The Forest Department, was in the charge of the Director of forest produce i.e. *Kūpyādhyakṣa*. This Director had to perform many

duties for the improvement of productivity of forests. But here one thing is worth mentioning that this Director had to take punishment measure in case of cutting or causing damage to the trees. He imposed fine on the misdoers (KA. 11.17.3).

Kautilya in the section 13 (physical injury) gives diverse forms of punishment for doing crimes to the animals and plants. He categorically mentions : "For cutting the shoots of trees in city parks that bear flowers or fruit or yield shade (the fine shall be) six paṇas, for cutting small branches twelve paṇas, for cutting stout branches twenty-four paṇas, for destroying trunks the lowest fine for violence, for uprooting (the tree) the middle (fine)" (KA 11.19.28).

Kautilya further states that "in the case of bushes and creepers bearing flowers or fruits or yielding shade the fines shall be half, also in the case of trees in holy places, penance groves and cremation grounds". (KA 11.19.29). In some cases he increases the rate of fine and mentions that in the case of trees at the boundaries, in sanctuaries and of trees that are prominent, these same fines doubled shall be imposed, also (in the case of trees) in royal parks.

It is amazing that about 2000 years back this Indian thinker could assess the importance of trees and plants for maintaining the ecological balance. This balance can be upset by rampant destruction of trees. Human society always thrives at the cost of vegetal world. So any profligacy in the exploitation of nature's contribution was strictly disallowed. The Mauryan statecraft regarded this act of protection of plants and trees as an arena of Govt. activity.

There is no doubt that the factor of economic benefit derived from the plants and herbs was a matter of serious consideration. A

collapse in green domain would destroy the means of subsistence of the people. But Kautilya's view was not confined to mere resource gain.

There is also an indication of approach to protection/conservation of plants and thereby wild animals. Even he advocated for capital punishment in case of large scale destruction. His instruction in this respect is, "he shall cause to be burnt in fire one who sets on fire a pasture a field a threshing ground, a house, a produce forest or an elephant forest (KA. iv. 11.20).

Trees came to be regarded as so important that their felling or depletion without reason and prior permission was looked upon as punishable offence. Various degrees of punishment are prescribed in the Laws of Manu³⁸. "According to the usefulness of the several (kinds of) trees a fine must be inflicted for injuring them; that is the settled rule (MS. viii. 285).

Manu advises for state protection of the following 'old gardens, forests, natural and artificial groves (MS. ix. 265). Manu classifies the offences injuring (living) plants (MS. xi. 64) and cutting down green trees for firewood, (MS. xi. 65) as *upapātakas*. This classification implies a special importance to the living plants. Manu further laid down minor penal measures for restraining man from destroying plants. These were : 1. 'For cutting fruit trees, shrubs, creepers, lianes or flowering plant, one hundred Rikas must be muttered.' (MS. XI. 143).

2. "If a man destroyed for no good purpose plants produced by cultivation, or such as spontaneously spring up in the forest, he

shall attend a cow during one day, subsisting on milk alone." (MS.XI.145).

In *Viṣṇu Saṁhitā*,³⁹ there are serious attempts to introduce to laws to restrain people from doing any harm to plant and herbs. In the chapter dealing with crime and penalties, punishment measures have been prescribed to check such misdoings. It is clearly stated that (1) the hewer of fruit bearing trees shall be punished with the highest fine (VS. v.54), (2) the hewer of flower trees with an intermediate fine (VS. v.55), (3) the hewer of creepers and groves (shall be fined) a hundred *karsha paṇas* (VS. V.56), (4) the destroyer of grass (shall be fined) one *karsha paṇam* (VS. V.57). In an ecosystem all kinds of plants contribute to the maintenance of ecological balance. The punitive measure even for spoiling the greases appears to be an instance of ecological consciousness of those days. A person may be guilty of upapātakas in case of cutting trees, shrubs, creepers, climbing plants or cereals (VS. xxxvii. 24). Persons guilty of upapātakas are advised to practise *cāndrāyana* or to celebrate a cow-sacrifice by way of expiation (VS. xxxvii. 35).

