LET US PRESERVE OUR INDIGENOUS KNOWLEDGE

Indigenous knowledge is generated through the diverse experiences faced by people in meeting different challenges posed by nature and by society. The indigenous knowledge is the knowledge inherent to a particular community or country. This knowledge flows down from generation to generation and is embedded in the culture of the community or area concerned. Therefore indigenous knowledge progresses with the progress of the community or area and also degenerates with its decline.

In ancient times autocrats who ruled our country adopted diverse systems of government. However, the ancient works of irrigation, the temples, the dagabas, the medical system, and architecture all bear clear evidence to the fact that in the indigenous knowledge was utilized readily in the past than the present. The consequence of repeated foreign invasion of the country caused the gradual destruction of the invaluable indigenous culture and knowledge inherent to our country. Although it is obvious that the society changes with the time, it is not incorrect to say that our indigenous culture was destroyed in this way due to the people in our country indiscriminately imbibing cultural practices of the aliens. The ultimate result of this situation which aggravated day by day, was that our country has gained a name among world powers as a destitute country in the Third World. The foreigners who invaded our country however, studied our valuable culture and sciences and other scholarly aspects and enriched their own culture and knowledge based with what they derived from it whereas we indiscriminately embraced their customs and practices and turned our backs on our own culture. Concealing traditional knowledge as the property of the "Gurus" was another reason for the decline of indigenous knowledge.

In spite of an advanced agricultural technology of our own, even today we try to adapt our fertile farmland to artificial agro chemicals brought from the so called developed countries to destroy the countries that are recognized as 'poor' but are rich in ecosystems. Although we had an advanced metallurgy, developed architectural practices and an advanced irrigation engineering industry, all of it is now in decadence. Sri Lanka was in a developed state at the time when the countries that are developed today were in a primitive condition. There are historic facts to prove this. Let us take a look at the creative workers of the past and their creations. It is very clear that our indigenous technology, aesthetic values and the environment were all well preserved by their creations. We should not forget our past. Science and technological knowledge should not be considered unsuitable merely because it has come to us from a foreign country. All intelligent choice should be made of what is needed. We should be able to adapt the knowledge selected in this way while preserving our indigenous knowledge.

In this issue of "VIDURAVA" an attempt is made to reflect on a few facets that have a scientific value such as agriculture, metallurgy, textile technology, indigenous medicine as well as astronomy, in the vast body of knowledge which is specific to Sri Lankan society and these articles convey to students and to the general public, the significance of preserving "Indigenous knowledge".

Editor

Vidu 19-1-3

INDIGENOUS KNOWLEDGE, SCIENCE AND TECHNOLOGY :

An overview

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WHAT IS INDIGENOUS KNOWLEDGE ?: **Knowledge is 'understanding and familiarity gained by experience' (OALD, 1989) and according to Roling and Engel (1991), 'knowledge occurs between the ears, a property of mind. It cannot be heard, seen or touched'. Indigenous knowledge (IK) is often defined as local knowledge that is unique to a given culture or society. It is the basis for agriculture, health care, food preparation, education, environmental conservation, and a host of other activities. Much of such knowledge is passed down from generation to generation, usually by word of mouth (Warren, 1989). IK is also known as local knowledge, people's knowledge, folk's knowledge, traditional knowledge, traditional wisdom, non-western knowledge and traditional science.**

IK is generated by people through their day-to-day experience when they face the challenges of nature and society. Most of it is not documented but embedded in culture in various forms such as cultural practices, customs, traditions, religious and spiritual beliefs, rituals, ceremonies and folk stories and songs. It is a knowledge system which has evolved in a given locality, and it describes how to face and win the challenges of nature and society of the locality of its origin. Therefore, IK is the knowledge of a given location, and it, as its existing form, cannot be generalized and globalised. Hence, it is location-specific and less applicable outside its original locality. IK is also coded in local terms of local languages, and therefore, it is, very often, not standardized and cannot be understood by outsiders.

CULTURE : STORE- HOUSE OF INDIGENOUS KNOWLEDGE Culture is defined as the complex whole which includes knowledge, belief, art, morals, law, customs, and any other capabilities and habits acquired by man as a member of society. As mentioned before, IK is stored in culture in various forms in which it has been evolved. It is related to the entire culture of the given community, including its identity, spiritual and religious beliefs. Hence, IK and culture are inseparable. Local people see IK as part of their overall culture and vital to their survival. Some argue that more culture is more wealth, that having more know-how, more languages, and more centres of interest enriches indigenous people, as well as enriching in the process the rest of the country's citizens and some segment of humanity as well (Davis and Ebbe, 1993).

IK is preserved by the local people not because of its potential economic value, but because it is vital to meet their day-to-day survival needs. While preserved in the given culture, IK is being fed by both knowledge systems adopted from external cultures and inventions created by the community itself. Therefore, IK is, very often, in a changing and developing process. Hence, it is dynamic rather than static. Any IK system is preserved as long as the culture of the given community is preserved. When the culture is subject to internally generated changes the

IK is also changed, but not destroyed. However, if a culture is subject to externally generated drastic changes, the stress enforced on culture, causes destructive effects on culture as well as IK. When culture is destroyed, the IK system embedded in it is also destroyed.

INDIGENOUS KNOWLEDGE AND SCIENCE:

IK is different from science in a number of ways. Science is defined as an organized knowledge obtained by observation and testing of facts about the physical world, natural laws and society (OALD, 1989). Scientists explore nature and human communities in order to identify laws which describe relationships between various phenomena, seek explanations for the identified relationships and subsequently build theories which are then used for making predictions and designing technologies, the practical applications of knowledge. Local people too, similar to scientists, explore nature and society within the limits of their localities, but not as organized research. They explore nature and society as a part of their daily life and of their struggle to survive.

Science is generated by professional scientists whereas IK is generated by local people. While science is a knowledge system of capitalist market economies, IK is that of subsistence economies. Therefore, IK based technologies were designed for small-scale production to meet family needs. But on the other hand, science based technologies were designed for mass production to cater national and global markets. Local people have produced to meet their daily needs which were relatively few due to the low population and their simple way of life. They could produce to meet their needs without trying to dominate and exploit natural resources excessively. They have developed technologies which act in harmony with nature. However, science enables people to dominate nature and exploit natural resources. It was deemed to be necessary in the modern society to meet increased human needs in the modern society.

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Local people too, through their interactions with nature and society, understand the relationships between various phenomena, but perhaps, unlike scientists, they do not search for detailed explanations. At large, the identified 'relationships' remain as beliefs, without a detailed knowledge of rational explanations. As long as the beliefs perform to the level of their expectations, there is no need to seek rational explanations. Therefore, IK remains descriptive. Rational explanations are required when commodities are produced for market. When an economy is transformed from subsistence into a market one, producers begin to seek rational explanations for the identified relationships. Then, scientific inquiries begin to play an important role[1].

CRITICISMS AGAINST SCIENCE:

However, the popular belief that science and its technologies are universal is now being challenged. Both science and IK have been originated in certain locations, and therefore both are, in definition, location specific. But, science claims to be universal because (1) it travels fast and hence can be found everywhere on the globe, and (2) it can be

applied outside its original location. However, some argue that science is applicable everywhere not because it is universal but because we change the world to suit it [science]. Scientific theories are deducted from experiments which are conducted under artificial conditions created in laboratories or experimental farms. Therefore, scientific knowledge is replaceable anywhere on the globe where the same artificial conditions have been created.

It is also hard to justify the use of science as a yardstick to measure validity of IK, because science itself is a relatively young discipline which is still developing. It still has a long way to go. It has been evident that what is accepted once as a scientific truth, is later found to be untrue. Some argue that science is a subject of dead matter because in science, conclusions are drawn from experiments and analysis which have been done using dead matter. Hence, in science, 'life' and the spiritual elements of life are not taken into account. Science is objective and based on materialism, and therefore can deal only with the material world. On the other hand, IK deals with both the material and the spiritual world. Since it cannot deal with spiritual elements, science rejects a part of the IK which is based on spirituality; as myth.

It is also said that science is responsible for today's environmental crisis. Before modern science came into existence, nature was considered as a living mother who nurtures all living beings including plants and animals by providing air to breathe, water to drink, and food to eat. Therefore, it was believed that she should be given due respect, honour and protection if the human kind is to survive. However, science changed this attitude. Science views nature as an inanimate object which can be manipulated by humans for their benefits. It has reduced nature from the status of a living mother to an inanimate machine, a pool of resources and a man's slave which is separable, manipulable and exploitable. Science explores nature and tries to understand it, and there by to dominates it to use nature for the benefit of humans.

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MARGINALIZATION OF INDIGENOUS KNOWLEDGE :

IK is used by its creators and bearers themselves, in the place of its origin. Since it is less applicable outside its place of origin, it has no market value. But science is generated by professional scientists and it is claimed to be universal. Science and science-based technologies are sold to its users, the capitalist producers. Therefore, scientific knowledge is perceived as a commodity and an income-generating asset. If this commodity (scientific knowledge) is to be marketable, it should be globally usable. Therefore, unlike IK, scientific knowledge is made standardized and systematic so that it could be globally understandable. Being a commodity, science travels fast. But IK which is less applicable outside its place of origin, is deeply rooted and tied to the culture of its original place, and hence does not travel fast.

Science multiplies itself rapidly, because it has to search for solutions for the problems which have been created by itself. For instance, use of technologies produced by science to dominate nature causes 'new' problems, e.g. environmental degradation, health problems etc. Seeking solutions for 'new problems' calls for further scientific

research which leads to enhancement of science and creation of further advanced technologies. Hence, science is self-multiplying unlike IK which advocates living with nature. IK was designed to prevent such problems rather than to heal. Therefore, IK is generally incapable of dealing with most of the new problems which have emerged as a result of human interference in nature.

Science, by virtue of its self-multiplying nature, offers solutions to the problems it creates. Hence, scientific knowledge is becoming more and more demanded and marketable. However, on the other hand, the IK, since it often cannot offer solutions to the new problems, is increasingly becoming redundant and marginalized. Modern society prefers knowledge systems and technologies which involve less work and bring quick results. IK and IK based technologies generally involve hard work and it does not bring quick results. Furthermore, it is a common fashion that IK is justified by scientific yardstick, and the IK that cannot be proved by science, is branded as myth. ***At present, a large share of IK is considered as myth and are increasingly being condemned and rejected. This is particularly true with regard to the present young generation who have been trained and educated with western knowledge.*** In the modern society in which everything is measured in terms of its market value, IK is increasingly losing the place it had in the society.

POTENTIAL OF INDIGENOUS KNOWLEDGE FOR SUSTAINABLE DEVELOPMENT:

However, since recent times, many scientists, academics and policy makers are beginning to realize the potential value of IK for sustainable development. Local people have a wide knowledge of the ecosystem they live in and ways to ensure that natural resources are used sustainably. Therefore, IK which had been accumulated over centuries has potential value for sustainable development. It can help other people learn how to live in harmony with nature and the environment in a sustainable fashion. The potential values and suggested applications of IK for sustainable development can be summarized as follows:

(1) Historical evidence proves that some local people have utilized natural resources over centuries without impairing their capacity to support the community and their successive generations. Therefore, IK of natural resources management could provide valuable information base which could be used in the management of natural resources for sustainable development.

(2) If development is to be sustainable, the development projects should always involve local people as partners so that they could participate fully in designing, planning, implementation and evaluation. Use of IK for development projects facilitates the participation by local people.

(3) The knowledge developed by local people over centuries can be integrated with modern scientific knowledge in order to create appropriate knowledge systems and technologies leading to sustainable development. Agro-forestry is one example.

(4) Communication gap that exists between project personnel and local people often impedes sustainable development. IK can facilitate communication by providing a better understanding of how people perceived their environment and organize their perception.

But, IK is, very often, not known by development professionals because today it remains only in the memory of local groups in remote areas. It is also highly fragmented, dispersed and not always documented. Such knowledge is being lost with each succeeding generation because the younger generation may not be prepared to adopt IK systems which have been practised by their ancestors. It is being forgotten as its place is taken by modern scientific knowledge, technologies and education. It is often ignored and condemned by many, claiming that it is not scientific. As pointed out earlier, IK is in some cases, less effective and incapable of dealing with modern problems. Above all, people who are already accustomed to modern technologies which are easy and comfortable, are unlikely to return to IK based technologies.

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PRESERVATION AND USE OF INDIGENOUS KNOWLEDGE:

There is a controversy on how IK should be conserved: in-situ or ex-situ conservation ? In-situ of IK may be possible in a situation where the local communities remain isolated without being strongly influenced by modern cultures, and they are still interested in preserving their cultural heritage. In such a case, the following measures may contribute to the preservation of IK.

- Preservation of local culture
- Strengthening of local social institutions
- Empowerment of local people
- Legal recognition of local people's right to their physical as well as intellectual properties
- Use of IK and IK based technologies for development

Though in-situ conservation is the best way of conserving IK, it may not be possible to implement under many circumstances where local people have undergone drastic cultural changes. When a culture is changed due to modernization, IK embedded in the culture will also be replaced by modern scientific knowledge. In such a situation, the following measures may contribute to the preservation of IK.

(1) Blending IK with Modern Knowledge: Action should be taken to study local knowledge and local technologies with a view to understanding their scientific validity, and blend them with modern science in order to create and appropriate knowledge system. This is necessary because people in modern societies tend to accept only the knowledge systems which are consistent with science. It is suggested that the studies be undertaken with local people's participation, and the results should be disseminated into local communities.

(2) Documentation and Preservation of IK: Immediate action should be taken to document and preserve the IK systems of which scientific validity cannot be proved by scientific methods and discarded as myth (due to the limitations of modern science). Information on local setting (both physical and cultural) in which the IK system has evolved, should also be documented together with the knowledge system, because such information would be vital to

understand how the particular IK and IK based technologies did work and benefited the particular local communities.

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1. An example:

Local people grow Kohila *(Lasia spinosa)* in mud-holes in which the water drained from washing and bathing near the well is accumulated. They know the relationship between two phenomena: X=growing Kohila and Y=the mud-holes near the well. The IK with regard to growing Kohila is 'Kohila grows in the mud-holes near wells' or in other words 'X is related to Y'. However, as long as Kohila grows in the mud-hole near the well and its yield is adequate to meet their family needs, they do not want to bother to seek rational explanations for the question why Kohila grows in that particular location or in other words 'why X is related to Y'. Therefore, IK remains descriptive.

