

THEORY

Agricultural heritage – Historical facts – Development of human culture - Indus and vedic civilization. Status of farmers in the society. Agriculture and allied activities in Kautilya's Artha-Sastra and Tamil literature. Astronomy – prediction of monsoon rain.

Soil classification – water management - plant protection and ITK – harvesting threshing in ancient India. Crops and their origin. Gardening and medicinal plant in ancient period – Cattle and other domestic animals – Description of Indian civilization – vision for the future.

LECTURE SCHEDULE

1. Agricultural heritage – early history : Archaeological and historical facts Geology of Indian sub continent .
2. Development of human culture – stone age – Bronze Age – Iron age and beginning of agriculture.
3. Indus civilization – vedic civilization - current debate - civilization in other parts of India – developments in Agriculture.
4. Status of farmers in society - advice by sages to kings on their duties towards farmers.
5. Kautilya's Artha-Sastra; agriculture, animal husbandry, commodity trade etc. – features of village.
6. Agriculture and Tamil literature.
7. Astronomy – prediction of monsoon rains; Parashra, Varahamithira, Pachanga, comparison with modern methods
8. Soil classification – maintenance of soil productivity. Water management – water harvesting - storage – distribution and relevance to modern agriculture.
9. MID SEMESTER EXAMINATION
10. Plant protection - ITK – harvesting - threshing and storage
11. Crops- indigenous and introduced - history of rice, sugarcane and cotton.
12. Gardening in ancient and medieval period – arboriculture - orchards
13. Vegetable farming - floriculture – perfumes
14. Medicinal plants and their relevance today.
15. Role of cattle and other domestic animals – management of cattle for draft and milk – indigenous breeds
16. Description of Indian civilization and agriculture by travellers from China, Europe and USA.
17. Our journey in agriculture; vision for the future

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AGR.102 – AGRICULTURAL HERITAGE OF INDIA (1+0)

Need for studying this Course

Normally history denotes the continuous record of past events, where as heritage indicates the inherited values carried from one generation to other generation. Agricultural heritage denotes the values and traditional practices adopted in ancient India, which are more relevant for present day system.

Our heritage is unique than any other civilization. A citizen of India, we feel proud about our parents, language, state and mother tongue, since our country has rich cultural heritage. Likewise, one should be proud of our agriculture as it has lot of inherited sustainable practices passed from one generation to other generation. And also agriculture in India is not an occupation, it is way of life for many Indian populations. Hence the present day generation should be aware the facts about our ancient and traditional agricultural systems and practices. This will enable us to build the future research strategy also.

Lecture: 1

Historical facts

In a span of 2300 years (5th century BC through 18th century AD) only 56 reports of famines of droughts were recorded in parts of Indian sub continent. No famine or drought 12 centuries (4th to 22nd century BC 1st century to 8th century AD : 12th century AD). The famine occurred in different states were viz., Gujarat – 26, Rajasthan – 25, Maharastra – 18, Punjab (India + Pakistan) – 15, Delhi – 11, Central India – 10, Bihar, Orissa + Bengal – 9, Madras (TN / AP) – 6, Kashmir – 4, Assam – 3, Mysore – 1. These facts clearly indicate that agriculture in ancient India was more flourishing than any other country in the world. Another evidence, that European scientists (Voelcker 1897) opined that farmers of India are as good as and in some respect superior to the average British farmer.

Evidence in Epics

Ramayana 2000 BC – Sri Rama stated to Bharata that special care and attention should be given to the farmers, then only prosperity and happiness of the people could be ensured. The Mahabarath (1400 BC), also stated that agriculture,

animal husbandry and trade are the way of life of the people. It was mentioned that large irrigation tanks have been constructed for agriculture purpose.

Parashara (400 BC)

Parashara was the author of Krishi Parashara, which is regarded as highest authority of agriculture. It deals with knowledge and practices relating to agriculture, such as soil classification, land use, manuring, plant protection and agricultural meteorology. It also deals with the care of draught animals and grasses for cattle. This book contains important quotations about the cultivation namely.

- Farming is blessed and sacred
- Farming depends wholly on rainfall, hence one should acquire the knowledge of rainfall.
- The origin of plentiful yield is seed
- Crops grown without manure will not give yield
- Uniform seeds produce excellent results. Hence every effort should be made to produce uniform seeds.
- Even a well grown crop does not yield full returns if grasses are not weeded out. The yield was reduced due to grass.

These quotations were used as extension techniques in ancient times clearly emphasized the importance of farming, rainfall in crop production, quality seed, manuring and weeding in crop production.

Authors of some ancient literatures viz., Kautilya (321 – 296 BC), Manu (200 BC), Tirucalluvar (125 AD), Varahamihira (600 AD), Kashyapa (800 AD) Surapala (1000 AD) also mentioned about the importance of agriculture, agricultural practices and customs prevailed.

