

Agriculture: A Survey

India has a great variety of soils ranging from rocky to alluvial, diverse climate types and one of the most extensive agricultural lands in the world. India's monsoon is nature's abundant irrigating system and India is also blessed with a large network of perennial rivers that over ages have created vast stretches of highly productive alluvial soil.

Not surprising then that India has been an agricultural economy and civilization and has evolved a long, rich and diverse tradition of agricultural practices, including the selection of right soil and good seeds, techniques of irrigation and manuring, crop protection and grain storage as well as animal husbandry and pisciculture.

Agriculture in Prehistory and Protohistory

Recent archaeological findings indicate that rice was grown in parts of the Ganges Valley as early as in the 8th millennium BCE, and extended later to other areas, while the cultivation of barley and millets dates back to the 7th millennium BCE at Mehrgarh in Baluchistan.

A granary at Mehrgarh, Baluchistan, dated about 6000 BCE. Each 'box' of about 1 m x 1 m was lined with clay to protect the stored grain (barley or wheat) from dampness, possibly from insects. (The boxes' walls were higher than the remains suggest, up to 3 m.) Mehrgarh had many such granaries, suggesting a sophisticated collective management.



The next millennia saw the introduction and spread of many more crops:

- other cereals such as wheat;
- oil seeds such as sesame, safflower, linseed, mustards and castor;
- legumes such as green gram, black gram and fenugreek;
- fibre crops such as cotton; vegetables of cucumber family and eggplant (brinjal);
- fruits such as grapes, dates, jujube, jackfruit, mango, mulberry and black plum.

In the same period, cattle, sheep, asses, goats, dogs, pigs, fowl, etc., were domesticated. Archaeology has found evidence for them in the Indus civilization (pre-urban phase: 3500–2600 BCE; urban phase: 2600–1900 BCE), as well as of cultivation of barley, wheat, millets, cotton and other crops. Besides, the Harappans practised plough-based agriculture: a terracotta model of a plough share (*left*) was found at Banawali



(Haryana), while a field at Kalibangan (Rajasthan) dated to about 2800 BCE revealed two perpendicular sets of furrows, suggesting the practice of intercropping (growing two different crops at the same time).

Textual Sources

Agriculture, *kṛṣi*, is frequently mentioned in India's ancient literature. Apart from mentions scattered in various texts, it has a large body of specialized literature as well. The texts that have survived include *Kṛṣiparāśara*, Kauṭilya's *Arthasāstra*, the Sangam literature of early Tamils, *Manusmṛti*, Varāhamihira's *Bṛhatsamhitā*, *Amarakoṣa*, *Kaśyapīyakṛṣisukti*, and Surapāla's *Vṛkṣāyurveda*. These texts provide information about agriculture, horticulture, arboriculture and plant biodiversity. In addition, treatises on

horses by Śālihotra and on elephants by Pālakāpya are also available. We get a wealth of information on agricultural practices from such texts.

Types of Lands

The *Amarakoṣa*, a Sanskrit thesaurus, describes twelve types of lands according to the fertility of the soil, irrigation and physical characteristics. These are: *ūrvara* (fertile), *ūṣara* (barren), *māru* (desert), *aprahata* (fallow), *śadvala* (grassy), *pankikala* (muddy), *jalaprāya* (watery), *kaccha* (land contiguous to water), *sharkara* (full of pebbles and pieces of limestone), *sharkarāvati* (sandy), *nadīmātṛka* (land watered by a river), and *devamātṛka* (rain-watered). The Sangam literature (200 BCE to 200 CE) provides some information on soil types. For example, in *Tolkāppiyam*, an early work on Tamil grammar and poetics, five types of land are mentioned: *mullai* (forest), *kuriñci* (hills), *marutam* (cultivable), *neytal* (coastal land) and *pālai* (barren land).

Rain-Fed and Irrigated Crops

Since crop production often depended on seasonal monsoon rains, scholars worked out methods to predict rainfall. *Kṛṣiparāśara* and *Bṛhat Samhitā* describe such methods in every season. Parāśara's main technique was based on the positions of the Moon and the Sun in the sky. Varāhamihira in his *Bṛhat Samhitā* considered lunar mansions (*nakṣatras*) in predicting seasonal rainfall. Because of the confidence they have in ancient methods, a large number of farmers in India even today carry out farm operations based on them.

