TRADITIONAL CULTIVATION SYSTEMS AND APPROPRIATE TECHNOLOGY

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The industrial revolution, scientific discoveries and the growth of commercialism have had a profound effect on the transformation of systems of traditional agriculture practised by different civilisations for thousands of years. The theory propounded by Malthus that population growth will outstrip food supply would have acted as a significant catalyst in the search for new and improved methods of food production. However, the most powerful force was perhaps the commercial orientation in agriculture which placed the highest premium on profit maximisation rather than human welfare.

Commercialised industrial production is largely based on supply and demand. Selection of the appropriate technology and labour utilisation are largely governed by profitability considerations. Majority of inputs are physical in nature except in areas of labour and management.

The tremendous success in industrial production had its inevitable impact on agriculture, which came to be organised more and more on the very same lines. The net consequence of these developments has been the birth and establishment, throughout the world, of a system of agriculture heavily dependent on - and specifiically appropriate for - heavy machinery, artificial fertiliser, insecticides, weedicides and fungicides. Sri Lanka too was no exception to this phenomenon.

At the very outset, it may be necessary to emphasise one oint - that all these developments originally took place in countries in the temperate zone. The new systems may be highly appropriate to those countries - in terms of climatic conditions, soil types, dietary patterns of the population etc. However late it may be, a question can be posed, "How appropriate are they for tropical countries like Sri Lanka?"

Leaving that question aside, let us consider the nature and implications of the new system - beginning with fertiliser usage.

Modern scientific research has identified the macro and micro nutrient and trace element requirements of plants. These are, Nitrogen, Phosphorus, Potassium, Sulphur, Calcium and Magnesium (macro nutrients); Iron, Manganese, Zinc, Copper, Boron and Molybdenum(micro nutrients) and about ten trace elements. However, research work on plants has mainly been concentrated on the major nutrient requirements. Work on micro nutrients and trace elements has been conducted generally in response to specific problems that have come to light (e.g. yellowing of coconut leaves due to magnesium deficiency).

Through research work, macro nutrient and nutrient compounds appropriate for different soil types have been determined and recommended. This procedure is clearly seen in paddy cultivation. Nevertheless, it can be maintained that these findings and recommendations are based on inappropriate concepts and research data. There appears to be two basic defects in this system. Firstly, the concentration on major nutrients and the exclusion of minor nutrients and trace elements. Secondly, most research work is conducted in "special research plots" and not in the actual field.

When the recommendations based on this type of research are followed in the field, it can lead to deficiencies in trace elements and carbonic compounds. Application of nitrogen, phosphoric acid and potash under these circumstances results in chemical imbalances which can have the effect of weakening the plants. Application of nitrogen under nutrient imbalance situations can produce adverse effects rather than benefits.

Environmental pollution stands as clear evidence for the ill effects of artificial fertiliser usage.

Weak plants are highly susceptible to insect and pest attacks. When insecticides are used to eradicate insects, they destroy not only the harmful ones but also the other

insects and useful beings, as well, leading to an imbalance in the living organisms. (The same is true in respect of weedicides). Although a temporary control over the insects can be achieved by this method, the destruction of organic balance leads to a resurgence of the problem on a dangerously large scale after the lapse of some time. The present yields of paddy lands in the Polonnaruwa district are a good illustration of the consequences of plant nutrient imbalance. Under optimum soil and weather conditions, it is possible to secure a yield of about 200 bushels per acre from the modern hybrids that have been introduced in to the Polonnaruwa area. However, today's yields, on the average, do not exeed the 100 bushel per acre level. This is a 50% decline.

The advent of mechanised farming based on the profit motive has led to the development of machine compatible hybrid plants and the substitution of monocrops for mixed farming. Both developing and developed countries have accepted this agro technology as the 'system' - and they appear to be looking down upon the traditional systems of agriculture. Projects were implemented to wean the people away from age old traditions, and the intended objectives seem to have been at least partially achieved. The immediate effect of this transformation is the gradual increase in fuel consumption.

Energy Consumption in a British Farm - (1976)

Input Units		Output units	
Fuel (wood, oil and electricity)	122.2	Food crops	84.4
Fertiliser	83.5	Fruits and vegetables	3.2
Machinery	103.5	Animal products	80.6
Chemicals	8.5		
Buildings	22.8		
Transport	16.3		
Animal food (from outside sources)	53.2		
TOTAL	414.1		168.2

$$\text{Input/Output ratio} = \frac{768.2}{414.1} = 40.\%$$

In Africa, where animals are used in agriculture, these ratios stand at 18.5% for cereals and 29.5% for other crops.

Unfortunate and unforeseen symptoms began to appear in countries which could be considered as the earliest converts to this 'new' system. Thousands of acres turned into 'dust bowls'.