Available Documents

1. Rigveda (c. 3700 BC)
2. Atharvaveda (c.2000 BC)
3. Ramayana (c. 2000 BC)
4. Mahabharata (c. 1400 BC)
5. Krishi – Parashara (c. 400 BC)
6. Kautilya's Artha-shastra (c. 300 BC)

7. Amarsimha's Amarkosha (c. 200 BC)
8. Patanjali's Mahabhasya (c. 200 BC)
9. Sangam literature (Tamils) (200 BC – 100 AD)
10. Agnipurana (c. 400 ?)
11. Varahamihir's Brhat Sambita (c. 500 AD)
12. Kashyapiyakrishisukti (c. 800 AD)
13. Surapala's Vrikshayurveda (c. 1000 AD)
14. Lokopakaram by Chavundaraya (1025 AD)
15. Someshwardeva's Manasollasa (1131 AD)
16. Saranghara's Upavanavioda (c. 1300 AD)
17. Bhavaprakasha – Nighantu (c. 1500 AD)
18. Chakrapani Misra's Viswavallbha (c. 1580 AD)
19. Dara Shikoh's Nuskha Dar Fanni – Falahat (c. 1650 AD)
20. Jati Jaichand's dairy (1658 – 1714 AD)
21. Anonymous Rajasthani Manuscript (1877 AD)
22. Watt's Dictionary of Economic Products of India (1889 – 1893 AD)

Archaeological findings have revealed that rice (*Oryza sativa* L) was domesticated crop grown along with the banks of the Ganges in the sixth millennium BC. Later, it extended to other areas. Several species of winter cereals (barley (*Hordeum vulgare* L.) oats (*Avena sativa* L.), and wheat (*Triticum aestivum* L.)) and legumes (lentil (*Lens culinaris* Medik) and chickpea (*Cicer arietinum* L.)) domesticated in Southwest Asia, were grown in Northwest India before the sixth millennium BC. Some other millets, such as sorghum (*Sorghum bicolor* (L). Moench)), pearl millet (*Pennisetum glaucum* (L) R. Br.), and finger millet (*Eleusine coracana* (L.) Gaertn.) which were earlier domesticated in Africa, found their way to the Indian subcontinent more than 4000 years ago. In addition, smaller millets such as the species of *Panicum*, *Setaria*, *Echinochloa*, and *Paspalum* were domesticated in India since the Neolithic period. Archaeological research also revealed cultivation of several other crops 3000 – 6000 years ago. These include oilseeds such as sesame (*Sesamum indicum* L.), linseed (*Linum usitatissimum* L.) safflower (*Carthamus*

tinctorius L.), mustards (Brassica spp.), and castor (Ricinus communis L.) ; legumes such as mung bean (Vigna radiate (L), Wilczek), black gram (Vigna mungo (L.) Millsp.), field pea (Pisum sativum L.), grass pea (Lathyrus sativus L.; khesari), and fenugreek (Trigonella foenumgraecum L.) ; fibre crops such as cotton (Gossypim spp.) ; and fruits such as jujube (Ziziphus mauritiana Lam.), grape (Vitis vinifera L.), date (Phoenix sylvestris Roxb.), jackfruit (Artocarpus heterophyllus L.), mango (Mangifera indica L.), mulberry (Morus alba L.), and black plum, (Syzigium cuminii (L.) Skeels.). animals, including livestock, sheep, goats, asses, dogs, pigs, and horses were also domesticated.

Geology of Indian – sub continent

GEOLOGICAL TIME SCALE

Era	Period	Epoch		Age (Million years)
Cenozoic Era (Age of Mammals)	Quaternary	Recent (or) Holocene Pleistocene	Neogene	1.6
	Tertiary	Pliocene Miocene Oligocene Eocene Paleocene		Paleogene
Mesozoic Era (Age of Dinosaurs)	Cretaceous	Late, Early		144
	Triassic	Late, Middle, Early		213
	Jurassic	Late, Middle, Early		248
Paleozoic Era (Age of Trilobites)	Permian	Late, Early		286
	Pennsylvanian	Late, Middle, Early		320
	Mississipian	Late, Early		360
	Devonian	Late, Middle, Early		408
	Silurian	Late, Middle, Early		438
	Ordovician	Late, Middle, Early		505
	Cambrian	Late, Middle, Early		590
Precambrian	Early, Middle, Late			4500

The investigation of Voelcker in 1893 and by Leather in 1898, led to a classification of Indian soils into four major types.

- i. The Indo – Gangetic alluvium
- ii. The black cotton or regur soils
- iii. The red soils lying on metamorphic rocks and
- iv. The lateritic soils.

Indo – Gangetic Alluvium

It is the largest and most important soil groups in India. The soils of this group cover about 7,77,000 Km². It is distributed mainly in the northern, north western and north – eastern parts including the Punjab, Haryana, UP and Assam. They produce bumper crops of wheat and rice. Geologically alluvium is divided into

- i. Khadav, new alluvium, sand deposit light in colour
- ii. Bhangar, old alluvium, clayey composition, dark in colour and full of pebbles or kankar.

Black cotton soils

It is the typical soils of Deccan Plateau, otherwise known as regur soil. It is common in Maharashtra, M.P., Karnataka and Tamil Nadu. It is comparable with prairie soil of the cotton growing tracts of USA and chernozems of Russia. The black soil areas have generally a high degree of fertility, fine grained and dark with a high proportion of Ca and Mg carbonates. There are two distinct kinds of black soils are found.