Agricultural practices often involve some technique of irrigation. Wholly or partly irrigated crops were raised thanks to canals, smaller channels or reservoirs such as village tanks. Reservoirs also served the purpose of water harvesting to cope with the dry seasons or prolonged droughts. The simplest form of irrigation consisted in having a

pair of bullocks pull a leather bag out of a well; the bag would tilt over the edge of the well and empty its content into a small channel.

Whether simple or highly sophisticated, water structures have been constructed in India right from the time of the Indus civilization. (See module **Other Technologies** for more details.) In the 3rd millennium BCE, Dholavira in the Rann of Kachchh could sustain itself in an arid climate only thanks to vast reservoirs and water harvesting on a massive scale. In the Ganges plains, embankments, reservoirs, sluices, channels, interconnected tanks, wells of various kinds became common features in the 1st millennium BCE; in his *Arthaśāstra*, Kautilya referred to many of them and lay down strict rules for the management of water structures. The rich Indian vocabulary attached to them – *kulls*, *kunds*, *ahars*, *pokhars*, *khadins*, *arakere*, *kolas*, *surangam*, *tadagams*, *eris*, to mention a few – testifies the variety of structures India developed.



The 329-metre-long ‘Grand Anicut’ (*Kallanai* in Tamil) across the Kāveri River, thought to have been constructed by the Chola king Karikāla some 1,800 years ago (it has been restored several times since), is a massive and effective water-diverting device, splitting the river into four streams and irrigating thousands of hectares of agricultural land in the Kāveri delta. (Courtesy: Michel Danino)

Implements

The Ṛgveda describes a simple bullock-drawn wooden plough with a metal bar attached as a ploughshare to open the soil. *Kṛṣiparāśara* gives details of the plough's design with Sanskrit names for its different parts. This basic design has hardly undergone any change over centuries; even today, many farmers use a similar bullock-drawn plough. A bamboo stick of specific size was used to measure land. Disc plough, seed drill, blade harrow (*bakhar*), wooden spike tooth harrow, plankers, axe, hoe, sickle, *sūpa* for winnowing, and a vessel to measure grain (*udara*) have all been mentioned. One to eight pairs of bullocks were used for ploughing in early days.



Ploughing with a wooden ploughshare in West Bengal (source: Wikipedia)

Seed and Sowing

Farmers knew how to select healthy seed from a ripening crop. The importance of good seed was so clearly recognized that the law-giver Manu recommended severe punishment for the adulteration of seed.

Seed were covered with flours of rice, black gram, and sesame to ensure good germination. Surapāla listed several herbs as seed treatment materials for shrubs and trees. Cow dung has long been used for treating cotton and some other seeds by a large number of farmers.

The art of sowing rice seed in small areas, i.e., in nurseries, and transplanting the seedlings is not a recent practice. It was first perfected in the deltas of Godavari and Krishna rivers in the 1st century CE.



A few varieties of native rice from Tamil Nadu (courtesy: Centre for Indian Knowledge Systems, Chennai)

Manures

According to Parāśara, crops grown without manure will not give good yield. Kauṭilya mentioned the use of cow dung, animal bones, fish and milk as manure. In the *Agni Purāṇa*, application of ‘excreta of sheep and goat and pulverized barley and sesame allowed to be soaked in meat and water for seven nights’ is recommended to increase

flowering and fruiting of trees. Surapāla describes the ‘ancient’ practice of preparing fermented liquid manure (*kuṇapajala*) prepared by boiling a mixture of animal excreta, bone marrow, flesh and dead fish in an iron pot and then adding to it sesame oilcake, honey, soaked black gram, and a little ghee (clarified butter). No fixed quantities of materials were required to prepare *kuṇapajala*. This application of liquid manure is still practised by farmers.

Panchagavya, a mixture of five cow products, is a fermented culture of cow dung, urine, milk, curd and ghee (other ingredients are sometimes added to increase fermentation). Studies have shown that *panchagavya* works as a biofertilizer, enhancing growth and productivity of crops and increasing resistance to diseases.

