Can Sustainable Agriculture Ensure Food Security in Sri Lanka?

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The food production process in a country involves the provision of optimum conditions for the satisfactory existence of the plants and animals which include the crops, forests, grass lands, management of animals (cattle, goat, sheep, pigs, bees, fish, birds, etc.). However, the existing food production methods have not been successful in supplying the food in the required quantities and of suitable nutritional value to the world population which is growing rapidly day by day. The challenges listed below may be the cited as the reasons for the above crisis.

1. The limited cultivable land available
2. The difficulty in supplying the water, required for the cultivation of crops
3. The reduction in the productivity of the land due to the absence of proper land management
4. Rise in the cost of inputs required for the cultivation of crops
5. Fluctuations in the market value and challenges for selling the products
6. Marketing competitions, advertising and development of the selling process
7. Challenges associated with the management of animals
8. Quality control and regulations
9. Climate change
10. Failure of not considering traditional knowledge

Due to these specially in the developing countries in Asia and in Sub. Saharan countries the health and the wellbeing of a large number of people including children below two years age are specially affected due to not getting sufficient nutritional food on a result of food insecurity. The increase in the number of children who are malnourished, the increase in the risk of contacting various diseases due to low immunity, facing harmful health problems, decrease in body mass, birth of children who are physically and mentally retarded, wasting of muscles, shortening of the life span are among the ill effects.

The various organizations in the world, the scientists and the United Nations Organizations have thoroughly investigated this unfortunate situation and focused their attention towards developing agricultural practices which would provide nutritive and balanced

food in a continuous manner and searching for answers to the associated challenges that arise. In order to achieve this sustainable cultivation methods in agriculture have been identified on the most fruitful and the practical solution.

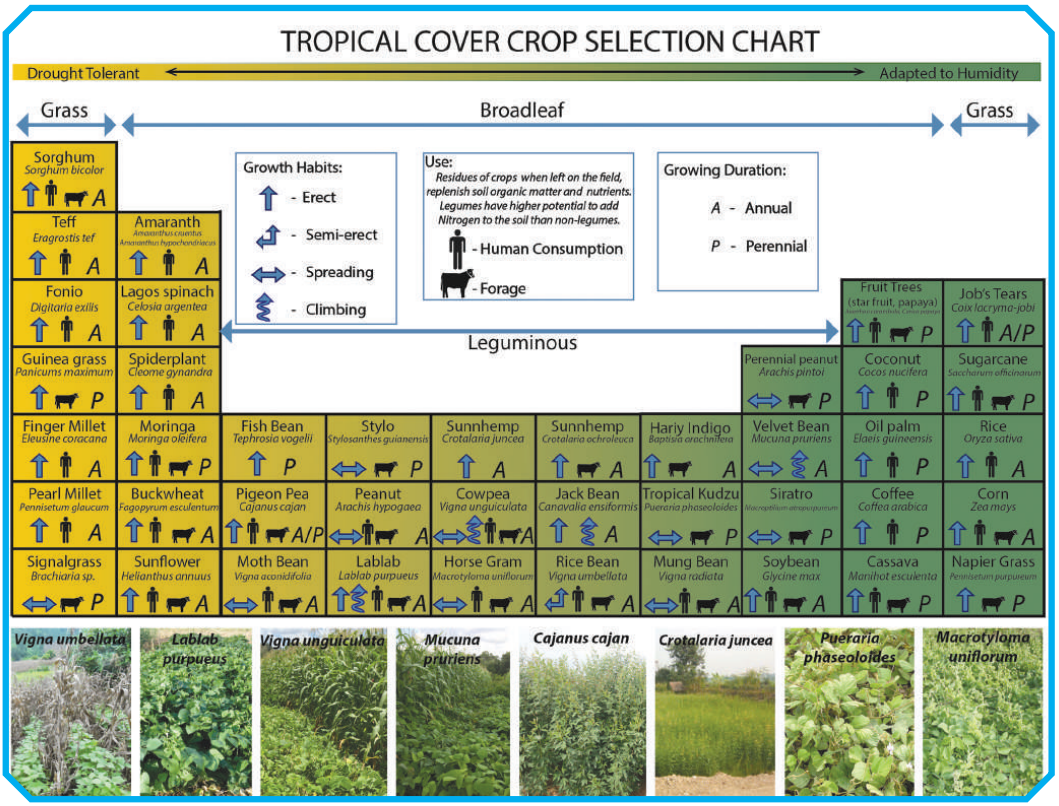
Sustainable agriculture is a food production process which at the same time maintains environmental, social and economical interrelationships at an optional level, during this process cultivation of crops is carried out while safeguarding the sustainability of the physical, chemical environment and its proper maintenance. Therefore, it is a cultivation method which while maintaining the coexistence of the environment and the society in an optimal manner, simultaneously making it economically profitable to cultivate. In order to propel the sustainable agriculture towards a successful level all factors of the agricultural process such on the cultivated medium-soil, soil, selection of seeds, supplying the irrigation water, weed control, disease and pest control, harvesting, processing of harvest, transport until it reaches the consumer, storage, being watchful of the changes in weather and climate. The environment in which the cultivation is carried out should be carefully investigated and steps taken to ensure the long-term sustainable security of all the steps and factors.