- i. Deep heavy black soil where cotton cultivation is predominant
- ii. Shallow black soil

Red soils

Red soils extend over an area of 2, 072, 000 km² covering Orissa, M.P., eastern A.P., Karnataka and major part of Tamil Nadu. Red soils were produced as a result of meteoric weathering of ancient crystalline and metamorphic rocks. The colour of the soil is generally red, some times brown or yellow. The redness is due more to a general diffusion than to a high proportion of Fe content.

Laterites

It is a soil type peculiar to India and some other tropical countries. In formation it varies from compact to vesicular rock composed essentially of a mixture of hydrated oxides of aluminium and iron with small quantities of manganese oxides, titania etc. It is produced by the atmospheric weathering of the several types of rocks. Laterites are specially well developed on the summits of the hills of Karnataka, Kerala, M.P. the coastal region of Orissa, South Maharashtra, Malabar and part of Assam. All lateritic soils are generally very poor in lime and magnesia and deficient in nitrogen, Occasionally the P_2O_5 content may be high, but there is deficiency of K_2O .

Other soil groups

In addition to the four principal groups of soils, three more groups are available

1. Forest and Hill soils
2. Desert soils
3. Saline and Alkaline soil

Lecture.2.

DEVELOPMENT OF HUMAN CULTURE – STONE AGE – BRONE AGE – IRON AGE – BEGINNING OF AGRICULTURE

Development of Human culture

It is supposed that man was evolved on earth about 15 lakh years ago. This man was evolved from the monkey who started to move by standing erect on his fact. Such man has been called Homo erectus (or) Java man. Later on Java man transformed into Cro-Magnan and Cro-Magnan into modern man. The modern man is zoologically known as Homo sapiens (Homo – continuous, sapiens – learning habit). In the beginning such man had been spending his life wildly but during the period 8700-7700 BC, they started to pet sheep and goat although the first pet animal was dog, which was used for hunting.

The history of agriculture and civilization go hand in hand as the food production made it possible for primitive man to settle down in selected areas leading to formation of society and initiation of civilization.

The development of civilization and agriculture had passed through several stages. Archeologist initially classified the stages stone age, Bronze and Iron age. Subsequently the scholars split up the stone age into Paleolithic period (old stone age), Neolithic age (New stone age) and Mesolithic age (Middle stone age).

Each of three ages, saw distinct improvements. The man fashioned and improved tools out of stones, bones woods etc to help them in day-to-day life. They started growing food crops and domesticated animals like cow, sheep, goat, dog etc.

Paleolithic age (old stone age)

This period is characterized by the food gathers and hunters. The man started making stone tools, choppers and crude choppers.

Mesolithic period

The transitional period between the end of the Paleolithic and beginning of the Neolithic is called Mesolithic. It began about 100000 BC and ended with the rise of agriculture. This period is characterized by tiny stone implements called microliths.

People lived as food gatherers and hunters. The domestication of the dog was the major achievements of the Mesolithic hunter.

Neolithic Agricultural Revolution (7500 BC – 6500 BC)

While people were hunting wild animals and subsisting on leaves and fruits of the jungle trees in India, a remarkable development took place in Western Asia viz., the discovery of Agriculture. The birthplace of the Neolithic agriculture revolution was Western Asia (Israel, Jordan, Iraq etc.). It is in this region that wild ancestors of two major cereals, wheat and barley and of domesticated animals like goat, sheep, pig and cattle are found. The period from 7500 – 6500 BC was in real sense of discovery of agriculture. Polished stone axe and sickle were used for the cultivation of crop like wheat, barley, rice, maize and millets. Domesticated horse and ass were used as draught and transport animals. A distinctive feature of Neolithic culture was the development of house built of locally materials. The development of agriculture and the practice of food grain in sizeable quantities led to the problem of storage. Pots were required not only for storing of food grain but also for cooking. Weaving was another landmark made possible due to abundant supplies of flax and wool.

Thus, Neolithic revolution brought a major change in the techniques of food production which gave man control over his environment and saved him from the precarious existence of mere hunter and gather of wild berries and roots. For the first time, he lived in settled villages and apart from security from hunger he had leisure time to think and contemplate.

Bronze age: (Chalcolithic culture 3000 – 1700 BC)

The term Chalcolithic is applied to communities using stone implements along with copper and bronze ones. In more advanced communities, the proportion of copper and bronze implements is higher than that of stones. The Chalcolithic revolution began in Mesopotamia in the fourth millennium B.C. from this area it spread to Egypt, and Indus valley.

The significant features are

1. Invention of plough
2. Agriculture shifted from hilly area to lower river valley
3. Flood water were stored for irrigation and canals were dug

4. Irrigated farming started in this period.
5. Sowing of seed by dibbling with a pointed stick
6. Salinity problem and water logging were noticed due to canal irrigation.

The main features of Neolithic culture in India

1. Neolithic culture denotes a stage in economic and technological development in India
2. Use of polished stone axes for cleaning the bushes
3. Hand made pottery for storing food grains
4. Invented textile, weaving and basketry
5. Cultivation of rice, banana sequence and yams in eastern parts of India
6. Cultivation of millets and pulses in South India
7. Discovery of silk.