Pests and Their Management

Parāśara used the word ‘disease’ in Sanskrit (*vyādhi*) to differentiate from visible pests. He even listed goats, wild boars, pigs, deer, buffaloes, parakeets and sparrows among pests. Varāhamihira’s chapter on treatment of trees mentioned that trees are vulnerable to disease when exposed to cold weather, strong winds, and hot sun; this possibly laid the foundation of classifying tree diseases based on humours such as *vāta*, *pitta* and *kapha* (the *tridoṣa* of Ayurveda), which were formalized in later centuries in Surapāla’s *Vṛkṣāyurveda*. (For more details, see Module **Life Sciences (3): Plant and Animal Science in Ancient India**.)

Surapāla’s text deals with arbori-horticulture and gives considerable information on the importance of trees, soil types, classification of plants, seed, sowing, planting, plant protection recipes, nourishment, types of gardens, locating groundwater, and bio-indicators to decide the suitability of raising specific crops or breeding animals. For treating disorders, Surapāla suggests using a number of plant species that we know today have antimicrobial properties, including mustard paste and milk.



Preparation of biopesticide based on traditional methods
(courtesy: Centre for Indian Knowledge Systems, Chennai)

Cattle Management

Since Vedic times, owning cattle meant possessing wealth. The R̥gveda is replete with references to cattle and their management. References can be found to grazing of livestock, provision of water from clean ponds and succulent green fodder, and livestock barns. Later, cattle sheds were constructed and cleanliness of the shed was emphasized. Cows came to be regarded as sacred, while Buddhism and Jainism promoted non-killing of all animals.



Village scene in a panel at Mahabalipuram, Tamil Nadu (courtesy: Michel Danino)

The Kannada text *Lokopakāra* (1025 CE) indicates treatments for livestock diseases such as those affecting the horns, teeth and buccal cavity, and human diseases / disorders such as sore throat, carditis, lumbago, rheumatism, atrophy of muscles and acute dysentery. Plasters were used to treat broken bones.

Among other officers, the *Arthasāstra* notes the ‘superintendent of cattle’, who supervised livestock in the country, kept a census of livestock and ensured their proper rearing. Livestock was classified as tame steers, draft oxen, bulls to be trained to yoke, stud bulls, livestock reared for meat, buffaloes and draft buffaloes, female calves, heifers, pregnant cows, milking cows, barren livestock (either cows or buffaloes), and calves up to two months old. The *Arthasāstra* gives an elaborate description of the rations that a bull, cow or buffalo should be supplied with. Maintenance of pastures around villages was encouraged.

Horticulture and Arboriculture

Harappans cultivated fruits such as date palm, pomegranate, lemon and melon. The Sangam literature refers to jackfruit, coconut, date palm, areca nut, plantain, and tamarind.

A method of grafting described in *Bṛhat Saṁhitā* was what is known today as ‘wedge grafting’. Surapāla’s text mentions 170 species of plants including trees, shrubs and a few herbs, and deals with the laying out gardens and orchards and growing unusual trees. Layouts included designs such as *maṇḍapa* (canopy), *nandyāvarta* (quadrangle with an opening to the west), *swastika* (design of religious significance), *chaturasra* (square), *sarvatobhadra* (a square enclosing a circle), *vīthi* (line), *nikuñja* (arbour), and *punjaka* (cluster). The text recommends layouts for ‘pleasure gardens’.

Fishing

The Harappans made fishing nets and consumed both sea and freshwater fish. The Ṛgveda makes a general mention to fishes, but not specifically as a food item, while the Yajurveda mentions capturing fish by sedating them in a pond by treating the water with the bark of some trees. *Manusmṛti* names two fishes, *rohu* and *pathen*, as suitable for food. It is believed that fish culture (or pisciculture) came from China, where it originated almost 2,500 years ago, to Bengal via Myanmar or Thailand. The Chalukya king Someśvardeva (1127 CE) described methods of culturing fish and listed 34 kinds of fishes.