In *Agnipūraṇa*²² penal measure is devised for damaging trees: *prarohisākṣhinām śākhā skandha Sarbbaupajībyadrumañāntu vidāraṇe bimśaterdviguṇā damāḥ*. In case of cutting the twigs trunk and roots of banyan and mango tree, the fine shall be twenty *paṇas*, forty *paṇas* and eighty *paṇas* respectively (Ag. 258.25).

In *Agnipūraṇa* also, it is categorically stated that a man shall cause to be burnt in the fire being bestowed with grass, if found guilty of burning crop field, threshing ground, dwelling houses, forest and villages (*Kṣetra-beśma, Vana-grāma - bibīkhaladāhakāḥ (rājapatnyabhigāmī) dagdhabyāstu kaṅṭāgniṇā* (Ag. 258.67). The

above references are sufficient to indicate that the śāstrakāras and puranic writers all had taken the task of creating an environment where all kinds of plants and trees would be looked upon with high esteem.

An ideal house should have *plākṣa* tree in the north, Nyagrodha trees in the east, undumbara in the south, Aśvattha tree in the west and garden in the left hand side. (*Agnipurāṇa* 247.24-25). One thing to be noticed in this context is that there is no provision of cutting or uprooting the trees in any circumstances even if the trees were not planted properly according to sastric instruction. The *Gobhila Grihya sūtra* states that to have an *Aśvatha* tree on the east side of the site, *plakṣa* and Nyagrodha tree on the south and west sides respectively and udumbara on the north side, should be avoided because the trees bring danger from fire, early death, hostility and eye-diseases respectively. But even under such situation, there is no permission of spoiling these trees to death. This is categorically mentioned that in such a situation the trees should be removed and replanted in other places.

The plants mentioned above are not of immediate economic value, yet their destruction was prohibited. The provision for replantation certainly hints at the ancient Indians knowledge of environmental awareness, by the way of protection of all sorts of plants.

That the planting, grafting and preservation of plants constitute an art (Śu. IV. 144) was proclaimed by Śukracārya.²⁸ He also suggests that the king or the state authority would be entrusted with the responsibility of plantation of domestic plants in villages and wild

trees in the forests. (Śu. IV. 91-93). Thorn bearing trees such as Khadira are known as wild and advised to be planted in forest land.

2.7. Protection/Conservation of Plants by *Punya* Entisement

The social thinkers of the early medieval period along with the imposition of social and scriptural bans on destruction of the trees, plants and herbs of all kinds, also tried to create an air of eagerness for acquiring *punya* by means of doing new plantation of trees.

In the medieval environment acquisition of *punya* was a social compulsion.

The medieval writers inspired the people to plant new trees by giving them the hope of attaining happiness as result of acquiring *punya*.

In *Viṣṇu saṁhita*³⁹ it is stated that trees sown by a man become his sons in the next world (XCI.3); the giver of a tree gladdens the gods with its flowers (X CI.4); the Atithis, with its fruits (X ci. 5), those with its shadow who chance to sit under it (X ci.6) ; and the pitrs with the rain water which trickles down from its leaves (Xic. 7). It further entises the people by saying that the offering of flowers to the God, adorns him with the boon of physical charm. The ultimate motive behind the propagation of such *punya* rituals might have been to inspire the people to protect and conserve plants. Probably the common people of the said period were not saicneitically conscious of the importance and significance of plants in nature's balance. The social thinkers of ancient India might have an idea to utilise the sentiment of the common people by developing a concept

of acquisition of puṇya and with this view in mind they probably proclaimed the act of planting trees as puṇya ritual.