Iron age

In India it started from early 1000 BC. The iron age immediately succeeded. The pre historic age in south India. The Aryans know the use of iron. We entered the iron age during vedic period. The iron age has already commenced when the rigveda was composed. Men started using iron for making weapons and implements. Iron implements have been found in Changanassery district. They have developed fairly good means of high culture and civilization in this age.

Lecture : 3

INDUS CIVILIZATION (3250 BC – 2750 BC)

In the year 1922, archaeologists dug up a few places in the Indus valley and carried out excavations at Mohenjodara (meaning a mound of dead) in Sind (in Pakistan) and at Harappa on the river Ravi in Punjab. They found traces of a very ancient civilization, which flourished more than five thousand years ago. They observed that the people utilized the pots, utensils and ornaments. These cities were built along the river Indus and hence this civilization is known as Indus valley civilization. It is also known as Harappan culture and occupied the area stretching from Delhi to Gujarat.

During this period the people identified the importance of ploughing for the proper sowing of crop (i.e). Soil has to be stirred and seed has to be covered. Ox-drawn wheel cart was used for transport. The people cultivated wheat, Barley, Gram, peas, Sesamum and rape. They also cultivated cotton and also devised methods of ginning spinning and weaving. Animal husbandry was also given more importance during this period. They domesticated buffalo, cattle camel, horse, elephant, ass and birds. They utilized them in agriculture and also for transport.

The most remarkable discovery in Harappa is the Great Granary used for storing food grain. These granaries, each 50 x 20 feet overall, area arranged symmetrically in two rows of six with central passage and 23 feet wide. From the size of the granary it can be concluded that the peasants paid their dues to the Government in kind, used the granary for payments to employees of various kinds. The artisans, carpenters and others received their wages in kind from the farmers.

The Vedic civilization

The word “ Veda “ is derived from “Vid” which means “Knowledge” Veda is the only literary source from which we know about the Aryans in India. Aryans were more prevalent during vedic time which extends from eastern Afghanistan, Kashmir, Punjab and Parts of Sind and Rajasthan. The land of Aryans are called land of seven rivers i.e., (Satlaj, Beas, Ravi, Chenab, Jhelum, Indus and Saraswathi. The Rig-veda was the oldest book of Aryans.

Pastoralism

The vedic Aryans were primarily pastoral. When they settled in the Punjab, they cut the jungles and built their villages. They grazed the animals in jungles and cultivated barley nearest to houses to protect from wild animals.

Vedic people realized the importance of off-season ploughing and they started ploughing as and when the rain was received. The first ploughing of the season was inaugurated amidst much ritual. The plough used was large and heavy, but a yoke does not seem to have been used. Bullocks and ox were used for ploughing. With regard to irrigation, channels were formed the rivers. Wells were in use for supply of drinking water and irrigation. There were kucha wells, which were just holes dug in the ground. Even now such wells are in use in the riverain areas of northern India.

Crops cultivated in vedic period

In early vedic period there is no mention of rice and cotton though there were cultivated in Harappa period. In the later vedic period (1000 – 600 BC) agricultural implements were improved. Iron ploughshare was used also improved. The people possessed the knowledge of fertility of land, selection of seed, seed treatment, harvesting manuring and rotation of crops. Barely sesame and sugarcane were the main crops. Cucumber and bottle gourd were also mentioned in vedic period, Aryans were accustomed to barley diet. Barley is good for men cattle and horses. Barley is used in Hindu rituals even at present. For cloths, wool and cotton were used.

The agriculture implements mentioned in vedic literature include the plough (langala, - a lase pointed type having smooth handle, Sira – a large and havy plough). Sickle was used harvesting sieves were used for cleaning.

Role of Women in Agriculture during Vedic Period

In Vedic period the economy of people largely depended on agriculture with cattle rearing as their main occupation. In all agriculture activities, women took active part as in sowing, ploughing, weeding, reaping threshing etc. They also assisted their husband went to fields and performed hard duties with them like harvesting crops with sickle, collecting bundles, beating them out on the floor of the granary, separating the grains form the chaff by a sieve and storing the grain safely. Besides these cloth making, stitching weaving spinning dyeing were some of the subsidiary occupation for

women especially in vedic period. There was also mention of the work like carpentry gold and black smithy and military training undertaken by women to earn their livelihood. All the available evidences thus indicated that in vedic period, women contributed a lot to build the economy not only of their own families but of the country too.

Lecture : 5 Kautilya's Artha-sastra – agriculture, animal husbandry commodity trade etc.

Kautilya (also known as Vishnugupta or Chanakya) (321 – 296 BC) was a great scholar of his time. He wrote a treatise titled, Artha-sastra, which deals with the management of resources. During Kautilya's time agriculture, cattle breeding and trade were grouped into a science called varta. Kautilya gave great importances to agriculture and suggested a separate post of Head of Agriculture and named it as Sitadhakashya. Agriculture today receive prime importance, by policy and administrative support from govt. officials. eg. (i) Supply of good seeds and other inputs (ii) provision of irrigation water (iii) Prediction of rainfall by IMD (iv) Assistance in purchase of machineries (v) Marketing and safe storage. All the important aspects mentioned by Kautilya in his book. He suggested many important aspect in agriculture which are highly relevant today.