Agriculture and Society

In India as in every country, agriculture was an integral part of popular culture and gave rise to annual fairs, cattle *melas*, festivals and rituals, all of which were occasions for celebration. Almost every part of India had its own dates and customs for the purpose:

Akshaya Tritiya, for instance, a Hindu and Jain festival, is now often taken to be an auspicious day for buying gold, but it is also a harvest festival in parts of western and northern India. So are Holi in the same region, Lohri in Punjab and neighbouring states, Magh Bihu in Assam, Nabanna in Bengal, Onam in Kerala or Pongal in Tamil Nadu, among others, most of them accompanied with rituals honouring cows and bullocks. Such festivals not only helped to bond local communities together, but have promoted national integration.



A decorated cow (source: www.sathyasai.org.ar)



Pongal celebrations in a village of Tamil Nadu (courtesy: Christine Devin)

A prosperous agriculture being the base of strong kingdoms or empires, it was almost always supported by the multitudes of Indian rulers. The tradition was to impose minimal tax on farmers, rarely exceeding one-sixth of the produce. We probably need to continuously remind ourselves of the wisdom of our ancestors and provide genuine respect and importance to farmers.



Decorated camels at a festival (source: www.leisurewings.com)

Comprehension

1. What are the elements that damage crops?
2. Study some of the implements used in agriculture in ancient India and compare them to the ones being used today.
3. How do you get to learn about the weather forecast today? How do you think weather prediction was made in ancient times?
4. How many land types are there? What physical characteristics are they based on?
5. What are the duties of the ‘superintendent of cattle’ mentioned in *Arthaśāstra*?

6. What do you understand by pisciculture and how did it reach Bengal?
7. What are the ingredients of *kunapajala*? What are the advantages of this manure?
8. What are the different types of manures mentioned by Kauṭilya?
9. What are the earliest pests mentioned in Indian literature? Name a few visible pests and explain how they cause harm to crops.
10. What do you understand by ‘arbori-horticulture’?
11. What is grafting? List out a few plants and trees that are grown using this method.
12. What should be kept in mind while designing a layout for gardens as mentioned in Surapāla’s text? In modern times what kind of professionals would you associate with the designing of pleasure gardens?

Activity 1

- Machines are replacing human hands in agriculture. Discuss in groups and brainstorm mentioning the machines used in place of manpower.

Activity 2

- Discuss in groups the various uses of different plants and their parts; complete the following table:

Plant	Part& Uses
Coconut	
Mango	
Cinnamon	

You may view this short documentary on the uses of every part of the coconut tree: www.theperennialplate.com/episodes/2013/04/episode-118-coconut-nose-to-tail/

Project Ideas

1. Visit a nearby village to study the prevalent agricultural practices in that area. Interview farmers and find out how differently they work compared to their ancestors. Prepare a questionnaire keeping in mind the following points:
 - Preparing the fields
 - Seeds
 - Manures/fertilizers
 - Irrigation
 - Varieties of crops
 - Harvesting
 - Storage
 - Transporting the produce to the market
 - Innovations/ experimentation in farming.
2. **Agriculture is a waste-free activity.** Nothing is waste for a farmer. Find out how reusing and recycling takes place in farming. Yours project may include the following:
 - Findings on recycling processes
 - Interview with farmer/s
 - Relevant pictures/images
3. Put together a presentation on ‘**Agriculture: A Promising Career Option**’. Use examples that inspired youth from different professions to revert to agriculture using conventional methods as a means of sustainable living.

4. The excavations of Indus Civilization have brought forth the early history of agriculture and animal husbandry. Make a project about the findings using maps, toys, pots, figurines and seals of that era.

Extended Activities

- Make a home visit to some relative / friend staying in rural India. Stay overnight, taking part in the daily routine of a farmer and experience the stress-free life and the pleasure of being in the lap of nature. Make a diary entry of your experience.
- Visit some farmers who practise organic farming to find out:
 - The difference between village food and what you eat at home
 - Why organic products are highly priced
 - What manures these farmers use in their fields and how they prepare them.
- There is a tradition of planting barley in an earthen pot during *Navaratri*. What do you think is the significance of this ritual? Can we relate it to seed testing? Discuss in groups some other traditions related to agriculture and suggest the logic or scientific reasons behind them.
- Animals are a part of the family of farmers. There is an emotional cord that binds them. They are respected and worshipped as also their agricultural equipments. Make a list of the different fairs and festivals which revolve around farmers. Note how the animals are attired and decorated on harvest festivals. To understand this rural sentiment, you may plan a visit from school or with family to a camel or cattle fair or markets and understand the significance of *pashudhan* in rural life.