However, such a descriptive knowledge becomes inadequate if Kohila is to be grown for the market, because large scale Kohila cultivation calls for a knowledge which explains the relationship between X and Y : what type of soils and what amount of soil moisture are required for Kohila cultivation. Such a knowledge is necessary when a vast area is to be made suitable for Kohila cultivation. It is at this point that one has to go beyond the scope of indigenous knowledge, and to seek rational explanations: why X is related to Y ? Once the rational explanations are found they are standardised and expressed in global terms, and it becomes 'science'. It may be a statement like this: 'Kohila can be cultivated on such and such soils with such amount of moisture under tropical conditions'. Then the 'science' is used to produce a package of technology which is subsequently sold to the potential Kohila producers.

Modern Kohila farms are different from traditional way of Kohila cultivation in mud-holes near wells. The traditional Kohila mud-holes are natural ecosystems whereas the modern large-scale Kohila farms are mono cultures in which Kohila is cultivated under the environmental conditions which have been artificially created by using advanced technologies. Therefore, modern Kohila farms are highly vulnerable to diseases and pest problems which call for technological solutions. In order to seek such solutions, scientists will start to conduct research and it further contributes to the development of science. Thus, scientists have to continue to do research in order to seek solutions to the problems created by science itself. Therefore, science is self-multiplying.

VIDU 19-1-9

MEDICINE AND SURGERY

Dr C.G.Uragoda

The earliest system of medicine that prevailed in Sri Lanka was *desiya chikitsa* which was handed down from generation to generation. Reputed prescriptions were jealously guarded secrets of a family. This secrecy was one of the very reasons for the decline of the system, for at times the possessor of the prescription died without bequeathing it to the next of kin. With the passage of time, *desiya chikitsa* became largely integrated with ayurveda which was introduced from North India about the time of the advent of Buddhism to the country.

Hospital concept

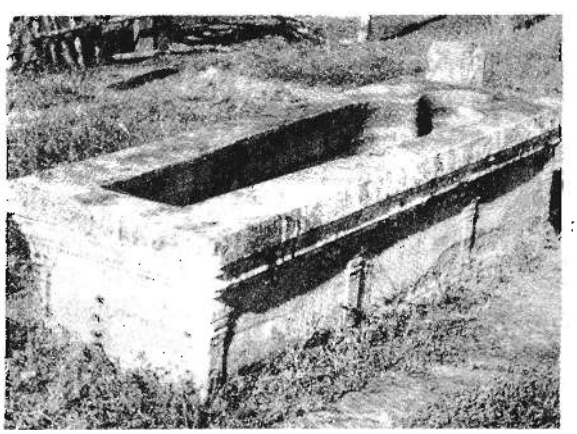
Hospitals were unknown in ancient civilisations such as those of Egypt, Assyria, Babylon and China. Hospitals were established for the first time in the world in Buddhist India before invasion by Alexander. Thereafter the idea spread to the neighbouring countries in Asia and thence to the west. One of the first such countries was Sri Lanka.

The concept of a hospital where a number of patients was collectively housed in special centres with the attendant advantages to the sick was recognised in Sri Lanka as early as the 4th century BC. Ancient kings built hospitals, both general and specialised, in Anuradhapura, Polonnaruwa and other parts of the country.

Teaching hospitals

Some monasteries, such as Mihintale, Medirigiriya and Alahana where large communities of Buddhist monks lived, had their own hospitals where the sick clergy could be conveniently treated. As ordained by Buddhism, looking after the sick was a highly meritorious act, and this attitude was an impetus to the development of health care in Sri Lanka.

The few ancient seats of learning of university status were confined to outstanding monasteries. Medicine and surgery were probably taught in hospitals attached to these monasteries in the same way these are now taught in teaching hospitals attached to medical schools. Since Buddhism encouraged humanitarian acts such as attending on the sick. It is likely that pupil monks were trained in medicine so that they could undertake the care of the sick in the adjoining hospital. It is also likely that these hospitals acted as training centres for practical instruction in medicine, much in the same manner as the teaching hospitals of today. Mihintale and Alahana probably antedated by several centuries the modern concept of a teaching hospital.



Bath for immersion therapy found at the Madirigiriya

Medicine trough

Hospitals at Mihintale (9th century AD) and Alahana (11th century AD) have now been identified, and the excavation of these sites has yielded valuable information regarding the practice of medicine and surgery in early times. The ruins of Mihintale are perhaps the oldest of any hospital in the world. A piece of equipment which is now considered the hallmark for the identification of an ancient hospital in Sri Lanka is the medicine trough or ***beheth oruwa***.

Immersion therapy, where the body of a patient was kept immersed in a bath of medicinal fluid, was an accepted form of treatment in ayurveda. A wide choice of bath fluids, which included embrocations of medicinal herbs, milk, ghee, oils and vinegar, was prescribed. Diseases treated in this manner included skin lesions, rheumatism, piles, snake bite and fever.

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Fever was probably brought down by physical cooling. Till recent times, ice caps on the head were a popular form of western treatment for high fever. The mode of action of immersion therapy for other conditions was thought to be through fomentation or absorption of the medicinal fluid through the skin. There was skepticism in western medical circles till recent times about the ability of medicinal oils to penetrate the intact skin. Now such doubts have been dispelled, a good example being the external application of diclofenac in an oil base for muscle and joint pains.

Medicine troughs were made of metal, wood or stone. Hospitals where generations of patients had to be treated would have used the long-lasting stone troughs in preference to wood which would rot with time or metal which was likely to corrode with certain fluids.

The surviving medicine troughs at Mihintale, Medirigiriya, Alahana, Anuradhapura and Dighavapi have been fashioned out of solid blocks of stone which have been scooped out so that the cavity would conform to the shape of the human body. There is much scientific merit in this design, for a patient could be completely immersed in it with the minimum amount of the precious medicinal fluid.

Surgery

There is little evidence to assess the state of surgery in ancient Sri Lanka. The main evidence has been unearthed from the site of the Alahana parivena. The instruments discovered may be dated to the 11th century AD. These included forceps probably used for dental work or to handle bones, scissors for cutting dressings or sutures, probes, lancets and scalpels.

In Sri Lanka, surgery was less developed than medical treatment. This was a common failing in all ancient civilisations, for without the advances in anaesthesia which took place only in the 19th century, surgery had to take a back seat.

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Herbal medicine

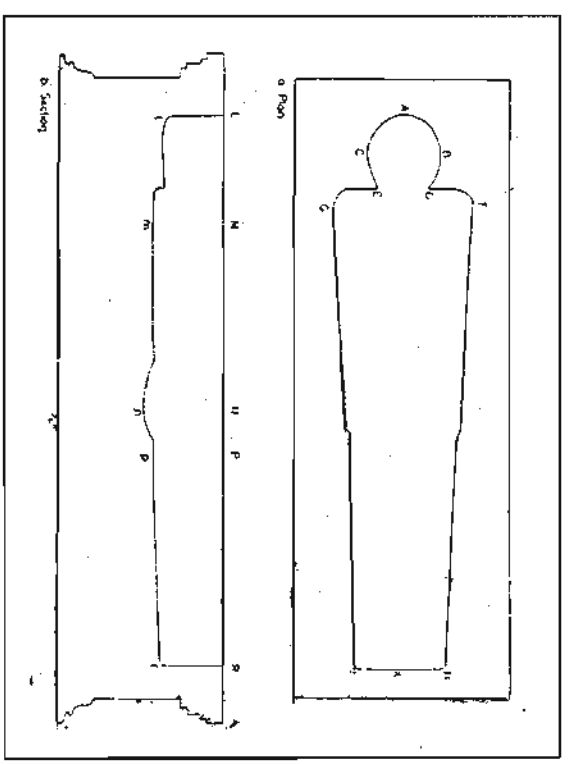
Herbs occupied a pre-eminent place in indigenous medicine. The expertise possessed by local physicians in this regard was admired first by the Portuguese and then the Dutch. Many of the plants these foreigners saw in Sri Lanka were new to them. They were previously unaware of their medicinal properties. When years of residence in the country had brought them into contact with practitioners of ayurveda, they began to develop a healthy admiration for local knowledge. They gradually absorbed some of these local remedies into their own pharmacopoeias. One medicine much admired by the Portuguese was the fruit of ***Aegle marmelos (beli* S).**

The Dutch used some of the local herbs in their hospitals in Sri Lanka. Further, they regularly sent back to Holland consignments of medicinal and other plants. These herbaria were later to earn international acclaim as the best in existence at the time. They were to advance the cause of botany throughout the world. Linnaeus, the father of botany, first applied his sexual system of classification of plants on a herbarium from Sri Lanka.

Towards the end of their rule, the Dutch began to appreciate and make use of the superior knowledge of herbal medicine possessed by the local ayurvedic physicians. In 1793 they appointed a 'native' physician to each of the Dutch hospitals in Sri Lanka. His duty was to assist the chief surgeon on his daily ward rounds so that his knowledge was utilised in the best manner.

Sanitation

There is convincing archaeological evidence that an efficient system of sanitation existed, at least in the monasteries and palaces. Some of the archaeological remains point to the adoption of sound scientific principles in the construction of sanitary facilities, a fact which is not surprising in a people who evolved a sophisticated irrigation system. The remains of several toilet complexes in ancient Buddhist monasteries have come to light.



Plan and section of immersion bath at Mihintale

INDIGENOUS KNOWLEDGE AND PATENTS FOR SCIENTIFIC ACHIEVEMENTS

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Indigenous knowledge is generated by people through their day-to-day experiences when they face the challenges of nature and society. These challenges could be different problems in agriculture, biotechnology, biology, and medicine etc. This mass of knowledge evolved is unique to a society of a country. This is a resource to be preserved and the people who have generated this knowledge should be respected and rewarded. Most of this knowledge is embedded in various cultures in various forms such as cultural practices, customs and traditions. For an example, as the traditional system of indigenous medicine was based on herbal preparations, the knowledge was stored in prescriptions called "Beheth Wattoru". Different prescriptions were written for different diseases. This specific knowledge in medical treatments had been with native doctors (Veda mahaththaya) and has been transmitted from generation to generation to date. But very recently it has been reported that some scientists have taken these herbal prescriptions for laboratory analysis to find the chemical components and the reactions of this components with other substances . Ultimate aim of these chemical analysis is to develop chemical structures towards the manufacture of drugs suitable to various ailments.

The researcher and the associated drug companies receive patents for these achievements while neglecting the knowledge generated by native people. Then the question **of "who is the real owner of this national knowledge ?"** is raised.

If the drug is effective, it is true that the discovery of a new drug is a contribution to the development of the medical science. But this patenting system has taken all the intellectual rights of people who have provided the original knowledge that was used for synthesizing the drug. And also no reneumerations considering the value of their knowledge contributed on this development. At present, there are many evidences that chemical analysis are being carried out in laboratories locally and abroad towards synthesis of pharmaceuticals based on herbal prescriptions of native doctors in developing tropical countries.

Not only in medical sciences, but in the field of agriculture, local farmers had obtained great achievements in producing different varieties of rice, yams and vegetables, food crops etc. These verieties are genetic resources unique to a society and their efforts should be appreciated and rewarded.

In the context of biotechnology, the genes from plants, animals and minor organisms of the developing world in particular are the strategic raw material for the development of new food varieties, pharmaceuticals, and industrial products. But these genes are seldom raw material in the traditional sense because they have been selected and improved by our local farmers and people over thousand years. Therefore it is difficult to talk about

biotechnology, or agriculture without looking at the global level and without an appreciation for the interdependence of all nations and societies.

All major food crops, the staple crops grown and consumed by the vast majority of the world population have their origin in tropics, and sub tropics of Asia, Africa and North America. Over the past years developing world farmers selected and domesticated almost all the food crops on which humankind survive today

Fresh infusion of exotic germplasm are vital for the ongoing improvement of agriculture. Whether they are used in traditional farming system, commercial breeding of modern biotechnology and genetic resources are a global asset of high value now and in the future.

But I like to mention that the knowledge of farmers and indigenous people and their role in conserving and developing biodiversity has not been given due consideration. For example, in the past it is mentioned in Poojavaliya written in 10th century A.D. more than 200 rice varieties were cultivated in Sri Lanka. Robert Knox in his "An historical relation of the Island Ceylon has written that a number of rice varieties with different life span were used in Sri Lanka. These indicates that Genetic diversity, the variation of genes within species and the distinct population of the same species were known to the Sri Lankan farmer.

Even today, for example, the Ifugao of the Philippine Island of Luzon can name more than 200 varieties of sweet potato. Jivaro farmers in one Amazonian community grow over 100 varieties of manioc. In one Liberian village Kpelle women maintain over 112 varieties of rice. These plant genetic resources reflect the ingenuity, intellectuality and inventiveness of the local people. There is increasing recognition worldwide that the indigenous knowledge of thousands of human cultures is very important in utilizing and conserving biological diversity for agriculture and sustainable development.

But, unfortunately, cooperation to conserve bio diversity and its sustainable use has been jeopardized by the efforts of some industrialized countries to obtain monopoly control over genes, plants, animals and other living organisms including human genetic material.

With introduction of genetic engineering the biotechnology industry has successfully promoted the industrial patenting systems to all biological products and processes. The historical decision with regard to that is mentioned below.

In 1980, the U.S. Supreme Court ruled in the groundbreaking case of Diamond vs. Chakrabarty that genetically engineered microorganisms are patentable.

In 1985, the U.S. Patent Office ruled that plants could be patented under industrial laws.

In 1987, the U.S. Patent Office ruled that genetically engineered animals are also patentable.

As a result of these decisions, virtually all living organisms in the U.S. including human genetic material bécame patentable. Genes, plants, animals and micro organisms whether simply discovered in nature or manipulated by genetic engineers became the intellectual property of private interests.

The General Agreement on Tariffs and Trade and Trade related aspects of Intellectual Property Rights (GATT- TRIPS) will obligate

signatory states to adopt intellectual property laws covering both microbiological material and plant varieties. This has forced many developing nations to adopt plant intellectual property rights and in many cases these laws may be entirely inappropriate for some nations needs and level of development.

This has caused for farmers and consumers of the developing world to pay royalties on products which are produced on their own biotechnological resources and knowledge. Several examples to explain the situation are given below.

A) 'Thaumatin' is a super-sweet product derived from a West African plant. Genetic engineers from Lucky Biotechnology Corporation and the University of California recently received patents for any plants that are genetically engineered to express super-sweet natural protein derived from thaumatin. This plant grown in the humid tropical forests of West Africa where local people have used it for centuries as a sweetener and flavour enhancer. There is a high market for this low calory sweetener but West African local people will get nothing out of it and their indigenous finding about this plant which had come from generation to generation over a large period has not been appreciated.