1. The superintendent of agriculture should be a person and knowledgeable in agriculture and horticulture. There was a provision to appoint who was not an expert but he was assisted by other knowledgeable person. This is applicable even today, appointment of the directors of agriculture/horticulture are sometime civil servants and assisted by technical persons.
2. Anticipation of labours by land owners before sowing and employ slaves, labourers and prisoners to sow the seeds in time. He also emphasized through ploughing provides good soil texture required for a particular crop. Even today the farmers in Punjab hired labours from Bihar at times of heavy demand period.
3. Timely sowing is very important for high yield particularly for rainfed sowing. For which, all the implements and accessories have to be kept ready. Any delay in these arrangements received punitive action.
4. Kautilya suggested for getting good yield of rainfed crop a rainfall of 16 dronas (one drona = 40 mm to 50 mm) mass essential and 4 dronas rainfall sufficient for rice. It is very significant to note that rain gauge was used during Kautilya's period. It was apparently a circular vessel (20 fingers width, 8 fingers width depth) and the unit to measure rain was adhaka (1 adhaka =12 mm approx.)

5. He also stressed the optimum distribution of rainfall during crop growing season one third of the required quantity of rainfall falls both in the commencement and closing months of rainy season (July / Aug; October/Dec) and 2/3 of rainfall in the middle (August, Sept; October) is considered as the very even. This concept is applicable even today i.e. even distribution is essential for rainfed crop.
6. The crops should be sown according to the change in the season. Ev. Sali (tramplant rice), Virulu (direct sown rice) till (Sesame), millets should be sown at the commencement of rain. Pulses to be sown in the middle of season. Safflower, linseed mustard, barley wheat to be sown at last. It is clear that even to day our scientific results proved that cereals, millets were sown early and oilseeds wheat barley require less water could be sown at last or as post rainy season.
7. He also stressed that rice crop require less labour expense vegetables are intermediate, and sugarcane is worst, requires more attention and expenditure. It is true even today after 2000 years the situation was never changed that sugarcane requires heavy labour and expenditure.
8. The crops like cucurbits are well suited to banks of rivers, Long-peper, sugarcane and grapes do well where the soil profile is well charged with water. Vegetable require frequent irrigation, borders of field suited for cultivation of medicinal plants. Eventoday the practice of growing cucurbits (Water melon pumpkin) on river banks continue from river Ganges north to Pamba river in south. This is an outstanding example of sustained practice, which utilization of moisture available in river bank.
9. Some of the biocontrol practices suggested by Kautilya has got relevance even today. They are :
 - a) Practice of exposing seeds to mist and heat for seven nights. This practices are followed even now in wheat to prevent smut diseases. Soaking of seed in water to activate fungal mycella and drying the seed under hot sun to kill the fungal.

b) Cut ends of sugarcane are plastered with the mixture of honey, ghee and cowdung. Recently evidences proved that honey is widely antimicrobial property. Ghee could seal off the cut ends prevent loss of moisture and cowdung facilitated biocontrol of potential pathogens.

10. He also suggested that harvest should be done at proper time. Nothing should be left in the field not even chaff. The harvested produce should be properly processed and safely stored. The above ground crop residues were also removed from fields and fed to cattle.

Trade and Marketting (Economic policies)

All the industries were categorized into two groups according to their ownership. One group of key industry was converyed by state and another group by private. It is interesting to note that this policy just resembles like the today's model mixed economy. The production, distribution and consumption of agricultural produces well controlled by the king. Agriculture was placed in the category of privately owned industries. The State Government should control and regulates all the economic aspects and evade the influence of market forces and private interests.

These practices suggested by Kautilya were followed by Indian farmers for over centuries which are more sustainable and relevance to scientific agriculture.

Lecture : 6 AGRICULTURE IN THE SANGAM LITERATURE OF TAMIL NADU

During the Sangam period (200 BC to 100 AD), the main profession of 80% of the population of the Tamil region (now Tamil Nadu) was agriculture. The region extended from Cape Comorin in the South to Tirupati (in Andhra Pradesh) in the North, parts of present Kerala and Karnataka in the West. The methods of cultivation practiced during this ancient period was revealed by several proverbs, village songs, and literature of the period which are available even today. It is rather surprising that the people had good knowledge about agriculture (seed varieties, seed selection, seed storage, ploughing, manuring, irrigation, weeding, crop protection, pests, and botanical pesticides).

The Sangam period literature covers wide aspects of the people's life, such as epics, ethics, social life, and religion. Several poems composed during this period have been passed on from generation to generation through memorizing and chanting and later through manuscripts written on palmyra leaves. With the advent of paper and printing machinery, Shri Swaminatha I Year who is popularly called “ Tamil grandfather” painstakingly collected them and brought them out as printed books. Two poems of the Sangam period, viz., Tholkappiyam and Thirukural, give us a vivid picture of agricultural practices in that period.

Tholkappiyam

The poem Tholkappiyam was written by the poet Tholkappier during 200 BC. It gives descriptions of various agricultural aspects and these are enumerated below.

Land classification

Land was classified into four groups, viz., mullai (forest), kurinji (hills), marudham (cultivable lands), and neithal (coastal areas).

Seasons

Six seasons are mentioned : early spring, late spring, cloudy, rainy, early winter, and late winter.