- India is going through a soil crisis, as discussed in articles such as the one below. Discuss what remedial measures traditional Indian methods may offer.
- http://articles.economictimes.indiatimes.com/2011-07-12/news/29765398_1_soils-farmers-cereal-production

Further Reading

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Internet Resources (all URLs accessed in May 2013)

- Asian Agri-History Foundation, Secunderabad, <http://asianagrihistory.org/>
- Centre for Indian Knowledge Systems, Chennai: www.ciks.org and www.youtube.com/watch?v=w5bHfqkQvHA
- Organic seed treatment: www.youtube.com/watch?v=PHDlaVH_F1U
- Food and Agricultural Organization (FAO): www.fao.org/ag/ca/
- A discussion forum on Indian agriculture: <http://farmnest.com/>
- Examples of traditional Indian farming: www.vedicsociety.org/an-introduction-to-vedic-farming-methods-p-185.html
- A resource on Indian organic farming: <http://ofai.org/resources/>



Agricultural Heritage: Excerpts from Primary Texts

Rigveda

This earliest Indian text insists that natural forces (earth – solid matter; water – liquid matter; air – subtle matter; fire – energy; and *ākāśa* – the opposite of matter) must remain in harmony with each other and humanity must not disturb the balance between them. The following verses relate to agriculture and deal with cow protection, cattle management, tree cutting, desire for rain, and contented animals and farmers.

‘O cows! Procreate calves, select fine quality grass, and drink clean, safe water from ponds.’ (6:28:7)

‘O humans! Do not kill a cow who is mother of Rudras [now Shiva], daughter of Vasus [attendant deities of Indra, and later Vishnu], sister of Āditya [the Sun], milk bearing, innocent without complex.’ (8:90:15)

‘O Pūṣan [Sun]! Do not destroy the trees that support birds but destroy those who hate me.’ (6:48:17)

‘Let the soil get soaked with water and give us harvests in the years to come.’ (4:57:7)

‘Let our ploughs open the soil happily, let the ploughman walk happily with the bullocks, and let clouds soak the lands with water. Give us happiness.’ (4:57:7, 8)

Kṛṣiparāśara (c. 400 BCE)

Parāśara's *Kṛṣiparāśara* is an introductory text addressed to farmers. He stressed soil management, seed health, and overall farm management that included water harvesting and conservation, animal management and maintenance of implements. The following verses are self-explanatory:

‘Farms yield gold if properly managed but lead to poverty if neglected.’

‘Even a fourfold yield of crops procured at the cost of health of the bullocks perishes soon by the sighs of their exhaustion.’

‘The bullocks of the farmer who keep the cow shed, strong, clean, and free of cow dung grow well even without special nourishment’.

‘Crops grown without manure will not give yield.’

‘Any implement which is not sufficiently strong or is not manufactured as per the measurements will, at the time of farming operations, obstruct the work at every step. There should be no doubt about it.’

‘Uniform seeds produce excellent results. Hence every effort should be made to procure uniform seeds.’

‘One should (therefore) put in maximum effort to procure and preserve these seeds. The origin of plentiful yield is the seed.’

‘What hope of harvest can that foolish farmer have who has not made arrangements for preserving water for the crop during *Aśvin* (October) and *Kārttika* (November).’

Kauṭilya (3rd or 4th century BCE)

Kauṭilya's *Arthaśāstra* is one of the most informative texts of ancient India. *Varta* or Economics – crop production, animal husbandry and trade – was considered one of the four sciences of the time, the other three being Vedas, Politics and Philosophy. Kauṭilya mentions intercropping of medicinal plants with any field crop. An example of wasteland utilization was planting cucurbits on river banks after the excess water receded. The practice continues even today in parts of India. Some significant statements by Kauṭilya:

‘Whoever hurts or causes another to hurt, or steals, or causes another to steal a cow, should be slain.’