B) Agracetus, Incorporation in US received a patent for all genetically engineered cotton varieties. That means transgenic cotton varieties cannot be commercially produced without payments to Agracetus not only in US but also in India, China, Brazil, Europe. The cotton was first planted and improved by farmers in Central and South America. The decision that Agracetus invented transgenic cotton is unjust. Modern plant breeders and genetic engineers are developing new species on the successful achievements of generations of local farmers.

Therefore, granting patents to cover genetically engineered varieties of a species has put in the hand of a single inventor the possibility to control what farmers could grow on their farms and gardens without ignoring how the genes were transferred.

C) In Sri Lanka, there have been more than 900 varieties of medicinal plants grown successfully which have different properties for different diseases. In recent times, extracts of several plants have been sent to chemical analysis and structure elucidation towards preparation of drugs. Based on this achievements USA has received patents for about 10 **Sri Lankan plants from which different chemicals derivatives and drugs have been produced. And Sri Lanka has lost the traditional ownership of the same**. This will cause Sri Lankan farmers, consumers, others to pay taxes on products which are produced by these plants. Students, teachers and general public should be aware of this situation before the problem becomes serious.

In this letter the author has tried to point out the magnitude of the indigenous knowledge which had been generated by local people in the areas of agriculture, biotechnology, medicine which have been used by the so called companies to produce plant varieties, foods and pharmaceuticals etc. But the problem of "How the real owner of this knowledge is to be rewarded" is raised.

However, legal recognition is necessary to be given to local people's intellectual property rights as it is timely important issue.

It is necessary to integrate indigenous knowledge and scientific knowledge, in the interest of sustainable development.The first requirement is to understand the interaction between farmers existing knowledge and the new information they need to deal with emerging problems. Therefore, Is it not worth to recognise the knowledge of both parties, farmers and scientists?

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Farmers in ancient Ceylon stored their paddy harvest in a store called " Wee Bissa". Then damage to the harvest due to sunlight, rain and dew was prevented. Even today farmer uses " Wee Bissa" to store paddy harvests. But the technology behind this storing system is still unique although different storage methods have been developed in the world.

VIDU 19-1-16

THE ROLE OF INDIGENOUS MEDICINE IN BIODIVERSITY AND SUSTAINABLE DEVELOPMENT

Dr Upali Pilapitiya

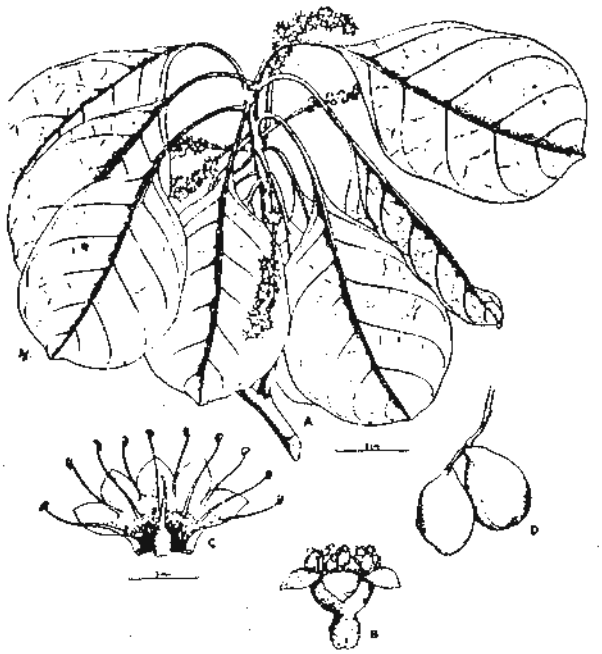
The Indigenous Medical System commonly known as Ayurveda is the source of health maintenance and cure of disease for a large proportion of the population of this country. W.H.O. accounts that over 80% of the population in Asian and South Asian countries still resort to the time old indigenous systems of medicine. This system of medicine is mainly based on herbal preparations. Hence it is called herbal medicine. The use of plants forms, the basis of traditional systems of medicine all over the world.

The development of systematic pharmacopoeias dates back as far as 3000 BC; even at that time the Chinese were having over 350 herbal remedies. In Sri Lanka there is no systematic cultivation of herbs except ginger and turmeric which are used more as condiments than medicine. All the other raw material for the medicines are collected from the wild.

There are over 10,000 Ayurvedic practitioners, scattered through out the country. The common practice of the physicians are that they prepare their own medicine, namely decoctions, herbal oils, herbal wines, herbal powders and pills. At the same time due to the growing demand, there is a fairly big market for these preparations. As a result there are over 70 private Ayurvedic manufacturing units in addition to the state owned Sri Lanka Ayurvedic Drug Corporation. Added to this, at all Ayurvedic hospitals, there are pharmacies to manufacture their own medicinal preparations. All this means that there is a great demand for the raw materials. This demand could be very much larger in the near future as there is a growing interest in the west for herbal preparations. There are over 2500 plants mentioned in the indigenous medical literature. Out of these about 250-300 plants and their by products are excessively used in day to day preparation. These preparations consists of herbal tea, decoction, herbal oils, powders, pills and herbal wines. Root, stem, bark, root bark, flower buds, nectar, leaves, tender leaves, ripe, unripe and dried fruits, seeds, gum, resins etc., are used in these preparations. Therefore there is a great need for systematic cultivation and collection of these plants and their byproducts. In view of the above factors the Bandaranayake Memorial Ayurvedic Research Institute has taken some initial steps towards systematic growing of herbs and research.

Growing and collecting of medicinal plants can be made into a very successful income generating project with additional benefits such as creating job opportunities, good quality raw materials for the market, awareness in using harmless plants as

medicine in the primary health care, so saving much needed foreign exchange and at the same time popularizing the indigenous system of medicine.



Bulu

Terminalia belerica

A, branch with leaves and flowers. B, flowers, lateral view. C, flower opened out. D, fruits.

The Bandaranayake Memorial Ayurvedic Research Institute has set up a medicinal plant research unit with the help of the Department of Ayurveda and WHO. Three nurseries are maintained at Haldummulla, Pattipola and Giradurukotte. A variety of experiments are carried out at these nurseries in propagation methods, harvesting, processing and storing etc. Fairly promising results have been obtained in the process of drying of Nelli ***(Phylanthus emblica)*** Ginger ***(Zingiber officinale)*** Turmeric ***(Curcumalonga)***. A collection of medicinal plants are kept for the purpose of identification and indepth study. In addition to the above there are arboretums at Bandaranayake Memorial Ayurvedic Research Institute and Janakala Kendra near the Parliamentary complex. Ten species have been identified for commercial level cultivation with the participation of farmers. At present all these ten items are imported from India.

The selected species are

Sinhala Name	Botanical Name
1. Katuwelbatu	***Solanum virginianum L***
2. Inguru	***Zingiber officinale Roscoe***
3. Amukkara	***Ruellia tuberosa L***
4. Malitha mal	***Woodfordia fruticosa (L)Kurz***
5. Kapukinissa	***Hibiscus priminus Alston***
6. Wadakaha	***Acorus calamus L***
7. Ingurupiyali	***Kaempferia galanga L***
8. Nelli	***Phyllanthus emblica L***
9. Ratnitol	***Plumbago indica L***
10. Welmadata	***Rubia cordifolia L***

Generally Katuwelbatu, Amukkara, Nelli grow in the dry zone, Malitha mal grow in Haputale area and Welmadata in Nuwara Eliya district other plants grow throughout the country. Apart from these plants there are many other plants largely imported from India and other neighbouring countries but which could be grown well in Sri Lanka.

Herbal teas are becoming a life style in the west as well as in the Far Eastern countries like Japan, Singapore and Korea. These plants which are used in tea can be cultivated in different parts of Sri Lanka. Plants like Polpala ***(Aerua lanata)*** Gotukola ***(Centella asiatica)*** Niramulliya ***(Asteracantha longifolia)*** can be collected from the wild.

Many of weeds that are destroyed are valuable medicines. For example Kikirindiya ***(Ectlpta alba)*** Kalanduru ***(Cyperus rotundus)***, Bavila ***(Sida cordifolia)*** are extensively used as medicine. Apart from the edible oils other than coconut and sesame, there are many other edible oils

like mee ***(Maduca longifolia)*** Kokum butter ***(Garcinia morella)***. There are another host of oils which can be used in various industries and medicine, they are Dorama (Dipterocarpusglandvlosus Kekuna ***(Canarium zeylanicum)***.

Domba ***(Calopyhllum inophyllum)*** which could be transformed into another income generating venture. In addition to oils which are used in food and industry, many wild plants contain essential oils, which contain essences and aromas and used in perfumes and cosmetics such as sandalwood, camphor and Hibiscus abelmoschus.

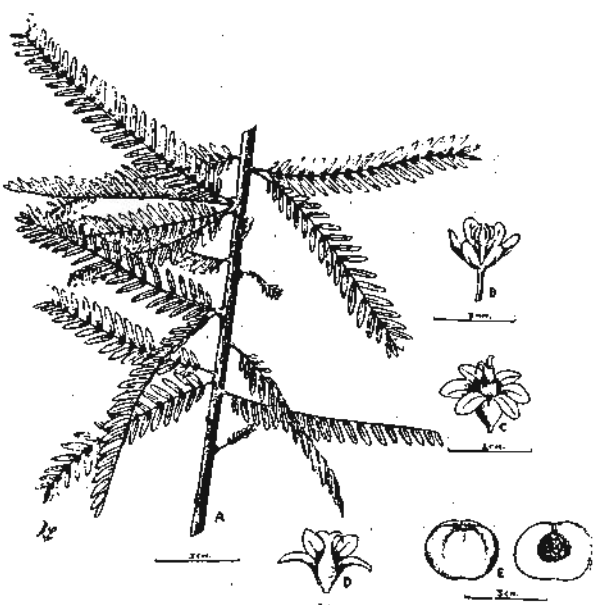
Achiote ***(Bixa orellana)*** yields a bright orange dye which is widely used to colour foods such as butter, cheese, bread and rice.

Many plants can be used as natural pesticides property which they have acquired during the long years of evolution as a defence mechanism against insects and flies. The most valid example is neem ***(Azadirachta indica)*** where the leaves, oil and oil cake are used as natural pesticides. Other examples are pyrethrum and holly basil.

The modern pharmaceutical industry too depends on certain plants for some of their products. Senna, **Catharanthus roseus**, Dioscorea, Datura are some of the important plants.

There are many cultural values attached to plants, Betel leaves play a leading role in Sinhala and Hindu culture. The Bo tree and Banyan tree are sacred to Buddhists and Hindus. According to Buddhist literature twenty eight Buddhas have attained the supreme wisdom under different trees which number seventeen. Five Buddhas have attained Buddhahood under the Na (ironwood) tree, the national tree. Hindus and Buddhists believe trees are the abode of devas and deities.

An ancient Sanskrit book on gardens called 'Upawana vinoda' gives a vivid description on plants, the uses merits and demerits of growing them in gardens. It lists out the auspicious trees which are to be planted in front of a house and on different sides. It is said Beli ***(Aegle marmelos)*** and Sandalwood are the most auspicious to plant in front of a house. In astrology it is said that by planting certain special trees which are special to plants, is possible to ward off the evil effects of the planet. All these cultural beliefs help to protect the plants.

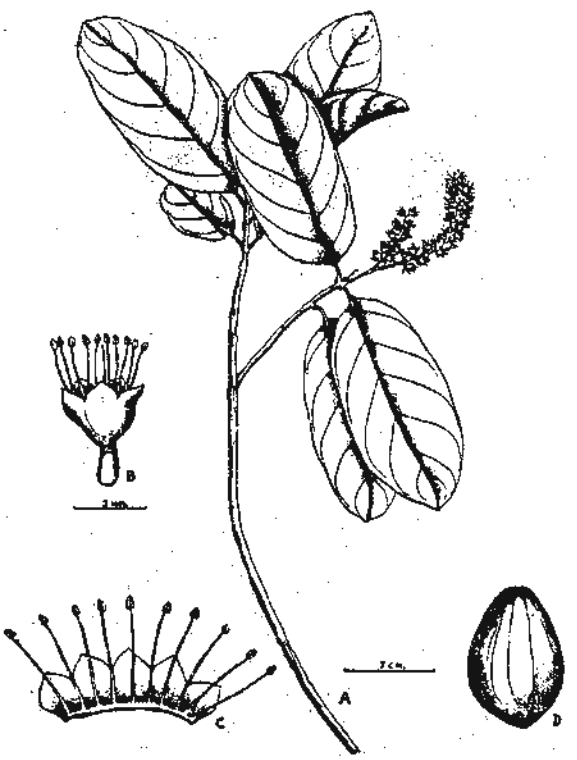


Nelli *(Phyllanthus emblica.)*
A, branch with brachlets and leaves. B, male flower C, female flower. D, longitudinal section of female flower. F, fruit. F, longitudinal section of fruit showing pericarp and seed.

The Bandaranayake Memorial Ayurvedic Research Institute has conducted many workshops and seminars on medicinal plants. The salient points which were discussed were-

a) the method of collection with least damage to the tree.
b) processing of raw materials
c) methods of storage to preserve the quality of the drug) methods of propagation
e) biological pest control
f) use of natural fertilizers
g) seasons for collection of roots stems leaves fruits etc. of different plants
h) preparation of byproducts through various processing methods

Ancient Sanskrit book on gardens called 'Upawana vinoda' gives a vivid description on plants, the uses merits and demerits of growing them in gardens. It lists out the auspicious trees which are to be planted in front of a house and on different sides.



Aralu ***(Terminalia chabula)***

A, branch with flowers. B, flower, lateral view. C. Calyx-tube opened out showing the stamens. D, fruit.

[The article was adapted from the magazine "SOBA" Vol. V/ No. 3, Nov. 1994]

VIDU 19-1-20

Our Ancestors who Exported Textiles

Sirinimal Lakdusinghe
Director, Department of National Museums.

A person exploring the history of Sri Lanka would discover that Sri Lankans have inherited a multifarious wealth of technology from their ancestors. Our historical chronicals begin with the story of prince Vijaya's arrival in the island in the 6th century B.C.. One of our earliest chronicles, the Mahavamsa records that Kuvenni when she met prince Vijaya was spinning cotton yarn. If so, the making of textiles using cotton thread would have already been in existence in this country at a very distant date. The Mahavamsa records that at the time of the death of King Dutugemunu, King Saddhatissa, brother of Dutugamunu, had the upper portion of the partly built Ruvanweli Dagoba covered with white cloth to make it appear complete. This is clear evidence of the fact that the textile industry existed in our country prior to the year 137 B.C.. Fa-Hien the Chinese monk who visited Sri Lanka in the 5th century, had noted that either side of the rout of the procession of the Tooth Relic was decorated with drawings. It could be assumed that these drawings had been done on cloth.