1. The cultivation medium/ soil

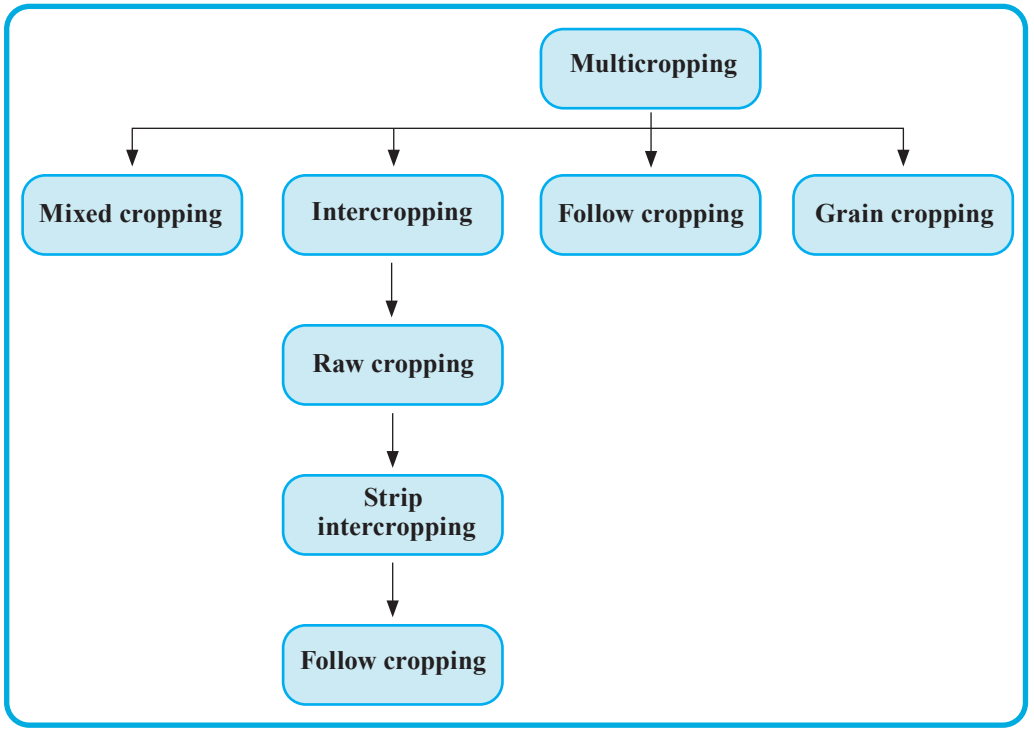
For sustainable agriculture, the first thing to do in to build the soil (which in the cultivation medium) to an optimum state to promote the cultivation of the crop and maintain it, for this the physical, chemical and the biological properties of the soil has to be improved. Specially when the soil structure soil texture and soil are in suitable state that the soil is also well aerated. Then because the pH of the soil, its cation exchange capacity and the activity of the soil organisms are optimum the soil nutrients are made soluble so that the plants can absorb them easily. In other words when the soil that is "non-living" or "pantically alive" become a "fully alive soil" the crops can absorb the nutrients easily. As a result, an economically profitable harvest is obtained then propelling the food production to a higher level.