Cultivated crops

There are references to rice, millets, sugarcane, banana, cardamom, pepper, cotton, sesame, coconut, and areca nut. Farmers were aware that rice could be

grown only in wetlands with assured irrigation from tanks while millets could be grown as rainfed crops. Banana and sugarcane were rationed. Plants were considered as living beings and endowed with sensitivity. Tholkappier mentions about monocots and dicots 2700 years ago.

Importance of agriculture

Kings considered agricultural development as their primary duty. They felt that soil fertility and irrigation facilities should be the country's assets. Increased agricultural production was considered a yardstick of prosperity of the country. The stability of a kingdom was ensured not by the army but by agriculture and sufficient crop production. Failure of monsoon rains and reduction in grain yield were attributed to the king's sins.

Irrigation

Kings dug tanks at locations where water flow from rains was plentiful. Semicircular bunds were raised adjacent to small hillocks and water reservoirs akin to present day dams were constructed. This indicates awareness of water harvesting. The king Karikal Cholan brought 1000 slaves from a conquered country and raised the bunds of river Cauvery. The stone dam constructed across the river Cauvery centuries ago is considered a master piece of engineering even today. River water was diverted to tanks through channels. It is mentioned that irrigation should be given either in early morning or late evening and not during hot mid-day.

Agricultural Implements

Buffaloes were used for ploughing with a wooden plough. Deep ploughing was considered superior to shallow ploughing. A labour saving tool called parambu was used for leveling paddy fields. Tools such as amiry, keilar, and yettam were used to lift water from wells, tanks, and rivers. Tools called thattai and kavan were used for scaring birds in millet fields. Traps were used to catch wild boars in millet fields.

Seeds

Seed was selected from those earheads that first matured. The selected seed was stored for sowing only and never used as food grain. It was believed that such a diversion would destroy the family.

Crop rotation

Crop rotation was practised by raising black gram (urd) after rice. This indicates that farmers were aware of the benefits to the following rice crop which we now know is due to the nitrogen fixation in the root nodules of urd. They also practised mixed cropping; e.g., foxtail millet with lablab or cotton. Today we know that a balanced diet should have starch (supplied by rice and millets) and protein (supplied by lablab). In coconut and jack fruit plantations, ginger and turmeric were grown as intercrops.

Threshing

A tool called senyam was used for harvesting rice. Threshing of rice was done by hand with the help of a buffalo (and in large holdings by elephants). Hand winnowing was done to remove chaff. One sixth of the produce was paid as taz to the king. Farm labourers were paid in kind.

The land was immediately ploughed after harvest or water was allowed to the field to facilitate rooting of stubbles. These agronomic practices are recommended even today based on scientific principles. Operations requiring hard work such as ploughing were done by men while women attended to light work such as transplanting, weeding, bird scaring, harvesting, and winnowing.

In Kandapurāṇam, it is mentioned that Valli, daughter of a king, was sent for bird scaring in millet fields where Lord Muruga (son of Lord Shiva) courted her and married.

Marketing

Products were exchanged by weight. In Madurai (the headquarters of Sangam poets), there was a food grains bazaar where 18 kinds of cereals, millets, and pulses were sold. Each shop had a banner hoisted high so that it could be seen from a distance indicating the grains sold. What a novel method instead of neon signs and name boards! Customs duty was collected on imports and exports.

Thirukural

The poem was composed by a gifted poet named Thiruvalluvar during 70 BC. It consists of 1330 couplets (133 topics each having 10 couplets). It is the pride of Sangam Tamil literature and its greatness can be realized from the fact that it has

been translated into English and several other languages. It devotes one topic (10 couplets) for agriculture under the chapter politics. This clearly reveals the recognition that the prime duty of a king is to ensure agricultural production. Even today we know that Governments fall when people are starved. The French revolution 200 years ago can be traced to food shortage leading to the fall of Louis XVI. One of the causes of defeat of Germany in World War I was potato shortage due to the late blight disease of potato. When the available copper was diverted to meet the army's requirements, production of copper sulphate suffered. So Bordeaux mixture (a fungicide consisting of a mixture of copper sulphate, lime, and water) preparation was affected and late blight could not be controlled. The available potato was sent to soldiers fighting in the front. Hence, potato was not available to families of soldiers. This severely affected the morale of German soldiers. Horsfall and Cooling jocularly mention the story in the following lines :

For want of a nail, the shoe was lost.
For want of shoe, the horse was lost.
For want of horse, the soldier was lost.
For want of soldier, the war was lost.

In India also, several state governments have fallen when they failed to ensure adequate supply of food grains through public distribution system.

The importance of agriculture and related aspects are indicated in the following couplets and descriptions.

Importance of agriculture

- “ World spins around many industries. All such industries spin around agriculture”.
- “Farmers alone live an independent life; others worship them and are second to them”.
- “ If farmers stop cultivation, even rishis (sages) cannot survive”.

Ploughing

- “If land is ploughed deep and soil allowed to dry to one fourth weight, even manuring is not necessary”.

Manuring

- “ Manuring is more important than ploughing : crop protection is more important than irrigation”.

Green leaf manuring, farmyard manure, and sheep penning were in vogue though farmers were not aware that they supplied nitrogen to the crop. One is amazed at the depth of agricultural knowledge our ancestors possessed.