Although a handful of persons foresaw the impending disaster, they were labelled as fanatics, but the situation went on changing form bad to worse with commercial agriculture entering the ranks of major sources of environmental pollution. With the realisation of the threat posed by environmental pollution to the survival of life on earth, and the short term and temporary nature of modern technology, the attention of intellectuals, environmentalists and agronomists was drawn towards agriculture. They were motivated to search for alternative agro technologis, and to develop new systems. These systems or technologies are known by several names - organic cultivation, bio dynamic farming, natural forestry farming, energy farming, sustainable agriculture - to quote a few. The number of persons and institutions involved in these new optional systems is on the increase with a proportionate rise in attention and emphasis. As a result of this development, the production and marketing of health foods are under going a rapid expansion in the West, accompanied by a similar output of related publications.

Through these steps, the scientists, environmentalists and related institutions strive to achieve three main objectives. Firstly, the maintenance of a pollution free environment and the preservation of the atmosphere, soil and water on earth in a condition conducive to the life of plants and animals. Secondly, the rehabilitation of arable lands destroyed by modern agro - technology and the utilisation of systems that ensure increasing yields year after year. Thirdly, the protection of life on earth through the world wide application of measures designed to achieve the above objectives. This is not an easy task, because most countries of the world have embraced destructive technologies and alternate, less harmful technologies are not always readily forth coming.

Formulation of alternative solutions through normal research procedures takes a long time. Therefore, many scientists are inclined to believe that better methods

could be found by collection, codification and analysis of technologies used by countries with a history of several thousand years. Practical details of these technologies could be sought from elderly farmers and those living in remote areas. An examination of facts thus collected leads one to conclude that, "the ancient agro production has been based on an environmentally sustainable long term technology."

It is evident that in ancient times agriculture was merely a sub-component of a total system that embraced environment, society, religion and the state - and not a mere production process as practised today. For instance, the chena cultivation was not a destructive system like some of the systems used today. It can be described as an appropiate agro - forestry technology compatible with modern scientific ideas. Large trees were not felled or burnt. What was done was only clearing of the jungle to a degree just sufficient to provide light for growing plants. Thus, only the undergrowth and low hanging branches and creepers were removed. Further, the other elements of chena cultivation, namely, selection of appropriate seasonal crops, land preparation, crop pattern and the adoption of mixed farming display a high level of land management, maintenance of soil fertility and water conservation.

An Intergrated System

Further examination of the above mentioned aspects of the traditional Sri Lankan systems is bound to reveal features that can surprise the modern scientist. Maintenance of eco-systems through appropriate land use, rational water management, optimum utilisation of forest resources, recycling of plant nutrients and the adoption of appropriate crops are some of these notable features. When the insect populations reached epidemic levels due to adverse climatic factors, they were brought under control through mechanical procedures couched in rituals, natural bio chemial agents such as leaves and barks of plants and by crop rotation.

The dry zone of Sri Lanka is served by a network of rivers originating from the central mountainous country and the tanks have been built in a series along the waterways where the overflow from one tank and the connected fields feeds the tank below it. This method of water storage is conducive to soil conservation and prevents erosion. It also improves the underground water holding capacity.

Forests in the wet zone helped the soil to retain rain water and thereby act as reservoirs. Run off water from the forests and the chenas deposited the top soil and the plant nutrients it carried in the form of sediment in the series of tanks. Annually, during the dry season tanks were dredged and the rich sediment transferred to the paddy fields. Tanks were built in ascending order of size down the stream so that almost all the sediments got collected in the smaller tanks that dried up completely during the dry season facilitating easy dredging. Once the water passed through several such tanks which functioned as effective filters, it was virtually free of all sediment. It is this 'pure'water that entered the larger tanks located further down stream. This explains why the large tanks in Sri Lanka have not completely silted up even after thousands of years.

The farmer in ancient times possessed three types of lands. A chena in the forest, a home garden with useful perennials, vegetables, etc. near the tank and three different types of paddy lands (average mud, medium mud and heavy mud) usually determined by the degree of proximity to the source of irrigation water. The system of chena cultivation, in the manner it was practised then, actually preserved the forest; because the large trees were never felled and removed as is done today. Chena was a source of food, fuel wood, timber, fodder and fertiliser for intensively cultivated paddy lands. It was really a good example of optimum use of resources.

Forest and chena adjoining the village; homes and home gardens adjoining the tank; paddy lands below the tank bund; cultivation based on animal husbandry; rational land use - these were the elements of this integrated system that preserved the environment and ensured ecological balance. Cow dung from the cattele sheds, ash and decaying vegetable matter from the kitchen and home garden were collected and applied to the paddy fields. Fields were kept water logged before ploughing. This ensured a certain degree of weed and insect control, depositing of nutrient rich sediment that came with surface run off in the fields and also facilitated the absorption of nitrogen that came with rain water associated with lightning during the inter monsoon periods. These measures, along with proper cropping systems, ensurd the

maintenance of fertility of paddy lands for centuries at a remarkably high level. Brilliant sun light, selected seeds, proper combination of crops and timely sowing of seeds led to vibrant plant growth, capable of resisting insect attacks and disease and ensured high fields.