2. Crop selection

In order to make cultivation economically profitable it is necessary that the selected crop should be well adapted to face the challenges existing in the relevant environment. The challenging factors are the weather and climatic conditions, diseases and pests and the weeds that compete with the crop. It is possible to reduce the risk to the crop brought about by weather changes such as floods, drought and strong winds. Also, because the selected crops are resistant to the diseases and pests in the region and to the weeds that grow in competition with the crops grown the risk to the crop can be reduced. Therefore, the use of agrochemicals such as insecticides is reduced. This in turn makes it possible to prevent the diseases and get rid of the pests with the minimum of expenditure. Also, the damage to the environment by the



artificial agrochemicals is kept at a minimum. As there is no hindrance to the existence of beneficial organisms. The natural environmental equilibrium is maintained. In addition, biodiversity provides habitats for the main predatory organisms of the organisms which cause diseases and pests of crops thereby protecting crops through biological control. Also, as there is no hindrance to the increase in the population of pollinating organisms. The pollination of the crops is enhanced resulting in a better harvest. Pollution of the environment as a whole is minimized because those is reduction in the pollution of air, water resources, soil and soil water. A maximum harvest is made possible from the crops which are well adapted to the environment and receiving the necessary inputs.



3. Crop cultivation method

In sustainable agriculture monocropping is not carried out. Instead, many crops are grown along with animal husbandry simultaneously in some extent of land. Thus, the concepts of crop rotation and mixed cropping are of special significance in sustainable agriculture.

In crop rotation leguminous crops are grown in one part of the field. As the leguminous crops for atmospheric Nitrogen as infertile soil is made fertile. In another section of the field grassing crops with a high marketing value helps to improve the economic status as well as the living standard of the farmer. Also, by cultivating yam crops in yet another section of the field helps to improve the physical properties of the soil. Using another section of the field for animal husbandry provides fertilizer for the crops and proteins for the food of human. Crop rotation and mixed cropping make it possible for the crop to obtain the nutrients and water in the different layers of the soil and to make use of the light falling off the field in an efficient manner. The growth of the weeds is also minimized in a natural way and therefore the expenditure by the farmer for weed control is reduced. This maximizes the profits that the farmer gets for his inputs. These practices therefore supply the economic, social and the environmental benefits and the farmer also receives a "Balanced diet containing the required nutrients.

Harvesting and post-harvest activities

It is possible to maintain the post-harvest obtained from the sustainable agriculture in a good condition because the crop has been grown in a suitable environment with less diseases and pests, it has been harvested on reaching the correct stage of maturity and containing the necessary nutrients. The steps