The book called "Theertha Kalpa" makes mention of a merchant who took textiles from Sri Lanka to the port of "Bharu Kachcha". The chronicle Rajatharanganie which belongs to the mid 12th century mentions that during the reign of King Meerakula, cloth was taken to that country from Lanka. Bhuvanekabahu the 1st in a letter he sent to the Sultan of Egypt had mentioned that in addition to merchandise such as pearls and gems he could also supply muslin cloth and cinnamon too. In the book called Paththippalai there is reference to a merchant who took textiles to the Kaveri Peninsula from Sri Lanka in the 1st and 2nd centuries.

Other than in such ancient times, in the Mahanuvara and Kurunegala periods too the various flags belonging to the two periods bear evidence to the textile technology which prevailed at that time. Ummagga Jathakaya, a prose composition in Sinhala, contains an interesting episode in which a woman is engaged in cultivating a cotton field.

Textile Weavers

It is mentioned that there were two categories of textile weavers living in Sri Lanka. The first included the 'Salagama's and the drummers who arrived from India. The drummers were the local cloth weavers. Those in the second category, played the drums and also engaged in astrology. During their spare time after playing the drum and astrological forecasting, they engaged in textile weaving.

The history of the Salagama's is as follows. King Vijayabahu the 3rd of Dambadeniya, who was highly appreciative of the art of textile weaving, sent gifts, tributes and letters through a Moslem named Pathiveera Lebbe and got down persons skilled in textile weaving. On the orders of the King, Pathiveera Lebbe brought eight instructors in textile weaving to this country. The king not only bestowed land and titles on them but even provided them with wives and made them settle down in this country. Later on, their successors earned the wrath of the Kandyan kings and moved to the east coast. Later they learnt to cultivate cinnamon and to crush cinnamon as required by the king. Thereafter they became the cinnamon crushers of this country. Later they were engaged for the same activity by the Dutch and the Portuguese.

Drummers who became the local cloth weavers had woven cotton cloth using plain yarn in the villages. Later, the entire hill country became renowned for the processing of cotton yarn and textile weaving. However the weaving of cotton cloth is done now only in the hamlet called Thalagune in Uda Dumbara. In recent times cotton cloth had been woven in a village close to Balangoda too. The eastern garments woven at that time were not made up by cutting and stitching cloth but were vowen on the batten as a complete item of cloth.

Accordingly, the cloth that were woven were of diverse sizes and shapes and were of different categories. There were napkins and towels (kerchifs) garments for men (thuppotti), garments for women (paada haela), men's bathing cloth (diya kachchiya), handkerchiefs and shawls (kerchief scarves), belts, mats, bed spreads (ethirily), rugs (paramadana), covers for pingo pots (gahoni), robe jackets, hats, pillow cases and betel bags. Plain cloth were measured in according to the measurement called 'waduriyan' length wise while the width was measured by spans.

Although the 'thupottiya' has now become a rare antiquity, it was one of the most important item among the garments that were widely used during the Kandyan period. This is a two piece garment which is firmly joined together at the centre and has a length of about eight or nine 'riyana's (4-4 1/2 yards). The 'than' cloth was known as the "paadaya". Its length was 4-6 spans. The breadth was determined according to the caste of the wearer. Persons of low castes were permitted to wear only narrow clothes. In place of the 'ohory' or the cloth and 'choli' worn by females of the high castes, the low caste women wore two short pieces of cloth-one around the waist and one around the shoulder.



Specimen of "Viyana" or a canopy used overhead along the route whenever the reliquary was taken in procession together with the sangha for ceremonial occasions.

Bathing cloth

This has a broad cover piece hanging in front and a narrow band of cloth at the back. This was useful for tying round the waist.

There was no decorative work on it. The villagers called this a span cloth. This was also a under garment of the Kandyan male at that time and it was also his bathing cloth. It was useful in running too. The "diya kachchiya" had been worn by persons in all walks of life in ancient times. It had a length of 5 - 6 feet. The front cover was around 1 ½ to 2 feet long. The 'Gahoniya' which was bell shaped was the cloth that was used to cover the vesseis containing food or other items being carried to the temple or to the king. A wall painting at the Degaldoruwa temple shows a pair of 'gahoni's and a pingo stem.

Somana

There were 'somana's of different types. 'Somana's worn by kings were called 'Raja Somana's. Likewise, Mudaliyars, Vidane's, Arachchis and farmers had 'Mudali' "Arachchi" 'Vidane' and "Govi" somanas respectively. It is therefore evident that the somana worn by persons in different positions in society at that time varied according to their status in life. The patterns used in the 'somana's also varied according to their status in life. The somanas' worn for different occasion also varied. However the somana was not worn at religious ceremonies. The largest 'somana' on display at present is 26 feet 4 inches long and around 4 feet wide. A special feature of this garment is that the colours of the somana never fade.

Among the patterns and designs used for somanas were flowers, fruits and leaves in addition to animals such as swans, eagles, parrots etc. Blue, yellow and scarlet were the colours frequently used. Another special feature was that all these patterns were separated by lines. Designs known as 'panawa' (comb), 'lanuwa' (rope), 'ditta', 'rosamal' (rose), 'gal binduwa' and 'haras pethi mala' were used to decorate the 'Somana'.

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Plain cloth

Such cloth were often nearly 28-30 'riyana's long. These were the cloth used as curtains at funeral ceremonies. Plain cloth has been used in making beetle bags. All this cloth were of plain white colour. Other than green, red, white and blue were the only three colours found on decorative textiles. The item of textile that is woven mostly at present at Thalagune are sheets. The larger spreads were 4 ½ x 2 'riyana's (11x5 feet) in size. Smaller sheets of 6 x 3 ½ feet or smaller than that were also in use. A sheet was also known as "Erattuwa"

'Aluva'

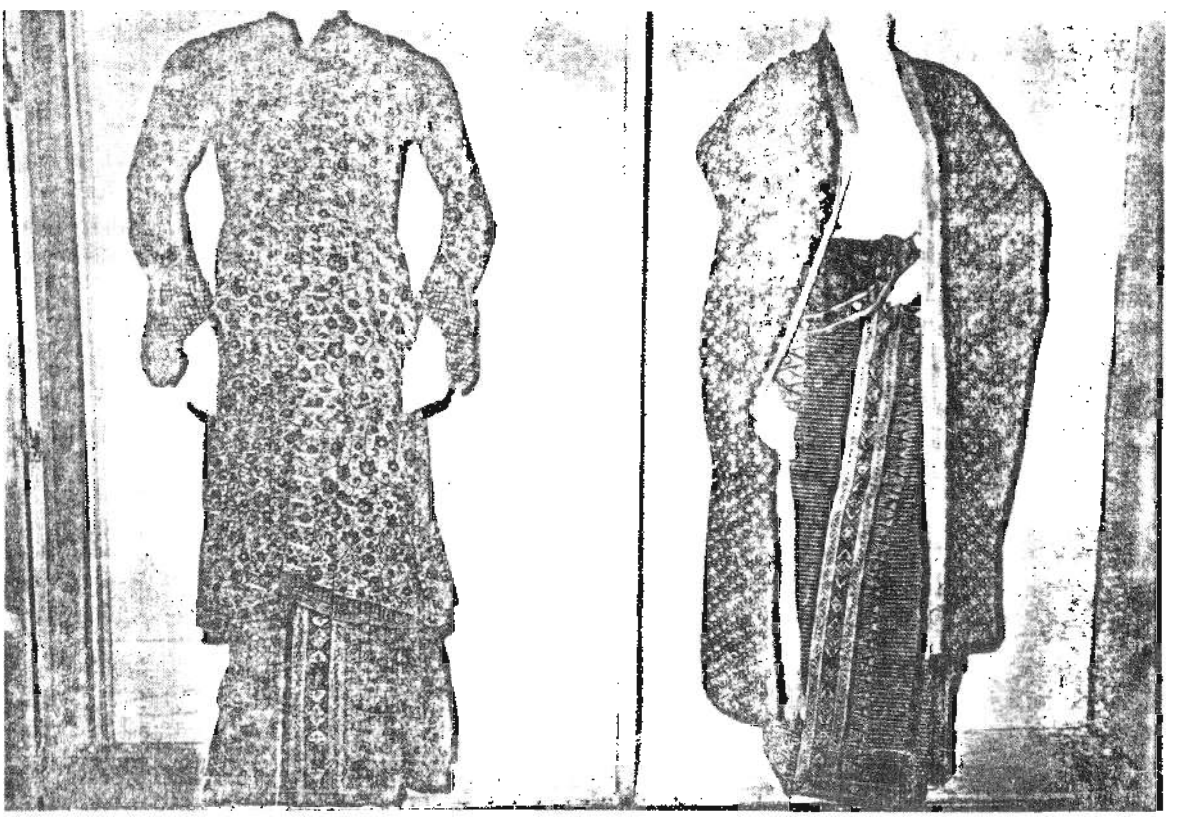
The loom was known as the 'Aluva'. The weaving machines and weaving techniques found in our country are similar to those found in India and in Burma. The 'aluva' or the loom was fitted in an open shed. This shed was known as the 'alge' meaning 'the loom house'. It was built adjacent to the outer veranda of the weaver's house. The material and the equipment required for weaving were thus stored in a room.
When alternate threads are being selected from the warp by the shuttle ropes in weaving plain cloth, the shuttle moves to either side. The loom was operated by treadling.

Designs

Designs are actually symmetrical geometric creations. These designs were known as "Pannan Koora" "Heen ratawa" "Mahagal ratawa" "Gal piyuma" "Domba mala" "Bopatha" "Ata pota lanuwa". The names of some of the designs seen in the Thalagune area are "Heenmal peththa" "Maha mal peththa" "Atapethi Mala" "Para mala" "Dethi mala" "Kathuru mala" "Paehena mal peththa" "Maha mal peththa" "Haali Dangaya" "Heen negi dangaya" "Depota Lanuwa". "Valalu Lanuwa" "Diya vella" "Bokola" and "Iri thonduwa".

Spinning of yarn

Cotton was grown as chena cultivations in the highland areas inancient times. From the hill country to Anuradhapura and in all other areas cotton was a major trading material. Cotton was not spun in the chena. The cotton plucked from the chena were dried and cleaned in the home compounds. The seeds were removed by passing the cotton through bars in the cotton ginning machine. Thereafter wicks suitable for spinning were prepared by beating the cotton with a bar and winnowing and rolling



Man and Woman- This picture on exhibition at the Museum shows how an ancient man and woman were clad. On the left is a man wearing a mudliyar's overcoat of the Kandyan period, while on the right a woman is seenovering her bust with a "lansoluwa".

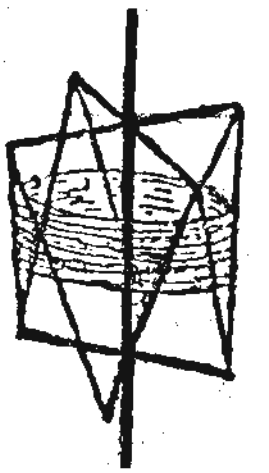
Designs were also woven manually. These are known as hand work. Hand work include designs such as birds, snakes, Bo leaves and large flowers.

Cotton was spun by women. It was customary for a large number of women to gather together and engaged in the spinning of cotton and they sang while at work. The

songs were selected from the Wessanthara, Magamaana and Vidura jathaka stories. The yarn woven lightheartedly in this way by the women are wound on a wheel made out of bamboo strippings. From these it is wound on a large wheel called "Madaawa" made out of bamboo striping and thread. The robe offered to the Buddhist priests during the "vas" ceremony which is a very special religious ceremony, is prepared and completed by spinning and weaving the cloth and preparing the robe on one and the same day. Ordinary people join the king and the ministers in performing this meritorious act.

When we examine the reasons for the decline of the textile industry which was being carried out according to a highly advanced technology at that time, the main reason appears to be the import of textiles from India. However we are fortunate that we have been able to preserve this technology which we may call our own, through the efforts of a few individuals.

Cotton was spun by women, it was customary for a large number of women to gather together and engaged in the spinning of cotton and they sang while at work. The songs were selected from the Wessanthara, Magamaana at Vidura jathaka stories.



Madawa

The yarn woven light heartedly in this way by the women are wound on a wheel made out of bamboo strippings. From these it is wound on a large wheel called "Madawa" made out of bamboo striping and thread.

VIDU 19-1-25

ANCIENT KNOWLEDGE IN METEOROLOGY

K.R. Abhayasingha Bandara
Department of Meteorology

The man's understanding of the nature has reached the today's level through a number of mileposts. As in any other field, in Meteorology, the initial explanations of weather phenomena were based on some kind of belief of mith.

There are a few historical records on how the ancient Ceylonese (Sri Lankans) understood and forecast weather. But some stories particularly those on rural themes contain information of some methods used by our ancestors to understand changes of weather.

Natural feelings stimulated by the atmospheric conditions like hotness and humidity and some visual observations have been used by people as tools to forecast weather in short range. Cold nights and mornings were regarded to be followed by days with dry weather. Hot and warm feelings during the day times were positive signals of rainy evenings.

People, particularly those sho were engaged in agriculture, used to forecast weather through observants of the sky and movement of clouds. Red sky on sun rise and sun set had been regarded as warning for rainless days ahead. The direction of movement of clouds were regarded as indicators grain. Movement of clouds in one direction indicated rainy weather while the movement in opposite direction signaled dry weather.

It was known to man even a long time ago, that the behaviour of some creatures had some relation to weather parameters and such particular behavior were used as tools to forecast weather. The loud noises of frogs were regarded as signs of arrival of rainy weather condition. Bees are also supposed to be good forecasters of weather. They do not come out of the lives if it is going to be rainy. Some animals like buffalos and cats use to make unusual noises before bad weather conditions like those influenced by cyclones.