In the *Tarumahimā* section of *Upavana vinoda*³⁴ there is a detailed account of acquisition of various grades of puṇyas by means of plantation, and a description of the glory of trees. These are : 1. (It is) better to have a tree (planted) by the wayside where many rest under its shade than to have many sons born who are devoid of wealth and virtue.

2. We read in the *śāstras* that (excavation of) a pond is equivalent (in virtues) to (sinking of) ten wells, a lake is equivalent to ten ponds, and a son is equivalent to ten such lakes and a tree is as good as ten sons.

3. He, who for pleasure makes him a good garden full of fruit and flower trees, is destined to go to the abode of Śiva and resides there for as many as three ages.

4. One should plant trees with full knowledge of these particular, in as much as, from trees proceed virtues, material prosperity, fulfilment of desires and salvation - all these four sovereign things.

5. A man is sure to reside in *vaikunṭha* (the abode of *Viṣṇu*) for as many thousand years as there are Basil plants planted in his house.

6. *Lakṣmī* (the goddess of wealth) lives for generations in the house of a man who plants the vilva trees, peculiarly favourite with 'Śiva'.

7. He, who plants *Aśvattha* trees after proper methods, no matter where, goes to the abode of *Viṣṇu*.

8. He, who plants the *Āmalaka* trees, reaps the fruit of constant asceticism, the giving of earth and of many sacrifices (*Yajña*).

9. He, who plants after a proper method two Banyan trees, goes to the abode of *Śiva*, and is waited on by the seraphim.

10. The virtuous man who plants three *Nimba* trees attains to the abode of the sun and stays there for three thousand years.

11. There can be no doubt of the fact that the man who plants four *plakṣa* trees enjoy the fruits of a *Rājasūya* sacrifice.

12. He, who plants five *Āmra* trees by the wayside or in the garden, secures the salvation of fourteen generations past and future, backward and forward.

13. He, who plants six *Śirīṣa* trees by the wayside, attains to the abode of *Garuḍa* and spends his days therein as much pleasure as the gods do.

14. The man who plants either seven or even one *Pataśa* tree, gets at the abode of *Brahma* and is waited upon there by the best of gods.

15. He, who plants eight *udumbara* trees himself or gets them planted by others, reaches the abode of the Moon and enjoy intensity of pleasure there.

16. He, who plants a *Madhūka* tree, becomes free from all diseases and by him all the gods, especially the goddess *Pārvati* is pleased or gratified.

17. He who plants a tree along with any of these trees ; *Kṣirika*, *Kadali*, *Dṛākṣā*, *Piyāla*, *Panasa*, etc. ensures himself against all diseases for seven lives (births) to come.

18. He, who plants a *Jambū* tree, either with knowledge or in ignorance, enjoys the fruits of virtue in his own house every day.

19. He, who plants trees capable of bearing fruits and flowers besides those that have already been mentioned enjoys the fruits of the gift of one thousand cows of gold.

20. He, who plants *Aśvattha*, *pichumanda*, *Nyagrodha*, one each, ten tamarind trees, and *Kapittha*, *Vilva* and *Āmalaka*, three each, and five mango trees, is never fated to see hell.

Thus, there is clear evidence of attempts of the social thinkers to inspire the people to take the act of planting trees to be a holy work and the performance of these, might have led them to the world of eternal happiness. Indians always believe in the existence of a life beyond death. By performing the *punya* rituals, they can knock the door of *Śiva loka* or *Viṣṇu loka* i.e. the abode of gods. The common people though dependent upon the supplies of nature, are not always conversant with the role of plant and trees in maintaining the ecological balance. They generally do not pay interest in the preservation/conservation of plants. So, attempts were made by the thinkers of ancient society to invent such means by which the ultimate

objective of protecting the green world could be acquired. A series of rules were laid down in *smrtis* and *purānas* in order to restrain people from wanton destruction of plants and trees.

Along with these penal measures mentioned above, the old thinkers tried to entice the people with the hope of eternal happiness of heavenly abode like Visnu loka or Śiva loka as a reward of planting of trees.

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