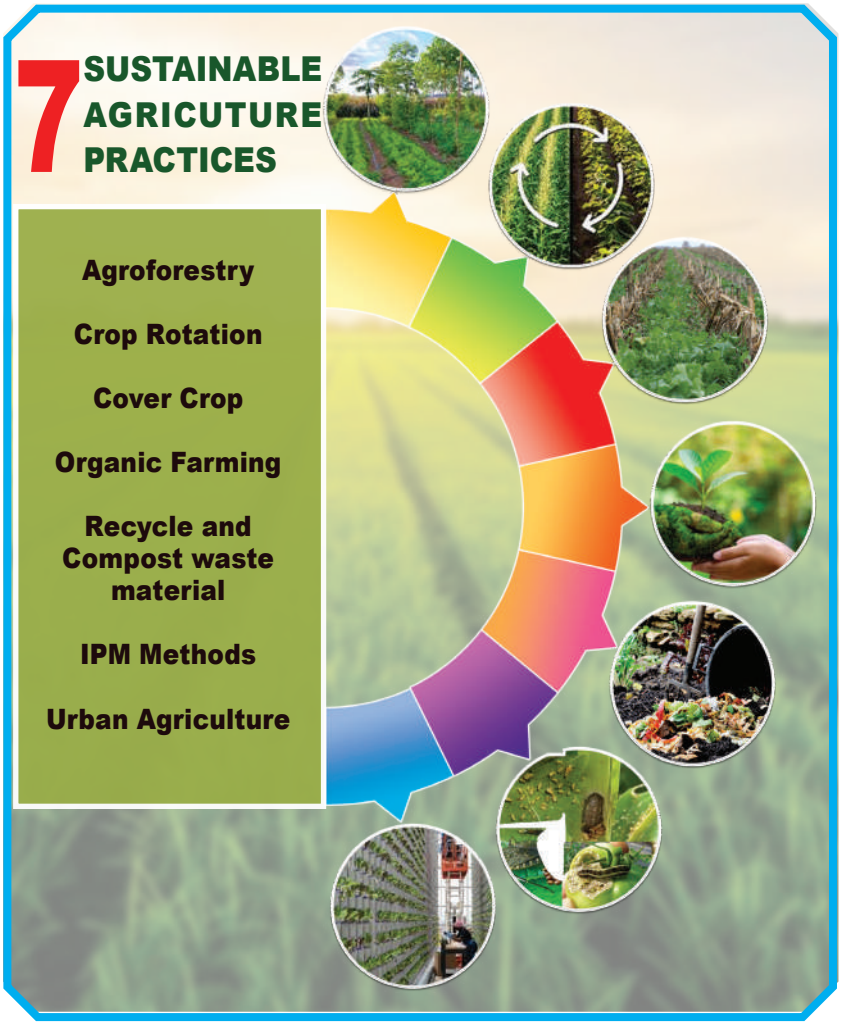
and methods of delivering the harvest to the consumer has to be environmentally friendly. The primary and secondary methods of population have to be done under poor sanitary conditions. Storage a transport should also be carries out properly so that the food is safe for health. Following the correct practices reduce the post-harvest losses and the conservation of food is maximized. Consequently, the profit to the farmer is maximized and his living standard is brought to a higher level. All individuals /people involved in this value addition chain have to be made aware of the modern technological methods, the indigenous and traditional knowledge regarding agriculture which reduce harm to the crop and the harvest. They also have to be provided with the infrastructure (Knowledge and material requires). So that they become confident. This way the process of supplying a nutritious and a balanced diet to every body is secured.

The future prospects of sustainable agriculture

It has been predicted that by 2050 the global population would increase to 9 billion. The necessity to provide the infrastructure such as housing and other facilities for the increasing population, its reduction in arable land due to urbanization, use of absolute methods in agriculture failure to build up a living/fertile soil, the cultivation of crops which are genetically modified (GMO) with the expectation of increasing the harvest (these GMO crops may show higher response to fertilizers), incurring a higher expenditure to control diseases and pests and not protecting the biodiversity due to practicing of monoculture has threatened the progress of agriculture.

Therefore, the existing traditional agriculture patterns have to be organized such that they fall in line with the basic/primary concepts of sustainable agriculture. It is important to select seeds which bring in more harvest which are resistant to weather changes such as flooding, long lasting drought, winds, resistant to damage caused by diseases and pests. Seeds which are traditionally used because of their adaptability to the environment should be selected. Attention should be paid to protecting the equilibrium of the environment by reducing the unnecessary use of agrochemicals and maintenance of the natural biological cycles.

Adhering to the basic principals of sustainable agriculture is very crucial to supplying nutritive food in sufficient quantities and at affordable price to the daily increasing population, using the existing resources to the maximum. To achieve this more attention has to be paid to the naturally available energy resources, taking steps for soil conservation and prevention of soil pollution. Use mobile inputs for smart agricultural production which deliver with high accuracy example data from satellite, GPS technology, drone technology ad inputs attained through sensors.



It is useful to correctly incorporate or combine the traditional agricultural practices handed down, with modern sustainable technology. By selecting the crops which are well adapted to the environment and the climate of the region, practicing crop rotation, mixed cropping, using natural fertilizers, preventing soil erosion, improving the desirable properties of the soil and having discussions with possible to grow crops which will yield more profits.