Irrigation

Bed method was followed as an efficient method of water management

Weeding

- “ Just like the farmer pulls out weeds with the root system, so the king should eliminate rowdies from society”.

Care of crops

- “If the farmer does not regularly visit his field, the crop will not grow”.

The foregoing account of agriculture from ancient Tamil literature clearly indicates the agricultural knowledge of our forefathers. By following their footsteps, the present generation of agricultural scientists have used the advanced technologies and have tried to stabilize agricultural production in our country to meet our food requirements.

Lecture : 7

ASTRONOMY – PREDICTION OF RAINS – PARASHARA, VARAHAMIHARA PANCHANG

Modern scientific knowledge of methods of weather forecasting have originated recently. But ancient indigenous knowledge is unique to our country. Indian had glorious scientific and technological tradition in the past. A scientific study of meteorology was made by our ancient astronomers and astrologers. Even today, it is common that village astrologers (pandits) are right in surprisingly high percentage of their weather predications.

Meteorology is generally believed to be a new science. It may be new to the west, but not in India, where this science has existed from a very early late. A systematic study of this science was made by our ancient astronomers and astrologers. The rules are simple and costly apparatus are not required. Observation coupled with experience over centuries enhanced to develop meteorology.

The ancient / indigenous method of weather forecast may be broadly classified into two categories.

1. Observational method

- Atmospheric changes
- Bio-indicators
- Chemical changes
- Physical changes
- Cloud forms and other sky features

2. Theoretical methods (or) Astrological factors (or) planetary factors

- Computation of planetary positions and conjunctions of planets and stars
- Study of solar ingress and particular date of months
- Study of Nakshatra Chakras
- Study of Nadi Chakras
- Dashatapa Siddhanta

Almanacs in Indian astronomy and astrology (Panchangs)

According to the Encyclopedia Britannica (1969), “ an almanac is a books or table containing a calendar of the days, weeks and months of the year, a register of

ecclesiastical festivals and saint's day and a record of various astronomical phenomena, often with weather prognostications and seasonal suggestions for countrymen".

In India, the classical Hindu almanac is known as 'Panchang'. This book published yearly, and is the basic book of the people all over India. For astrologers, it is one daily basis and is extensively used by the people all over India. For astrologers, it is one of the basic books for making astrological calculators, casting horoscopes, and for making predictions. For farmers, it is an astrological guide to start any farming activity.

The word 'panchang' has its roots in two Sanskrit words, viz., 'panch' and 'ang', which means 'five' and 'body part/limb' respectively. These parts are

1. Tithi (or) Lunarday – Total of thirty tithes in a lunar month, fifteen in each fortnight.
2. Vara or week day – seven varas, namely
Ravivara (Sunday)
Somavara (Monday)
Mangalavara (Tuesday)
Budhavara (Wednesday)
Guruvara (Thursday)
Shukravara (Friday) and
Shanivara (Saturday)
3. Nakshatra (or) asterism (or) constellation – Total of twenty seven nakshtras named according to the yagataras (or) identifying stars of each of the twenty seven equal parts of the ecliptic (or) solar path.
4. Yoga (or) time during which the joint motion of the sun and the moon covers the space of the nakshatra (there are twenty seven yogas).
5. Karana (or) half of a lunar day (or) half – tithi.

The other items considered for astrological prediction are

1. Rashi (or) twelve equal parts of the Zodiac belt, hence twelve rashis
2. Planets

3. Solar months and solar year
4. Lunar months and lunar year
5. Era

Theoretical basis of weather forecasting in ancient literature and panchangs

According to varahamihira and other scholars, the formation of clouds (or) garbhadharana takes place 195 days before their birth (or) delivery (or) garbhaprasava. During his period clouds were grouped as Abartak (Avartak), Sambartak (Samvartak), Pushkara and Drona. It abartak is dominating one year, rain will be received in certain places in that year; if sambartak, rain will be received in all of the country; if pushkara, the quantity of will be very less; and if drona, that year will receive abundant rain water.

It is also true even today, the cloud classification indicates Cirrus, Cirrostratus, Cirro Cumulus, Altostratus, Altocumulus, Stratocumulus, Stratus, Nimbo Stratus, Cumulus and Cumulonimbus. Among this Nimbostratus and Cumulonimbus gives rainfall to the earth.

According to the ruling planet of a year, overall rainfall of that particular year should be anticipated as follows:

S.No.	Ruling planet	Rainfall
1.	Sun	Moderate
2.	Moon	Very heavy
3.	Mars	Scanty
4.	Mercury	Good
5.	Jupiter	Very good
6.	Venus	Good
7.	Saturn	Very low (Stormy wind)

For predicting the monsoon and its subsequent effects on weather, all panchang makers consider three different Nadi Siddhantas (Capsular theories) commonly known as Nadi charkas. These are :

1. Dwinadi charks
2. Trinadi charks
3. Saptanadi charks

Arrangement of nakshatras in Saptanadis and its associated effect on weather

Seven nadis	Effect on weather
Chanda	Bright sunshine, no rainfall
Vata	Sunshine and wind, normal rainfall
Vanhi	Strong hot wind (Westerlies)
Soumya	Normal rainfall
Meera	Very good rainfall
Jala	Abundant rainfall
Amrita	Heavy to very heavy rainfall causing flood

Prediction analysis and discussion

The analysis indicates that rainfall predictions made in panchangas based on ancient astrological theories are, on an average, better than and in some cases at par with the predictions made by Govt. meteorological department through modern techniques and procedures.