‘The Superintendent of forest produce shall collect timber and other products of forests by employing those who guard forests.’

‘Brahmins shall be provided with forests for *soma* plantation, for religious learning, and for performance of penance, such forests being granted with safety for animate and inanimate objects, and being named after the tribal name (*gotra*) of the Brahmins resident therein.’

Kaśyapīyakṛṣisukti (800 CE)

This detailed treatise gives advice on farm management not only to farmers but also to kings. Details about rice-growing practices are still widely followed in India today.

‘Land is intended to receive excellence in every age.’

‘A good quality land yields good results to everyone, confers good health on the entire family, and causes growth of money, cattle and grain.’

‘To the west, north, east, or south of the villages and cities at the most convenient places, he [the king] should prepare reservoirs of water according to the condition of the land.’

‘The reservoir of water to be founded should be deep, equipped with barriers, splendid in the shape of a bow, long in some cases, round in others but essentially unfathomable.’

‘They should also be equipped with inlets for water. Hence they should be founded near some hill or a high-level ground joined with a lake.’

‘The king should plan its construction at such places as not to cause fear of danger from flooding. Such reservoirs should be regularly examined.’

‘Large forests teeming with various trees, on the forest lands, or on the outskirts, or interiors of existing forests, or on mountain slopes should be propagated.’

About canals for irrigation, ‘Even more than the ponds, lakes, wells, etc. protection of canals should be treated by them [farmers and the king] as their *dharma*, said the sages who know the truth.’

‘That water [therefore] should be preserved by all sorts of efforts, as agriculture is said to depend on water. Hence, kings and [other] eminent persons should obtain water by exerting everywhere in the seasons and conserve it.’

For rice, ‘The second cultivation in a year is fruitful everywhere and is therefore recommended on various types of farmlands. For taking up this second operation, it is essential to raise the fertility of the soil, which can be achieved by using manure of goat-dung, cow dung, and vegetation [green manure].’

Vṛkṣāyurveda (c. 1000 CE)

Surapāla's *Vṛkṣāyurveda* is a 'complete' treatise on arbori-horticulture. It also emphasizes the importance of trees and environment. Some of the verses carry deep meaning. The importance of growing trees is versed beautifully thus:

'Ten wells are equal to one pond.
Ten ponds are equal to one lake.
Ten lakes are equal to one son.
Ten sons are equal to one tree.'

'... One should undertake planting of trees, since trees yield the means of attaining *dharma* [righteousness], *artha* [accumulating wealth without being greedy], *kāma* [procreation], and *moksha* [liberation], which are the four aims of life.'

'Seeds which are treated and preserved [in the prescribed manner] are all good for use. Trees grown from such seeds bear for ever abundant flowers and fruits of an excellent quality.'

Kṛṣigītā (c. 1500 AD)

Paraśurāma in *Kṛṣigītā* recommended deep summer ploughing. This has been in practice in Kerala for several centuries. Green manuring was recommended for rice. Although forest clearing was recommended as a means to expand cultivated areas, farmers were also encouraged to plant trees and other woody perennials.

Comprehension

1. Name a few texts that depict Indian agriculture in ancient times.
2. What is the significance of uniform seeds in farming?
3. List a few herbs that were traditionally used to treat seeds.
4. ‘... One should undertake planting of trees, since trees yield the means of attaining *dharma* [righteousness], *artha* [accumulating wealth without being greedy], *kāma* [procreation], and *moksha* [liberation], which are the four aims of life.’ Present your views on this statement.
5. What is the advice to the kings regarding water management in *Kaśyapiyakṛṣisukti*?
6. ‘O humans! Do not kill a cow who is mother of Rudras ...’ In the light of present day context, analyse the statement and present your views.

Extended Activity

- Literature is the mirror of society, for instance, films like *Do Bigha Zameen* and *Mother India* convey the essence of Indian farming traditions. The famous Hindi writer Munshi Prem Chand wrote extensively on the backdrop of rural India. Keeping this in view,
- collect folk and film songs;
 - read literature of various languages;
 - watch Indian classics with family and friends.

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