How should the future of sustainable agriculture in Sri Lanka be planned

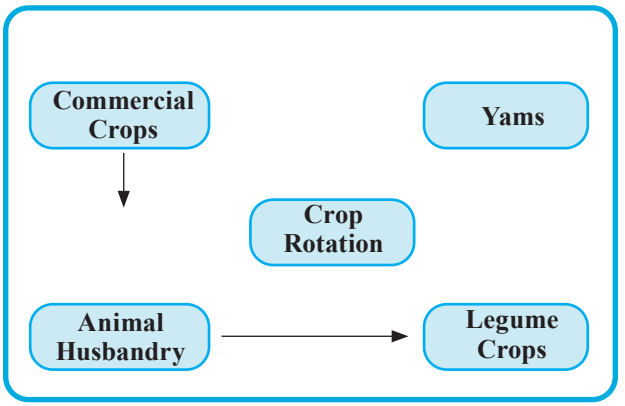
Sri Lanka is a small island in the Indian ocean having a rich biodiversity. Sri Lanka has been divided in to 46 distinct agricultural zones based on weather, climate, soil properties and nature of the plant population. Sri Lanka has more than 4170 flowering plant species which are adapted to the various agrochemical zones. Of these species 24% are endemic to Sri Lanka. More than about 2000 of the plant species processing medicinal properties are used in traditional and indigenous medicine. Sri Lanka has a unique status due to the historical agricultural practices that have been handed down from generation to generation, very special knowledge regarding irrigation, methods of preparation of traditional balanced food and the existence of indigenous medical practices which are successful in the cure and prevention of diseases. For improving the sustainable agriculture in Sri Lanka which has the natural resources, traditional knowledge, suitable Weather, climate and soil resources, sustainable agricultural methods have to be organized using modern technology and existing natural resources and traditional knowledge.

1. **Selection of crops adapted to the region**

   Profits of agriculture depend on and vary with weather and climate, temperature, rainfall, diseases from pathogens and other variable factors. Therefore, to find sustainable solutions to obtain the maximum harvest it is necessary to employ short term, mid-term and long-term methods to develop the agriculture. The selected agricultural crops to suit the 46 agroclimatic zones in Sri Lanka should be suitable to the respective soil, water availability, and climate conditions. Eventhough our country has nearly 2000 different plant species which can be grown as crops, the number actually used as crops is less than 100 species. Therefore it is necessary to introduce traditional grain species, indigenous yams, legume , vegetable and fruits to the cropping system and identify the more beneficial/ profitable crops and also make value added products from them. Though this process the income of the farmer can be enhanced. However crop plants which are genetically modified but not adapted to the environment or crop plants dependent on increased/ high inputs should not be selected simply with the aim of increasing the harvest.

2. **Use of intercropping, crop rotation, animal and crop rotation which are sustainable methods** instead of single species cropping. This is the growing of different types of crops (mixed cropping) in the same field. Eg: growing food crops and medicinal plants simultaneously.

   Through mixed cropping the sunlight necessary for plants, the fertilizers and other inputs provided to the crops are optimally used by all the crops



thus yielding a maximum harvest. Therefore maximum use can be made of the soil, water and sunlight.

3. selecting crops that do not require large inputs of agrochemicals but depend on maximum inputs. Therefore through the reduction of the adverse effects on the environment, the pollution of the soil, water and air is minimized.

4. Implementing the following activities /methods to identify the required inputs for the farming of crops and supplying them at the correct time and in the correct amounts inorder to improve the farming in an efficient and a profitable manner. Use of traditional water management methods natural methods of disease and pest control and methods of food conservation. Use of modern technology such as mobile inputs, data obtained using satellites, GPD technology and sensors to identify water and fertilizer requirements. The status of the crop, soil quality, weather and climatic conditions. By theses mwthods it is possible to improve the soil conditions by supplying water,fertilizer and other agrochemicals. These will contribute to the production of food in an economically profitable manner using a very limited land area.