(E.g.) The yearly fully corrected predictions of rainfall made during 1946-1955 were 75,78,74 and 75% respectively for different panchangam. The seasonal prediction also indicated that it was 89% for summer, 55% for rainy, 90% for winter and 78% for overall.

Method for measurement of rainfall

The method of measurement of rainfall is described by Varahamihira. A circular vessel with a diameter equal to one (human) arm or the distance measured by the width of 20 (human) fingers and with a depth equal to the distance measured by the width of eight fingers should be accepted for measurement of rainfall. When this vessel is completely filled with rainwater, the rainfall should be equal to 50 palas or one adhaka. This method has been explained by the Parashara.

According to Parashara, the basic unit of rainfall is adhaka.

$$1 \text{ adhaka} = 1760 \div 7 = 2514 \text{ cubic finger} = \frac{1}{4} \text{ drona} \quad (\text{eq.1})$$

$$\text{Volume of the vessel} - \pi r^2 d = 3.14 \times 10^2 \times 8 = 314 \times 8 = 2512 \text{ cubic fingers} \quad (\text{eq.2})$$

Where $p = 3.14$, $r = \text{radius of the vessel} = 10 \text{ fingers} - \text{width}$, and $d = \text{depth of the vessel} = 8 \text{ fingers} - \text{width}$.

Three units were used to measure rainfall in ancient India : pala, adhaka, and drona (50 palas = 1 adhaka = $\frac{1}{4}$ drona). These ancient units can be related to the modern ones using the relation 2514 cubic fingers of rainwater or 1 adhaka is equal in weight to 11 oz or 311.85 g. As 1 cc of water weighs 1 g, so

$$1 \text{ adhaka} = 2514 \text{ cubic fingers} = 311.85 \text{ cc} \quad (\text{eq.3})$$

In a modern rain-guage with a 200 cm^2 container, volume of 1 cm of rainwater collected is :

$$200 \text{ cm}^2 \times 1 \text{ cm} = 200 \text{ cc} \quad (\text{eq.4})$$

Based on equation 3, rainfall measured using the ancient method could be related to modern units as :

$$1 \text{ adhaka} = 311.85 \div 200 = 1.6 \text{ cm} \quad (\text{eq.5})$$

(i.e., volume of rainwater \div area of container = amount of rainwater collected

(see equation 4)

From equations 1 and 5:

$$1 \text{ drona} = 4 \text{ adhakas} = 6.4 \text{ cm} \quad (\text{eq.6})$$

(E.g) The distribution of rainfall indifferent parts of India during 4th century BC is also recorded in Artha-Sastra.

Anulent name of the region	Modern name	Amount of rainfall	
		Ancient units (drones)	Modern units (cm)
1. Malwa	Western MP	23	147.2
2. Aratta	South inland Maharashtra	13½	86.4

Krishi – Panchang

The researcher developed the Krishi panchang (or) Agroalmanac (or) Agro-panchang. It may be defined as basic astro-agricultural guide book/calendar published annually, giving calendrical information on various aspects of agricultural and allied, activities, basically suggesting region wise, seasonwise and cropwise. Crop strategy based on astro – meteorological prediction, giving auspicious time for undertaking various farm related operations, along with a list for performing religious rites, festivals, observing fasts and some non-astrological agricultural guidance, primarily useful for the farming communities and persons having interest in agricultural development.

The contents of the proposed Krishi-Panchang can broadly be categorized into two kanor groups as fallows :

1. Information which changes every year

- Annual date and Holiday calendar
- Month – wise daily guide for the whole year
- “Rashiphal”, i.e., month-wise forecasting of persons having different zodiac sings.
- Daily/monthly/annual weather forecasting for the particular year
- Crop prospects of that year based on planetary positions
- Season-wise crop strategy based on anticipated weather

2. Information which remains same irrespective of any particular year

- Theories relating to agricultural and meteorological forecasting
- Auspicious moments for agricultural and allied activities
- Some general agricultural guidance

Panchang-making

The content and coverage of the proposed Krishi-Panchang, indicate that only qualified astrologers cannot prepare the whole content on their own, rather an editorial board comprising of both qualified astrologers and crop specialists can do justice. While preparing the Panchang, the – editorial board members should keep in mind the following important points :

- The Krishi-Panchang is largely meant for the local farming communities, having very low educational status. Hence, it must be in the local colloquial language to facilitate reading and comprehension.
- Care should be taken to make the Krishi-Panchang easily understandable and clear in its meaning.
- It should be very comprehensive in its content and coverage with proven predictive information only.
- It should not contain any astrological details or complexities which would go beyond the understanding capability of our less educated farmers and agriculturists.
- It should be attractive in colour, and presentation of information should be systematic according to season (kharif, rabi, and summer) and crops.
- It must be low-priced/nominal-priced, within the affordable range of small and marginal farmers.
- More important, is, the must be made available to the farmers and needy persons sufficiently in advance, i.e., at least 1-2 months before the start of the agriculture year (July-June).