Some ancient Knowledge in meteorology in other countries

Buffalo hunters who lived on the northern great plains of North America believed that the weather events were created by four thunderbirds which could not be seen as they were concealed by dark clouds but their voice was thunder and their symbol was forked lightning.[1]

All the great civilizations of antiquity (in India, in China, along the Tigris and Euphrates, and in Egypt) had systems of belief in which weather was under the control of the gods. The belief in an unseen power, called God, is the basic concept of many religions. This has led the man to accept the creation of all weather

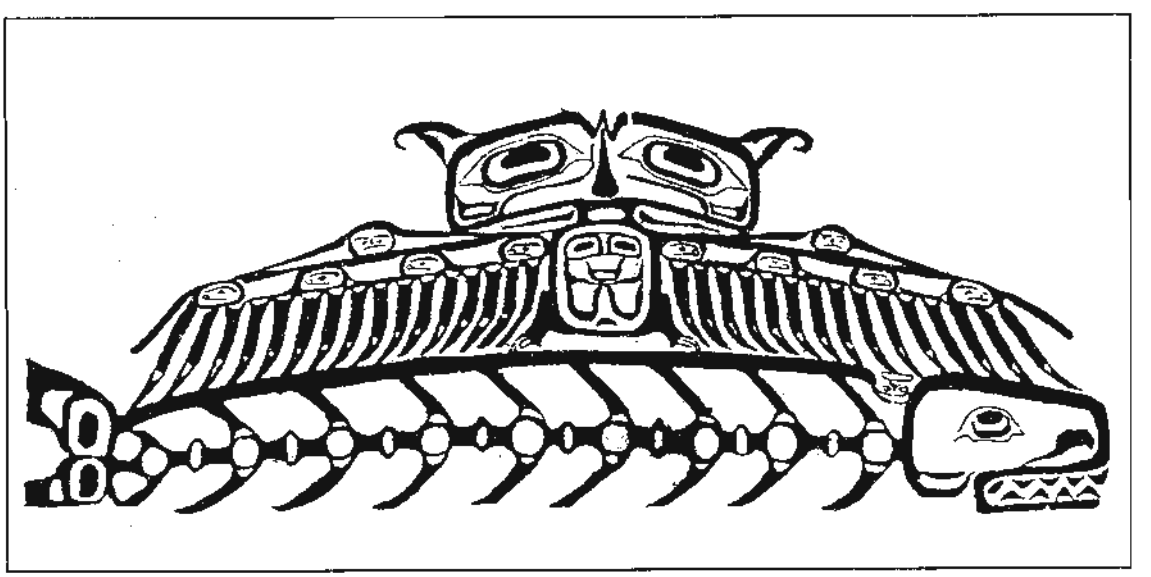
events by a 'Weather God' and this concept can be found in many historic literature of civilizations.

Early in the history of the human race, man's realization of the order embodied in the events around him and in the forces that gave him life came from his observation of the skies and the luminous objects that had wandered in the firmament for thousands of years. Priests searched the heavens from wide open plains, from the terraces of temples and from towers, thinking about the mysteries of the universe, the essence of all being and the origins of life and death.

The observation of the sky and its forces by ancient man can be traced back to the oldest civilization in the history of man as a key expression of man's will and is expressed most strongly in ritual exercise, mythological concepts and superstitious divinations.[2]

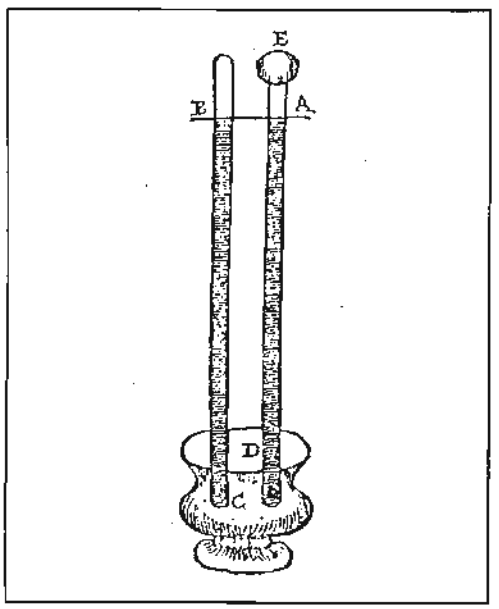
One of the hazardous weather events is lightning. In viewing the interplay of the forces of heaven the human eye was bound to detect lightning as the most magnificent form of the fiery lightning path. Accordingly, the symbols based on the concept of fire are among the oldest pictorial representations of lightning. They emerge from the archaic high culture of Mesopotamia, a country with frequent lightining. Around 700 B.C. Greek art began to use the lightning symbols of the Middle East, attributing them to Zeus, the lightning throwing God. In Chinese mythology of the opposite Yin and Yang, lightning is represented by the colorful goddess Tien Mu.

Many, different beliefs are found even in the more recent mythological concepts in many parts of the world. Some believe that the god Esege Malan exercises his powers of thunder and lightning by throwing round stones from the skies down upon the earth. In Africa it is not a thunderstone, but a magic thunderbird called Umpundulo which flashes down to earth from a cloud in a storm to work his flapping wings.



THE GREAT THUNDERBIRD CARRIES A WHALE ALOFT *in a depiction symbolizing the weather god's dominion over the sea.*

Old descriptions of other weather parameters like wind, rain, sunshine, mist, clouds etc and weather systems like storms, cyclones, tornadoes, fronts etc were also mixed with some kind of belief.



TORRICELLI'S BAROMETER.

The Greeks were the first to attempt an explanation of the weather that relied entirely on physical science rather than on a traditional cosmology. In the seventh century B.C., Thales of Miletus tried to associate weather with the movement of heavenly bodies, and considered water to be the basic element of all matter. He knew that water rises from the earth and then descends from the sky, but he did not understand the process of condensation or the nature of clouds. His student Anaximander understood that wind was moving air, an idea that was rejected by other Greek philosophers, including Aristotle, the greatest philosopher that time.[1]

Empedocles the great natural philosopher before Aristotle proposed in the fifth century B.C. that there were four basic elements: earth, air, fire and water. Fire and water were antagonistic, since water quenches a fire, but earth and air had an affinity for one another. This opposition and affinity governed the four qualities of heat, cold, moistness and dryness.

Many, different beliefs are found even in the more recent mythological concepts in many parts of the world. Some believe that the god Esege Malan exercises his powers of thunder and lightning by throwing round stones from the skies down upon the earth.

Aristotle was the greatest of the Greek scientists. In his book 'Meteorologica' written about 340 B.C., he had attempted to explain weather events. He believed the universe to be spherical, composed of concentric layers with the earth at their center. The outer layers, beyond the orbit of the moon, were the realm of the planets and stars, and Aristotle identified these layers as the province of astronomy. What happened in the inner layers was the domain of meteorology. He assumed of four inner layers composed of four elements fire, air, water and earth, the inner most layer. Also he realized that four layers could mingle and elements were interchangeable; heat could cause water to evaporate, changing it into a moist substance similar to air. This moist substance, though not water, gave rise to clouds and rain, while another of his 'exhalations' hot and dry was the cause of winds and thunder. Aristotle theorized that clouds could not form above the tops of mountains because this was in the layer of fire, too hot for condensation to occur.

The experimental methods in science became possible only with the development of precision instruments for measuring and

recording information. At initial stages, most scientific research was done in libraries rather than in laboratories. Any way with the birth of experimental science, accumulation of experimental evidence and the precision of data gathered were improved and this was very useful in understanding the weather.

The first important meteorological device developed by the German methematician Nicholas de Cusa, in the 15th century was a simple one to measure the humidity of the atmosphere. He hung out some wool and noted that it was heavier when moisture in the air had condensed onto it.[1] Johann Heinrich Lambert, the German Physicist, in 1768 developed a hydrometer to observe the changes of humidity in the atmosphere by hanging cord of twisted catgut with a metal arrow attached to its free end. As the cord picked up or lost moisture, its coil tightened or loosened, causing the arrow to turn along a dial.

Galileo was the first to realize that the expansion of a substance could be used to measure temperature. In Padua (around 1593). He invented the first thermometer a simple glass tube with a bulb at one end. This simple device was quickly copied and refined by scientists in several countries; precise and comparable measurements of temperature became standard.

In 1701, Isaac Newton fixed the freezing point of water at 'zero degrees of heat'. Using mercury instead of water, the German physicist Gabriel Fahrenheit developed his scale in 1714, the Swedish astronomer Anders Celsius proposed his in 1736.

Other instruments, such as wind gauge and calibrated rain gauges were invented during this same period, and the stage was set for the next phase in the history of weather science, in which the properties of water and air were verified by experiments, and large-scale, systematic gathering of precise weather measurements and observation began.

The experimental methods in science became possible only with the development of precision instruments for measuring and recording information. At initial stages, most scientific research was done in libraries rather than laboratories.

Ancient man believed that weather systems were created by God whenever he wanted to show his presence and his force to people of a particular area. So the weather systems were thought to be local. The movement of storms along the earth surface was not well known to man until Benjamin Franklin era. On October 21, 1743, an eclipse of the moon occurred and it was visible in eastern North America Benjamin had hoped to witness it in Philadelphia, but the eclipse was obscured by a storm. A few days later he received a letter from his brother, who had seen the eclipse in Boston because the sky there was clear, his brother happened to add that a storm had occurred in Boston on the following day. This fact caused Franklin to speculate that the storm in Philadelphia and the one in Boston were the same, and that this single storm had traveled northeast from Philadelphia to Boston. He therefore proposed the idea of the motion of storms. But the circular motion of wind around the center of a storm was realized several decades later firstly by William Tredfield, an English physicist. In 1831, after much study, Redfield proposed the theory of circular winds in storms, nothing that the pattern of fallen trees he had observed could only be explained if then storm had been a giant whirlwind.

Since the weather has its influences in all activities of human beings, man has taken every effort to observe, explain and forecast it during the whole length of the history. Today, with high altitude balloons, radar, satellites, buoys, automatic observing systems and advanced computers, the movements and behaviour of the atmosphere can be plotted with considerable precision, and weather forecasts can be made with an ever-increasing degree of accuracy.

Reference:

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2. Golde, R.H, 1977: Lightning, Academic Press, London.
3. Herbert Riehl, 1978: Introduction to the Atmosphere, McGraw Hill, Kogakusha, Ltd, Tokyo.

Although it is not indigenous, author decided to include some information on Meteorology available in other countries as it is historically important



People in Ancient Sri Lanka obtained an understanding of climatic changes by studying the behavioural (flying) patterns of birds like swallows

VIDU 19-1-30

HISTORY OF METALLURGY & ANCIENT IRON SMELTING

Rose Solangaarachchi
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Metal has been a critical technological and economic resource in all historical societies. Studies in the pattern of ancient settlement proved that they had characteristic technological systems which were connected to their environmental resources. Even before the metallurgical properties of metals were discovered some iron ores such as haematite (Fe_2O_3), limonite ($2Fe_4O_3.3H_2O$) and goethite ($Fe_2O_3.H_2O$) were used as red, brown and yellow pigments by the lithic society.[1] The factors of archaeological findings suggests, man's natural attraction for colour sensation led to important steps in the evolution of technology and the use of such pigment might be the preliminary stage leading to the metallurgy.[2]

Around 3000 BC the settlements which were based on copper and bronze had established in Asia Minor, India and China. But, the most significant innovation from a technological point of view was the use of iron. Iron technology has probably been started in Asia Minor around 3000 BC.

The knowledge of iron technology might be spread other parts of the world after 2000 BC. According to archaeological evidence found from so far, the Mesolithic in Sri Lanka was superseded by the protohistoric early iron age.[3] The absence of an intervening Neolithic or Chalcolithic[4] may be attributed to ecological factors, the heavy soils of the island clothed in rain forests being difficult to work with Neolithic technology.[5] Other reasons might be during the Mesolithic period, iron technology was introduced to island from somewhere or the idea was started to practice indigenously by accident.

There are numerous references in ancient chronicles like the ***Mahavansa, Thupavansa, Pujavaliya*** and inscriptions, to use of gold, silver, lead, copper and iron in Sri Lanka from Early Historic times onwards. Archaeological explorations and excavations carried out in various parts of the island confirm such written evidence and the records of the metallurgical knowledge of our ancestors. The earliest known date for iron smelting, 10th century BC was established through C_{14} dating of an archaeological context from Aligala, Sigiriya.[6] It is thought likely that this technology was started at some point in time during or before the 9th century BC. The results yielded from the excavations in the Anuradhapura Citadal area have confirmed this evidence futher.[7]

It is important to examine whether Sri Lanka had an indigenous metal technology and if so, what the characteristics of such a technology may have been. The record of the metallurgical knowledge of our ancestors is essentially incomplete due to the scarcity of research material published on archaeometallurgy.[8] The study on pre-modern iron production in Sri Lanka seems to have started in the 19th century.

Early description and investigations such as those of John Davy,[9] Ondaatje,[10] Coomaraswamy[11] and Hadfield,[12] have indicated that Sri Lanka iron and steel occupied a significant place in the South Asian iron technology complex. Hadfield takes a prominent place among the early investigators of Sri Lankan Archaeometallurgy. In his studies on the samples of iron and steel from Sigiriya, he recorded that the iron masters of ancient times had known the art of 'quenching'[13] tostrengthen steel. These sample artifacts were made of pure iron. The outer surfaces had a high carbon content. He states that those iron masters who produced these artifacts had a knowledge almost as advanced as that of the iron masters of modern times. Hadfield's studies drew attention to the fact that case hardening or cementing,[14] the method of carbonizing wrought iron[15] and quenching were used to produce hard cutting edges. Like earlier observers, Hadfield was struck by the fact that traditional iron and steel production in Sri Lanka was of a very high standard.

In the late 1980's important breakthroughs in the archaeological investigation of this subject were made by the Postgraduate Institute of Archaeology (PGIAR)- in collaboration with the Swedish Board of National Antiquities, under the Settlement Archaeology Research Collaboration Project (SARCP) in the Sigiriya-Dambulla region[16] and by the Archaeological Department working in collaboration with a British team at Samanalavava on the bank of the upper Walave river.[17] However, in addition to these two sites, the remains of iron smelting furnaces unearthed at Ridiyagama (under the Department of Archaeology and the French Mission of Archaeological Co-operation) in 1995,[18] and the existence of iron slag mounds throughout the island, bear evidence that this technology was widespread.

There are numerous references in ancient chronicles like the *Mahavansa, Thupavansa, Pujavaliya* and inscriptions, to use of gold, silver, lead, copper and iron in Sri Lanka from Early Historic times onwards.

Research and scientific activities presented in this paper, were principally focused on this major 'factory' site at Dehigaha-ala Kanda near Alakolavava village (registered as KO_{14}), identified in 1988 and excavated in 1990 and 1991. This site is situated 8 1/2 Km south-east of the Sigiriya rock. This iron production site which is hidden in deep jungle 1 1/2 Km from Alakolavava village is demarcated on the north and the west by *chena* cultivation, on the east by the Kiri Oya which is one of the major waterways feeding the Sigiriya area. In the Kiri Oya valley alone, there are more than 20 iron production sites. Excavations revealed a series of furnaces and the science slag heap covering a site of nearly 3,750 m^2. Archaeological research enabled the identification of large scale iron production using an advanced bloomery process [24] with magnetite ore (Fe_3O_4) at the site. Pieces of iron slag of various sizes and shapes, slag mounds covered with soil layers and the research carried out bear testimony to the extent of production and the stage of development of the technology.