Another measure that helped in this matter was the crop pattern, that went hand in hand with rainfall. Tradition insisted that there should be specific time lags between one step of cultivation practice and another. E.g. between the first clearing of the forest and the second; between the first ploughing and the second and so on. The whole process of land preparation would have taken several weeks or several months. This practice was definitely helpful for the control of weeds and insects, and special eradication measures were generally not required.

Nevertheless, occasionally, due to adverse weather conditions insect epidemics did occur, and various measures were adopted to keep the insect populations under control. However, the remarkable feature of these measures is the fact that none of them were dependent on toxic agents or were harmful to the environment. Certain insect control methods had religious connotations, while the belief in super natural beings (prevalent among the farmers) also seems to have been exploited in devising insect control measures.

What has to be done today is to examine these measures, identify the underlying scientific principles and use them effectively. A few of these charms and their effective mechanisms are described below;

Whenever there is an attack by "godavella"s (a kind of worm that breeds profusely and noted for voracionsness), a thin disc cut off from the trunk of a banana is struck to a stake and several such stakes planted in the field infected with worms. A few small pieces of ripe fruit (e.g. mango, banana) and a piece of fried dry fish are kept on each disc of banana trunk. In addition, a lamp is also lighted towards the evening. Within a few days, the worm attack subsides.

The probable explanation is that the smell of fried fish, the light of the lamp as well as pieces of fruit serve to attract birds. As soon as they perch on the disc of banana trunk it topples into the field along with the bait. Birds follow the bait and note the worms - the better food. Once attracted, the flock of birds increases daily - until the entire fnsect population is destroyed.

In the Kandy district, stakes driven into paddy fields is a common sight. These stakes seem to serve two functions. Firstly, they scare away the rats and non-perching birds that feed on paddy (e.g. paddy birds). Secondly, they serve as perches for nocturnal birds such as owls which feed on rats. However, it may be noted that this practice will be ineffective where there are no nearby forests which provide the breeding ground for nocturnal birds - another instance showing the role of forests in agriculture.

Another 'charm' employed to contrl insects in paddy fields is to sprinkle a pot of milk and a pot of sand on the court yard near a Bo tree; collect a pot of sand from there and to dash handfuls of sand on to the infected paddy plants. Obviously, this act has the effect of throwing the insects on paddy plants in to the water in the field where they become prey to fish, water snakes and frogs. Again, thiis method will be ineffective in fields where systemic weedicides and insecticides have destroyed all living beings.

Lighting an oil lamp in the night to attract insects which ultimately end up as prey to aquatic predators is another method. Mechanical methods included the dragging across the paddy plants of winnowing fans and ropes to which latex from jak trees have been applied. In the process, the insects got stuck on the latex. Sprinkling of the juices of certain plants or placing the crushed plants on water ways in the paddy field were among the bio chemical measures employed. These are still practised in some areas.

The brief descriptin given above clearly shows that the traditional systems were niether harmful to the environment nor toxic to man. However, our soil, our environment and ourselves are facing disaster due to the impact of commercialism and the misguided belief in the infallibility of modern scientific systems. Therefore, a determined effort must be made to isolate the appropriate measures from our ancient systems and to introduce them to our farmers before it is too late.

Similar useful measures could be developed from those adopted in foreign countries. Two such examples now in vogue in Thailand are given below.

Use of Thiththa kinda - *Tinospora glabra* (Menispermacea) in the control of insects is one such example. Here, pieces of this plant are anchored to waterways or cut into small pieces and scattered in the field. Paddy plants (before being transplanted) are kept immersed in the water (prepared by keeping 2 kg of this plant in 10 litres of water for 24 hours) for 12 hours. This has been found to be an effective remedy against insect attack.

Margosa is also a widely used insecticide. Powdered seeds of Margosa is applied to the paddy fields in varying doses at different stages of the growth of paddy plants. It has been found to be an effective measure in insect control. Further, the farmers have noticed an improvement in the growth of plants as well as in the quality of paddy. This has been attributed to the ability of margosa to control fungi and fix soil nitrogen.

The main attention in this article was directed towards crop protection because of the prevailing belief among farmers that cultivation is not possible without agro chemicals. Therefore, it should be obligatory on our part to ensure increasing yields in food crops to feed the growing population and the protection of environment and soil fertility through harmless measures as described above. It is also necessary to formulate and discover appropriate new measures and to motivate the people to adopt them.