Systematic excavations conducted over two years in two stages and spread all over the site have resulted in the discovery of several furnaces used in iron production. These furnaces were made by carving the bedrock into an oval shaped pit. In every excavated furnace the front wall was missing. The reason for this may be that the wall had to be broken in order for the spongy iron bloom[20]- which was the final product of furnaces of this type-to be taken out. The front of the furnace

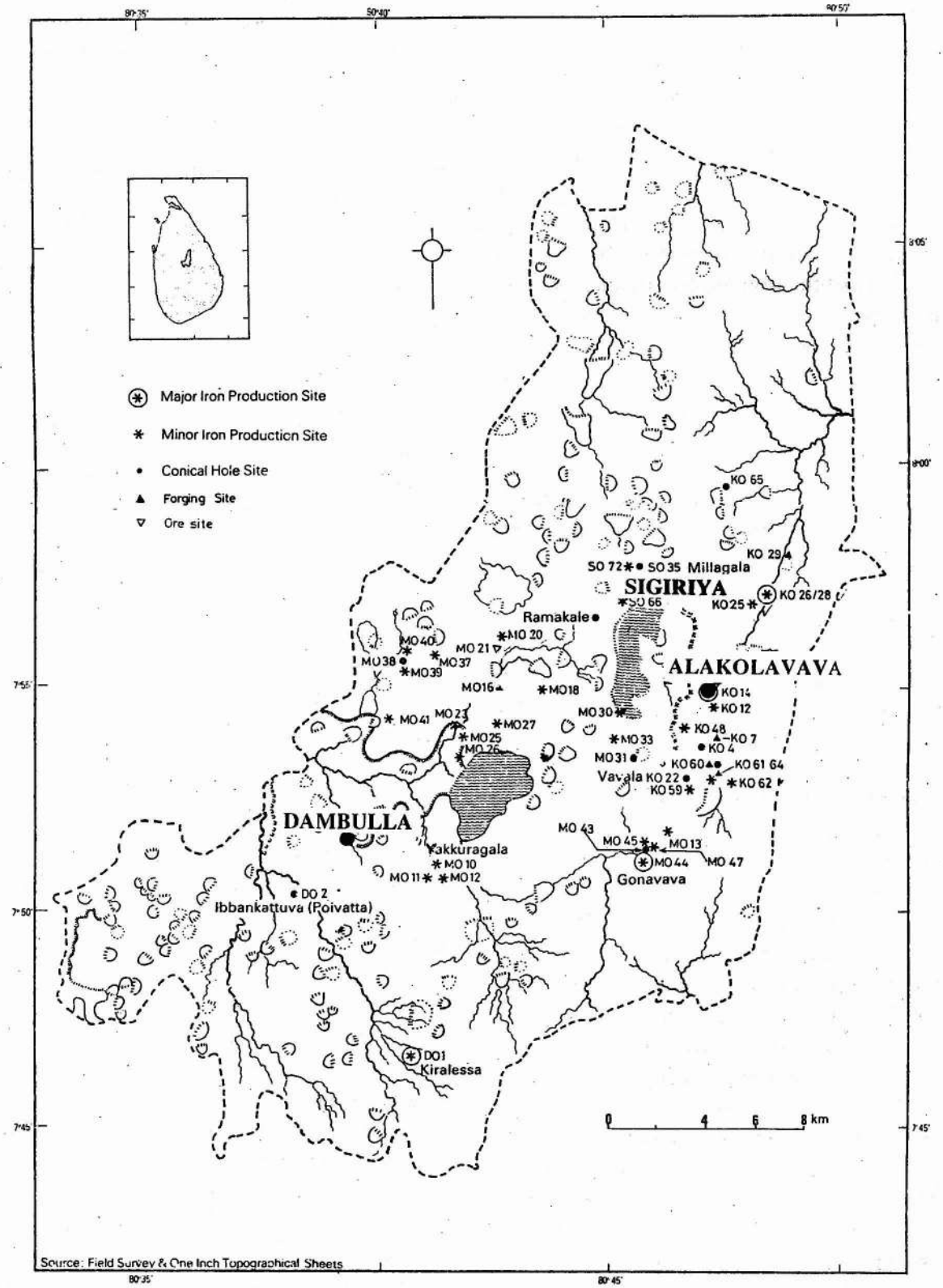


Figure 1: The study region with iron production sites

Iron extraction, the structure of furnaces used and their technological evaluation

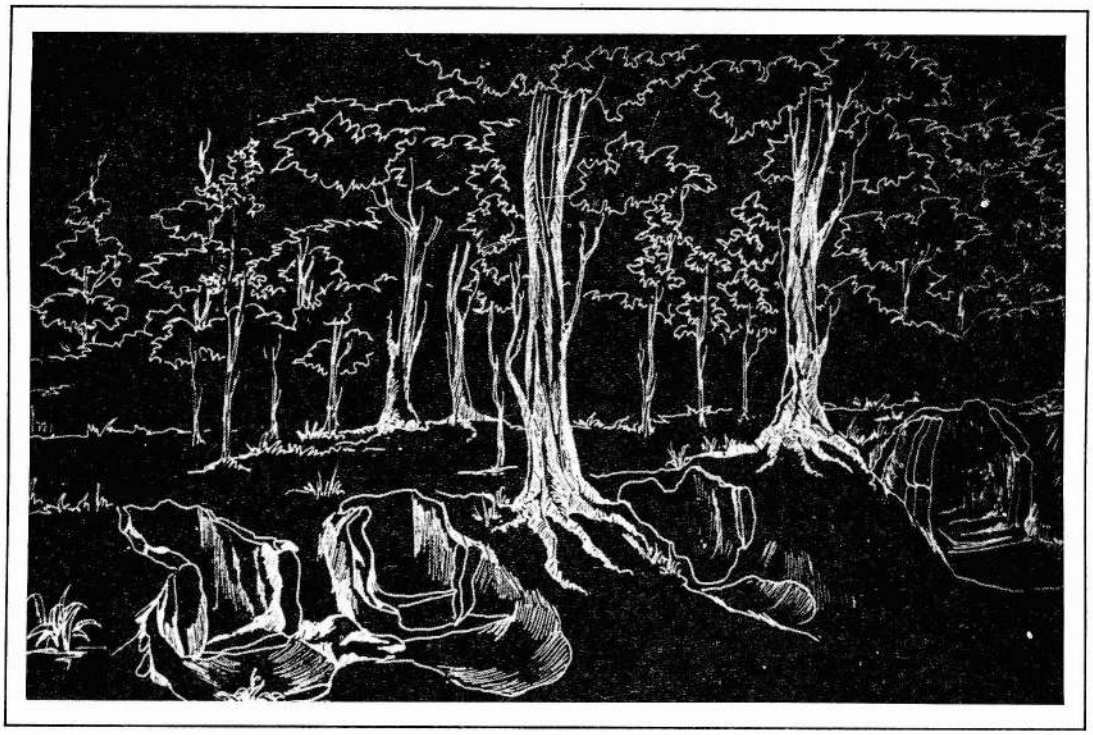


Figure 2: Drawing of series of furnace

shaft probably began from the top of the stone slabs which were used for making of side walls curving inwards.

Starting from the top of the stone slabs, the furnace shafts grew narrower as they increased in height. The height and shape of the shaft had the capability to control the temperature and ensure the strength of the furnace construction. The height of a furnace when reconstructed with the remaining fragments seems to be about 2 m. while the thickness of the side wall was about 20-40 cm. The special feature in the construction of these furnaces, is the carving out of the bedrock to resemble two rounded steps in front of the furnace. This may have been done to facilitate the removal of iron bloom and waste material from the pit afterthe smelting process. The width at the bottom of a furnace was 80-95 cm and the depth (east to west) was 40-60 cm.

Taking the above as well as the height of the furnace in to condideration we can see that the furnaces at Alakolavava were relatively broad. This construction feature also had the capability to control the temperature at a suitable point to obtain a high production activity from the production process.

The maximum production which can be obtained out of raw material used, generally depended on the ability to control the reduction conditions in the furnace. Heat is the most important factor of the iron smelting process. The heat generated by an ordinary charcoal fire may reach up to 700^0 C. The furnace, therefore, should have facilities either of natural draught[21] or forced

draught[22] to raise the required high temperature for the smelting process. A natural draught of air through a furnace is induced by a high chimney. A forced draught furnace will have provision for anair blast blown in by bellows[23] through a tuyere.[24]

The primitive bellow was made of two large inverted terracotta pots covered with an animal skin. The more developed blown through one blow pipe but in larger furnaces four or even more bellows were provided[25] In the furnaces excavated at Alakolavava pressure marks on the lower parts of the back walls, indicate the use of aforced draught which must have been blown by bellows.

It must be mentioned here that unlike at Alakolavava it is believed that the smelters at Samanalavava used the monsoon winds that lashed across the region at a velocity of 70 km per hour from April to August as a natural draught.[26]

There is evidence or the iron masters of Alakolavava on same occasions used eight tuyeres at a time for one furnace. This was a very special arrangement used for controlling the heat which was essential for the success of the production process. And they also had the ability to avoid cold zones and distribute the air equally to all parts of the furnace.

Analysis reports have shown that the composition of the clays used in the furnace walls and the tuyeres are different at Alakolavava. It is clear that the tuyeres were made of a type of clay which was capable of withstanding much higher temperatures than the furnace walls.[27]

Iron or used and its contribution in the bloomery furnace system

Generally, iron smelters have used haematite and limonite for primitive bloomery furnaces. This is due to the difficulty of reducing very dense iron oxide in a bloomery furnace.



Figure 3: Two furnaces seen from the west Tuyere, bellows and air supply system

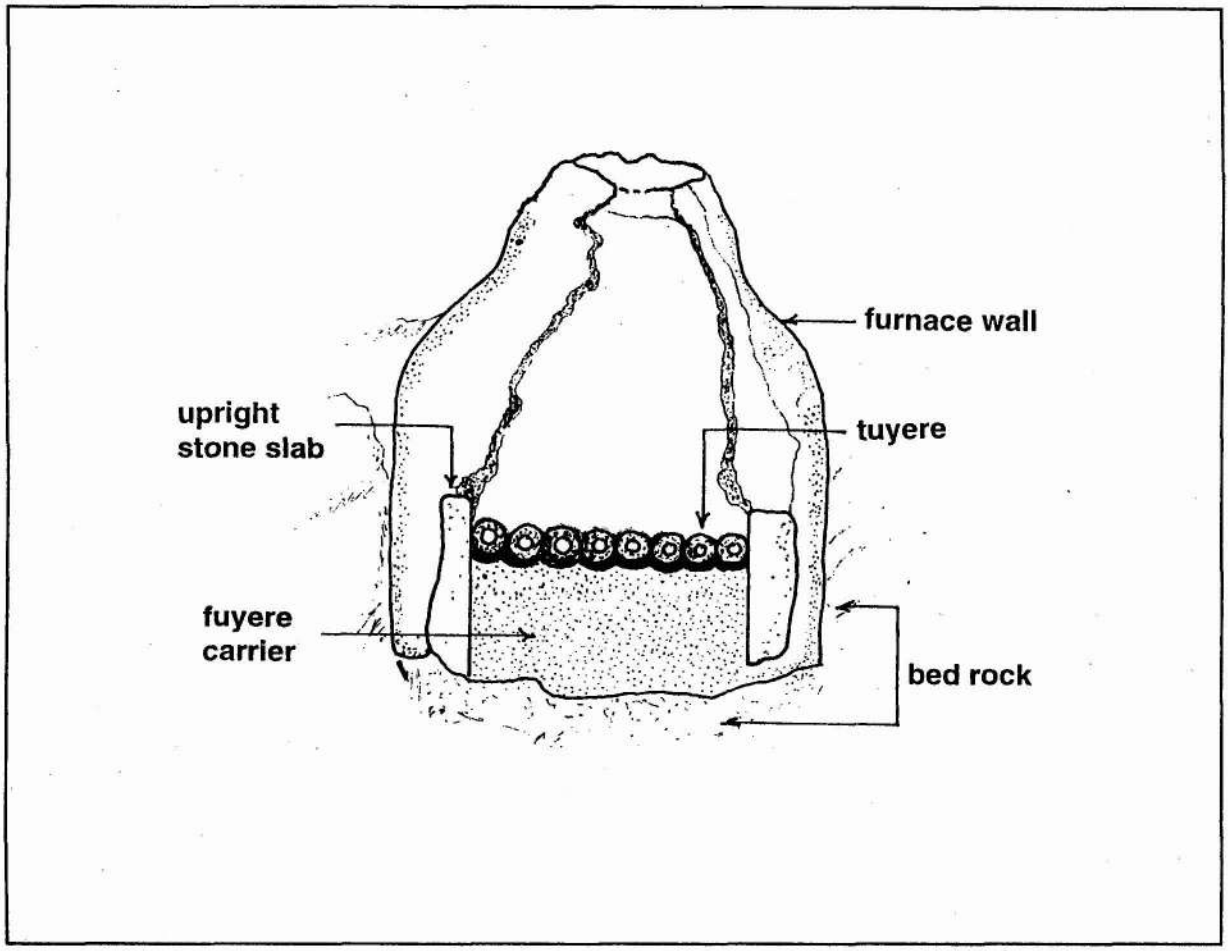


Figure 4: Reconstruction Drawing of well preserved furnace (Furnace no. 27) at Dehigaha-ala kanda

The use of magnetite in bloomery furnances has so far been identified only in a few exceptional cases. Modern archaeometallurgists assume that the dense magnetite ore would be difficult to reduce with this technique.

However, in view of the iron ore fragments found around the boulders at the site and from around the furnaces and attached to the iron slag at the Alakolavava excavation site, it seems that magnetite had been used for this bloomery process. Chemical analyses have shown that the average percentage of iron oxide content in these magnetite grains is 98[27].

According to chemical analysis the slag samples from Alakolavava consisted of a fayalite (Fe_2SiO_4) compound and a lower iron oxide content when compared with slag samples from other production sites which were situated around the area. This indicates that the yield at that site has been very high.

Chemical analyses have shown that the average percentage of iron oxide content in these magnetite grains is 98. Among the waste heaps found from the site there were traces of ore mixed with quartz.

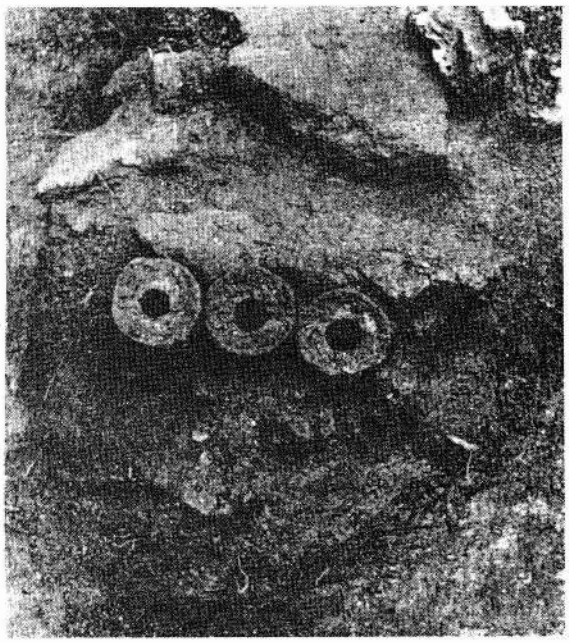


Figure 5: Three tuyeres found with fragment f a tuyere carrier

Dating of the production site.

C_{14} dates[28] indicate that the 'factory' was in operation from about the 2nd century BC to the 4th century AD, a particularly early period for iron production of this scale and quality.

Calibrated age ranges from *cumulative probability,*
one sigma (68.26%). CalibETH 1.5b (1991).

The pottery types found at the site indicate that production was carried out during the Early Historic period (continuing at the site until the 4th century AD). Thus it seems that there had been a well organized iron production system prior to the 5th century AD Kashyapan period which was the main construction phase in Sigiriya city.

However, excavations carried out in the area make it clear that iron production in the Sigiriya-Dambulla area was in existence before the Alakolavava production site and subsequent to the Sigiriya kingdom. Evidence of iron production sites belonging to the post-Kashyapan phase has been found in excavations carried out recently in the outer moat of Sigiriya[29] while evidence has also been found of protohistoric iron production sites in excavations carried out at Aligala prehistoric cave within the citadel of Sigiriya[30] and at Ibbankatuva in the Dambulla area[31]. It is important to note that the protohistoric layer in which evidence of iron production was found at Aligala, was dated to the 10th century BC This is the oldest dating obtained so far for the iron smelting in the island.

Age Range

Agriculture helped the expansion of the protohistoric settlements in Sigiriya which flourished around the waterways in the area. The emergence of minor irrigation networks which gave rise to large irrigation systems and the food surplus which was the result of that system may have created a favorable background for new technological methods. These factors may have contributed to the emergence of Sigiriya as a suitable location for urbanization.

Therefore, in the light of this and the various excavations conducted around Sigiriya, it becomes clear that even long before the 5th century urbanization, there were iron production and related socio-economic activities in the Sigiriya area. Similarly, a thorough study of ancient economic patterns show that the economic structure of the Raja Rata i.e. the irrigation and agricultural society, was based on iron use.

According to the *National Atlas of Sri Lanka*, hydrated iron oxide, limonite and geothite deposits are found in the Rathnapura and Matara districts, while high grade iron oxide deposits of magnetite are found in the Puttalam District and near Trincomalee.

Title - : Average weight percentage of - Metal O centent in different areas.

WEIGHT%	Fe_2O_3	MnO	SiO_2	Al_2O_3	P_2O_5	TiO_2	MgO	CaO	K_2O
KO 14 1	98.3 98.0	- -	- -	1.3 1.6	- -	0.4 0.4	- -	- -	- -
KO 14 2B	98.6 96.5	- -	0.4 0.3	0.9 0.3	- -	0.1 0.1	- -	- -	- -
KO 14 12B	97.7	-	0.2	1.4	-	0.4	0.3	-	-
KO 14 14B	98.4 98.5	- -	- 0.1	1.1 0.8	- -	0.1 0.1	0.4 0.5	- -	- -
KO 14 14BX	99.0 98.1	- -	0.2 0.2	0.5 1.1	- -	0.1 0.2	0.3 0.4	- -	- -
KO 14 18	97.9 96.7	- -	- 0.2	2.0 2.5	- -	0.1 0.2	- 0.4	- -	- -

Figure 6: Analysis chart of the iron are samples Alakolavava-Dehigaha-ala-kanda (KO 14)

In the 1920s, the archaeologist Hocart observed that the transition from limestone to granite as a building material took place in the 5th century AD. He draws special attention to the use of "square hammered stones" in the constructions of the Sigiriya fortress wall and the cyclopean style stone walls at Mapagala. [32,33] The ability to cut massive blocks of granite of the types mentioned above probably depended on major developments in the production of iron and steel in the Sigiriya hinterland. This finds further support in the quality of the granite carving of the stone thrones in the assembly hall and in the palace on the summit of the Sigiriya rock.

The Brahmi inscriptions of pre-Christian times, speak of the existence of craftsman in different kinds of metal. They are referred to as *kabara* (ironsmith), *tabakara* (coppersmith) and *topasa* (tinsmith). The word *kabara* derives from the Pali word *kammara*.

Iron Production and Communities

In more recent times the different stages of the iron production process have been associated with particular castes. Those who extracted the iron from the ore were called the ***yammanno*** caste. While the producers of 'steel' or iron tools belonged to the ***navandanno or aachari cast.***

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In folk songs or ***jana kavi,*** handed down from generation to generation which refer to iron producers, a clear distinction is shown between the ***yamanno*** and the ***aachari*** or ***navandanna*** caste. In ancient times the caste system was mainly occupation based. As a result, technology was preserved by being

handed down from generation to generation. The caste system in ancient Sri Lanka was developed to maintain the socio-economic systems of the day. This social pattern changed with the advent of foreign rule and as a result the traditional technological know-how was lost under colonialism. Another reason for this decline was cheap steel and iron implements imported from Europe and the inability of the indigenous iron producers to adopt new advance in technology.

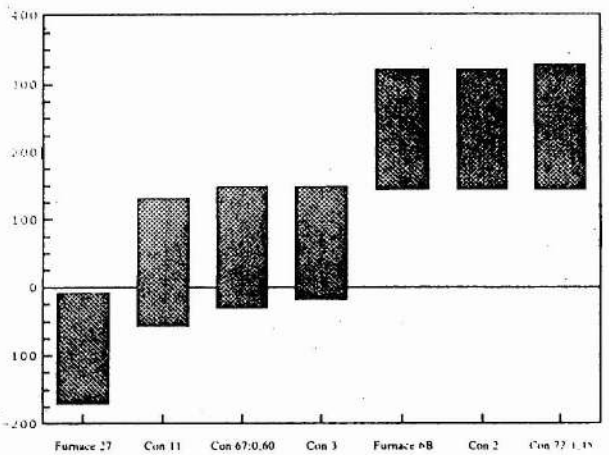


Figure 7: Radiocarbon dates. Dehigaha- ala- Kanda.
Age range

Frequency of production

The approximate volume of iron production can generally be estimated from the amount of slag remaining on the site. However, most of the slags remain buried under soil layers. According to rough calculations, more than 10,000 tons of iron had been produced at the Alakolavava site.

A study of the high technological knowledge possessed by these iron masters, the highly developed furnaces used in the process, the high iron content of the iron ore used, the iron content of slag etc. makes it clear that they were capable of producing very high quality iron relative to the amount of raw material used. The high quality of iron produced, the quality of output and the nature of the organization of production suggest industrial level production for use beyond the Sigiriya-Dambulla region, for local purposes such as agriculture and war, and even possibly for export.

A total of 35 iron production sites including about 5 of similar magnitude have been found in the area. There are some records in neighboring India about the Early Historic site of Kamrej, situated on the banks of the river Tapi which was dated to the same period as the Alakolavava production site. This site was mentioned in a Greek maritime guide ***Peripius Maris Erythraei*** as a coastal trading station engaged in the export of iron to the Red Sea littoral and the Mediterranean region[35].

Wood was used by the ancient iron workers as the main source of fuel in the production process. The ability to do so depended on the natural vegetation. A reduction of wood and ore probably caused the decline of iron production at Alakolavava. In considering ancient production systems, there is evidence to suggest that the distribution of Sri Lanka's natural vegetation, mineral resources and natural fuel played an important role in production processes in any region.

Agriculture helped the expansion of the protohistoric settlements in Sigiriya which flourished around the waterways in the area. The emergence of minor irrigation networks which gave rise to large irrigation systems and the food surplus which was the result of that system may have created a favorable background for new technological methods.

FOOTNOTES:

1. **lithic society** : An old world chronological period started with stone tool technology. The Paleolithic period is the earliest known stone period. Mesolithic is the theoretical phase situated next to the Paleolithic period. The Neolithic is the recent stone period characterized by the development of agriculture with an increasing emphasis on sedentism. Lithic society is described as the society that lived in the stone ages which are mentioned above.

2. Schmandt-Besserat, Denise. 1980, Ocher in Prehistory, ***The coming of the Age of iron***, Theodore A Wertime and James D. Muhly (eds), new Heaven & Yale University Press, London.

3. **iron age** : The theoretical division of the technological stage characterized by the use of iron.

   protohistoric period : the period situated between the prehistoric period and the historic period. According to the Deraniyagala's chronology, the period between 900-600 BC belongs to this period. It is distinguished by the appearance of iron technology and irrigated agriculture (wet rice cultivation) (Deraniyagala, 1990).

4. **chalcolithic period :** The period characterized by the use of copper with stone tools.

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6. Karunaratne, P. and Adikari, G. 1994, Excavations at Aligala Prehistoric Site, ***Further Studies in the Settlement Archaeology of the Sigiriya- Dambulla Region***, Bandaranayaka, S. and M. Mogren (eds.) ***PGIAR***, Colombo.

7. Deraniyagala, S.U and Abeyratne, M. 1997, Radiocarbon Chronology of Iron Age and Early Historic Anuradhapura, Sri Lanka: Revised Age Estimate (Unpublished)

8. **archaeometallurgy :** The science which studies ancient metallurgy in its widest sense from its beginning up to the industrial age.

9. Davy, J.1983, ***An account of the interior of Ceylon, and of its inhabitants, with travels in that island,*** Tisara Prakasakayo Ltd, Dehiwela.

10. Ondaatje, W.C. 1854, The Kandyan Mode of Manufacturing Steel, ***Ceylon Almanac and Annual Register***, Government Printer, Colombo.

11. Coomaraswamy, A.K. 1956 (1908), ***Medieval Sinhalese Art***, Pantheon Books, New York.

12. Hadfield, R. 1912, Sinhalese Iron and Steel of Ancient Origin, ***Journal*** at red heat into cold water.

13. **quenching or water treatment :** The hardening of steel by plunging it at a red heat into cold water.

14. **case hardening or cementing :** The production of a hard surface on steels by localized heating and quenching of the surface.

15. **wrought iron :** pure iron made by forging (by direct process).

16. Forenius, S. And Solangaarachchi, R. 1994, Dehigaha-ala-kanda (KO 14) at Alakolavava: An Early Iron Production Site with a Highly Developed Technology, ***Further Studies in the Settlement Archaeology of the Sigiriya - Dam bulla Region,*** PGAIR, Colombo

17. Juleff, G. 1990, The Samanalavava Archaeological Survey, ***Ancient Ceylon No 9,*** Department of Archeology, Colombo.

18. Bopearachchi, O and Wijeyapala, W. 1995, The fluvial and maritime trade centers of ancient Sri Lanka. Results of the explorations and excavations conducted by the Sri Lanka-French Archaeological Mission.

19. **bloomery process :** The production method of iron in solid condition directly as the result of a reduction of iron ore.

20. **spongy iron bloom:** soft mixture of iron that has been produced by the bloomery process.

21. **natural draught:** a current of natural air.

22. **forced draught :** a strong current of air produced by bellows.

23. **bellows:** an instrument for producing a strong current of air.

24. **tuyere :** a ceramic tube for blowing air from the bellows into a furnace.

25. Prakash, B. 1990, Scientific Basis and Technology of Ancient Indian Copper and Iron Metallurgy, ***History of Iron and Steel Making in India,*** Kuppuram, G. And K. Kumudamani (eds.), Sundeep Prakashan, Delhi.

26. Juleff, G. 1996, An ancient wind powered iron smelting technology in Sri Lanka, *Nature, International Weekly Journal of Science, vol.379.*

27. Noreus, D. 1994, Chemical Characterization of Ore, Slag and Iron from an Advanced Bloomery Process in the Sigiriya - Dambulla Region, *Monograph on Iron Production,* (unpublished report).

28. C_{14} : A dating technique which measures the length of time which has elapsed since any living thing died by analysing the ratio of normal carbon-12 to ratioactive carbon-14 in its remains. This technique is used to date bone, wood, shell, charcoal and other materials which consist of carbon.

29. Bandaranayake, S. (ed.) 1993 ***Site Report, Sigiriya Project,*** (unpublished).

30. Refer number 6.

VIDU 19-1-41

Ancient Food and Farming systems in Sri Lanka

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Research Officer
Hector Kobbakaduwa Agrarian Research Training Institute.

It is acknowledged that Sri Lanka has been the home of one of the earliest civilizations in the world. Archaeological evidence indicates that about the 10th century B.C there were people who knew how to make a fire and make pottery (Daraniyagala, 1992). Before the consolidation of agriculture, these hunter-gatherers used a wide range of plant species for food and medicine. In this process, they enhanced their knowledge on edible plants and learned about those which were toxic (Querol, 1992). This knowledge was transmitted from generation to generation.

Traditional Farming Systems in Sri Lanka

The development of agriculture in Sri Lanka, as in any other country, has been gradual starting first with the planting of a few seeds of the most useful plants in the area surrounding the gatherer's camp and later around the settlements of settled populations. According to Siriweera, a man made agro-ecosystem probably began to evolve around sixth and fifth centuries B.C. The people developed cultural practices and farming systems according to the requirements of the plants with the improvement of knowledge on the environmental responses of each plant cultivated. According to historical evidence, three major types of farming systems have been adopted by the Sri Lankans from the earliest time (Siriweera, 1990).

Paddy Cultivation

The most widely practised farming system in Sri Lanka is paddy cultivation. Being the staple food, paddy has been cultivated from ancient time in the valleys of the Mahaweli Ganga and the Malvatu Oya. More areas were brought under cultivation with the construction of tanks and canal systems for irrigation. Short and long duration varieties of paddy were selected for cultivation in both Yala and Maha seasons, respectively. According to the ***Mahavamsa***, not only was Sri Lanka self sufficient in rice, during the reign of king Parakramabahu the Great (1159-1186 A.D) rice was also exported to other countries.

A large number of rice varieties were developed and selected by our farmers to suit to various agro-climatic conditions and to the preferable characteristics, such as colour, smell taste and nutritive values.

According to ***Poojavaliya***, written in 10th century A.D. more than 200 varieties were cultivated in Sri Lanka. Robert Knox in his "An historical relation of the Island Ceylon" provides evidence that a number of rice varieties with different life span were used by the farmers during the Kandyan Kingdom. "They had several sorts, and called by several names according to different times of their ripening: However, in taste little disagreeing from one another. Some will require several months before it come to maturity, called mauvi; some six, Hacteel; while others will ripen in five, Honorowal; other in four, Hinat; and other in three, Aulfancol: In 1902, Chief Nugawela Dissawa exhibited a collection of over 300 local rice varieties at the Kandy Agro-horticultural and Industrial exhibition. By 1993, over 3000 rice varieties were collected and conserved in the Plant Genetic Resources Centre of the Department of Agriculture, Gannoruwa, out of which, a significant percentage consists of traditional varieties.

The most widely practised farming system in Sri Lanka is paddy cultivation. Being the staple food, paddy has been cultivated from ancient time in the valleys of the Mahaweli Ganga and the Malvatu Oya. More areas were brought under cultivation with the construction of tanks and canal systems for irrigation. Short and long duration varieties of paddy were selected for cultivation in both Yala and Maha seasons, respectively.

Buffalo and cattle rearing played a vital role in agrarian economy in the past. They were widely used in paddy cultivation, particularly, in land preparation and thresting of the harvest. Besides, cows milk was used in preparation of pasgorasa (five products from milk) namely milk, curd, butter milk, ghee and butter.

Chena Cultivation

The farmer chooses a patch of forest and cuts down some of the trees, leaving only larger and economically important trees, clears the undergrowth with a knife or cutlass and burns the debris. Virgin land of the chena was fertile since it contained minerals from ash. Crops were planted for several years on some land until it become less fertile and then cultivation shifted to a new area.

Chena provided varius types of food: grains, pulses, vegetables, oil crops and sugar crops. Upland rice varieties ***(Oryza sativa)*** are known as **goda wee or al wee** were grown in chenas. Kurakkan or finger millet ***(Eleusine coracana)*** which was considered as the second staple, meneri, ***(Panicum miliaceum)***, thanahal ***(Setaria italica)***, ***(Paspalum scrobiculatum)*** and heen meneri ***(Panicum miliare)*** were the common coarse grains cultivated in chenas. Mung been ***(Phaseolus aureus)***, black gram ***(Phaseolus mungo)*** and long been ***(Vigna marina)*** were the protein rich pulses, vegetables such as wattakka ***(Cucurbita maxima)***, melon ***(Cucumis melo)***, ash melon ***(Benineasa hispide)***, bottle gourd ***(Lagenaria siceraria)***, fence gourd ***(Luffa accstangala)***, snake gourd, egg plant ***(Solanum indicum)***, Thibbatu ***(Solanum indicum)***, ladies fingers also cultivated as mix crops in chenas. Oil crops grown in chenas were ***(Sesamum indicum)*** and mustard ***(Brassica alba)***. Sugar cane ***(Saccharum officinarum)*** was used as a sugar source and people knew how to prepare honey and **jaggery** out of it.

All these crops were cultivated in the same land, and in many cases seed mixture of different crops were sown on the wet land after yala maha monsoon rains.

Although, throughout the heyday of the dryzone civilization particularly, three crops grown in swidden plots namely cotton, sugar cane and gingili were important and three principal cottage industries developed around them. In literature there are frequent references to ***kapuhen, uk hen***, and ***tala hen*** which mean swideen plots where cotton sugarcane and sesame were grown (Siriweera, 1978).

The chena cultivation has the following advantages.

1. **Chena crops are often high yielding.**
2. **Chena cultivation normally requires a low energy input.**

Further mixed cropping practised in chenas has some distinct advantages from the agronomic point of view. First it ensures food security. Since a large number of crops are cultivated, failure of one or another crop due to adverse conditions can be compense with the survival of other food crops. Cultivation of various crops with valuable food and nutritive values ensures food and nutritional security throughout the year. Secondly, mix cropping increase the food production per unit of land. Various researchers have shown that mix cropping increases the productivity, compared to monocropping, due to intercrop completion and rational utilization of soil minerals. The third reason is that mix cropping reduces the spread of pest attacks and diseases in a crop since other crops act as a biological fence.

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Home gardening

Home gardens were maintained from early time. Useful fruit, vegetable and medicinal plants were cultivated around the houses. Composition of plants cultivated varied according to agro-climatic conditions of the area, although traditional root and tuber crops, jak (***Artocorpis heterophyllis***), coconut (***Cocos nucifera***), areacanut (***Areca catechu***). wineplam (***Caryota urens***), banana (***Musa sp***), sugarcane (***Saccharum officinarum***), ginger (***Zingiber offcinale***) turmeric (***Curcuma domestica***), citrus species such as orange (***Citrus aurantifolia***) and lime (***Citrus aurantium***) and other important food and medicinal plants were commonly cultivated in home gardens.

Role of forest in ancient food system

In addition, it is very well known that the forest played a vital role in the food system of our people. It provided a wide range of food varieties. Wild yams such katuala (***Dioscorea pentophylla***), hiritala (***D. oppositifolia***), gonala (***D. spicata***) were a good source of carbohydrate during hungry seasons. Seeds of hal (***Vataria copallifera***), beraliya (***Shorea megistophylla***) and madu (***Cycas***) and plant heart of kitul, indi, madu and thala were ground to flour and used for various preparations. Wild bread fruit and banana have been used from prehisroric era (Daraniyagala, 1992). Large number of forest plants such as woodapple, indi, wira, palu, longan, velvet tamarind, tamarind, donga, timbiri, ulkenda has been used as fruits.

A large number of green leafy vegetables grown in forests have been used for human consumption, palms such as kitul and thala provided starch, particularly kitul was a very important tree which provided palm sugar. Trees such as mi provided both oil and sugar.

Traditional Food Systems in Sri Lanka

Culinary is one of sixty four noble arts in ancient Sri Lanka Rice was the staple of ancient Sri Lankans. Normally, rice was steamed and eaten, although several types of preparations were recorded in the literature. It was cooked in oil (***tela-bhatta***) or made sour (***ambila-bhatta***). It was frequently served as sweet dish with various ingredients, such as raw sugar (***Sakkara***), lump sugar (***Gula***), honey (***Modhu***) or clarified butter (***Sappi***). Sankhata modhu payas was milk rice prepared with sugar. honey, ghee and oil. Rice cooked in the milk of the king coconut, ghee and five spices was considered excellent dish.

Flesh of animals, fish, vegetable and pulses were offered with rice. They were prepared according to seven methods (***Hatmaluwa***), namely ***Ambula, Hodda, Niyambalawa, Malluma, Godamas, Diyamas*** and ***Baduma*** other cereals particularly, ***Kurakkan*** were eaten and number of preparations such as sweetmeats were enjoyed by our ancestors.

They had the knowledge to destroy the toxic compounds of some foods during the preparation. They also identified some food varieties that should not be eaten together since they may be harmful. They knew food varieties which were good for various ages. The unique knowledge accumulated with women which was transmitted from generation to generation from mother to daughter.

A large number of green leafy vegetables grown in forests have been used for human consumption, Palms such as kitul and thala provided starch, particularly kitul was a very important tree which provided palm sugar. Trees such as mi provided both oil and sugar.



Although the farmer presently uses the tractor for preparation of land for paddy cultivation, the farmer in ancient times used only buffaloes and plough for this work. Even today the buffaloes and the plough are commonly used for the same task in many village areas due to the reason that farmer knows that soil fertility and structure are well protected when animals rather than machinery are used for the land preparation work.

Vidu 19-1-45

The Challenge to indigenous people and their knowledge

The indigenous people always live in their traditional territories interacting with nature around them. They have been acquiring unique capabilities and techniques in order to survive in the given environment. If they are removed from their homelands they might gradually loose their traditional knowledge, cultures and abilities which had been obtained during a long period of practicing them with the locality. A large number of indigenous people have been directly and adversely affected by heavy exploring activities carried out by transnational mining companies in some regions of the world. Within the process of globalization these companies can have access to large areas of mineral lands and are more active in entering indigenous peoples' lands effecting their ancestral land rights.

Recently many indigenous people from different parts of the world gathered on August 9-10, 1999 at the United Nations Headquarters in New York to commemorate the International day of the World Indigenous People. The organizations which involved in organising this event are as follows:

NGO Committee on the Decade of the World Indigenous Peoples
United Nations High Commissioner for Human Rights(**UNHCR**)
International Labour Office(**ILO**)
United Nations Development Programme(**UNDP**)

This is the fifth year that this activity was held and the theme of this year was "Indigenous peoples and their Relationship to Land". The representatives adopted three important resolutions as mentioned below.

- **land rights be made a regular agenda of the UN Working Group on Indigenous Populations**
- **the Draft Declaration of the Rights of Indigenous Peoples be adopted even before the Indigenous Decade ends in 2004**
- **sessions of the UN working Group be increased to last two weeks to give more time for all Indigenous Peoples to bring out their issues and concerns**

In Sri Lanka, the people living in the area - Eppawala where phosphate mineral deposits are available might face challenge due to a situation which is similar to the above. Peoples' land rights should be protected in order to preserve IK.

References:
Ceylon Daily News dated 05 February 2000, 16 p

Something about Science and Society

Science and humanity are largely incompatible. Science is based on the pursuit and distribution of truth , even if we make errors and miss that truth. Human society is heavily based on the selective pursuit and distribution of selected truths. In the agroscape and the urban landscape, the genes and the know-how are patented, bought bartered, stolen, lost, hidden, and lied about. And – public domain or not – it will be the same in the wildland garden. *Tropical ecologist Daniel Janzen, professor of biology at the University of Pennsylvania. 'Gardenification of Wildland Nature and the Human Footprint' Science, 279 (27 February 1998): 1312-3.*

Many non-scientists who like to think of themselves as knowledgeable about modern science really know only about technologies – and specifically those technologies considered likely to bring economic profits in the short term. Thus science for Homo economicus and homo faber is flourishing, while science for Homo sapiens is diminishing. Given this scenario, it seems that the ascent of man has been left in the care of homo ignorantis. Within this fortress, the 'Better Living Through Science' crowd is busy trying to monopolize science and technology funding and is, in the process, choking off what remains of funding for pure research. As we struggle to counter their court intrigues , we may one day wake up to find barbarians at the gate, in the form of an upsurge in 'new' science- that is, not science at all – promoted by one or another fundamentalist religious or occultist group ready to lead us into a new Dark Age. *Science Journalist Takashi Tachibana. 'Closing the Knowledge Gap Between Scientists and Nonscientists': Science, 281 (7 August 1998): 778-9*

As individuals we are amazingly ignorant and incapable...Is there anyone now alive who knows even a tenth of everything there is to know in science?..We have no permanent ubiquitous record of our civilization from which to restore it should it fail. We would have to start again at the beginning. Crating a permanent record of our civilization may not be as difficult as we imagine. What we need is a primer on science, clearly written and unambiguous in its meaning – a primer for anyone interested in the state of the Earth and how to survive and live well on it. *James Lovelock, orginator of the Gaia hypothesis, which posits that the Earth is a self-regulating system.*
A Book for All Seasons'. Science, 280 (8 May 1998): 832-3

Science has become least popular and most feared at the height of its influence and intrinsic interweaving with our daily lives and activities – least pursued and cherished when most essential to the core of education for all thinking people. *Stephen Jay Gould, in the essay mentioned previously.*

Sadly, science is no longer a calling where scientists are the guardians of knowledge, but has become a narrowly specialized employment. *James Lovelock, in the essay cited previously*

For although science may feed technology, technology is steadily changing how we do science, how we think of science, and what it means to be a scientist. Tools have always done this, but in the last few decades our tools have taken over. The status of the technologists is ascending because for now, and for the foreseeable future, we have more to learn from making new tools than we do from making new concepts or new measurements. *Kevin Kelley, executive editor of. Wired. "The Third Culture" Science.279(13 February 1998):992-3*

Science makes me qsuestion things that I know and keeps me from accepting anything simply because I'm told it is the truth. *Robert Jackel. one of the students of Holmdel High School in New Jersey asked about his thoughts on science and society. 'Science – far More Than Required High School Cousework'. Science. 279 (20 March 1998): 1858-9.*

Many men and women in science seem uncomfortable with the notion of individual genius. Perhaps this is one reason that the world of science suffers in the youthful imagination compared to the world of art which is stuffed full of individuals and even some genuises. *Melvyn Bragg. Historian writer and arts critic. 'Opportunity Knocks! Science, 281 (21 August 1998): 1138-9*

(From Nature & Resources, Vol. 34 No. 4, October-December 1998)

Vidu 19-1-48

SCIENCE FOR EVERYDAY LIFE

The NSF Committee on Science Education has been conducting public awareness seminars on the central theme "Science for Everyday Life" for school students, teachers and the general public. The objective of these seminars is to create general awareness of the usefulness of science and to educate selected sectors of the population on the use of Science to enrich life and living. These are short seminars of 2 - 3 hours duration and are conducted in Sinhala. Messers A.W.J. Karunasinghe and Amal Udawatta organized these programs on behalf of the Committee. The seminars held during the year 1998 are listed below.

Theme	Venue	Participants & No.	Date
Food & Nutrition	* Zonal Education Office, Kuliyapitiya	Science & Home Science Teachers *- 208*	13.03.1998
	* Meerigama , Kandangamuwa Maha Vidyalaya	Teachers & Students *- 203*	27.03.1998
	* Woman Workers Education & Welfare Centre of Labour , Katunayake	Young Woman Workers *- 145*	23.08.1998
	* National Youth Services Council	Youth Trainees *- 150*	08.09.1998
Landslides	* Walhaputenna Maha Vidyalaya, Haldummulla	Students & Teachers *- 400*	15.01.1998
	* Koslande Maha Vidyalaya	Students & Teachers *- 250*	16.01.1998
	* Divisional Secretariat, Eheliyagoda	Gramaseva niladhari, Samurdhi assistants	18.12.1998
Panel Discussion on Earth Tremor in Kandy	* Auditorium of the NSF	Media representatives, Geologists, Other officers *- 15*	09.12.1998