5) Diversification of the existing agricultural process

By including the plants with medicinal properties in the suitable agricultural process by the diversification of the agricultural practices, using modern methods of soil conservation it is possible to obtain additional income and to produce various value added products. Most medicinal and other plants produce chemicals for their benefits. These chemicals may inhibit the germination of seeds of other plants or inhibit the growth of other plants. These chemicals are called allelopathic chemicals. Allelopathic plants can be used in weed management. These growing allelopathic plants can reduce the use of chemical weedicides. That is effective to reduce the expenditure on weedicides. Allelopathic plants will decrease the weeds which are resistant to chemicals, weedicides, reduce the residues from agrochemicals, decrease environmental pollution and ensure the proper natural cycling. In order to improve this it is necessary to identify the allelopathic plant species in Sri Lanka and use them in mixed cropping along with the crops. Also it is necessary to carry out hybridization research to enhance the allelopathic properties of these plants.

6. Controlling disease and pests through the cultivation of trash crops

If a crop is harmed by animals/ insects then by growing in the same field another crop- Trap crop which attracts such animals/insects the damage to the main crop is reduced. If the trap crop also produces a useful harvest . Then there are two benefits. Trap crops reduce the use of pesticides,decrease the expenditure, are beneficial to the ecosystems, increase the quality of the main crop and help in the production of the environment/soil. As examples the following can be cited

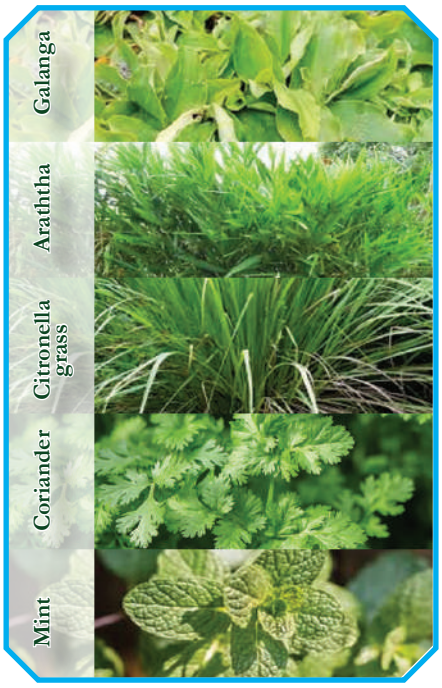
Ocimum sanctam (Maduruthala)
Tagets (Dhaspethiya)
Allium Sataivum(Garlic)
Viternegundo (Nika)

Gracing garlic with *Ocimum sanctam* and Tagets reduces the damage caused by thrips

Growing asaamodagam and coriander with vegetable crops reduces the damage by snails.

Aromatic plants

Galanga	: (*Alpinia galanga*)
Araththa	: (*Alpina calearata*)
Citronella grass	: Cymbopogon nardus,
Coriander	: Corriandrum safirus
Mint	: Minchi mentha spp



Selecting and cultivating varieties which are resistant to diseases and pests reduces the expenditure on disease and pest control. Cultivating plants with reduced water and fertilizer needs and adapted to the environment.

Eg: Traditional yam species have less requirements for water and fertilizers and therefore it is possible to increase the profits.

Diversification of the crops species used in agriculture

Introduction of plants containing essential oils and crops of economic value. The direct benefits are saving of the large amount of money spent on the control of diseases and pests, protecting the ecological balance, preventing the pollution of water and soil. In addition, these plants can be used to provide raw materials used in *sidhdha* and indigenous systems of medical practice, which are the traditional systems practiced in this country. Growing those plants will cut down huge expenditures incurred in importing these medicinal plants, in addition to the production of medicines with higher quality.

Carry out experiments to identify the crop species which can withstand natural disasters and weather changes (long periods of drought, floods, sudden emergence of pests, windy conditions and encourage the farmers to cultivate them.

Some of the crop materials used are very expensive and some are also susceptible to diseases and pests.

When selecting the growing material substitute them with locally produced matrials as far as possible. Also it is advisable to identify (After confirming by necessary records economically profitable and traditionally used crops and introduce them to the farmers.

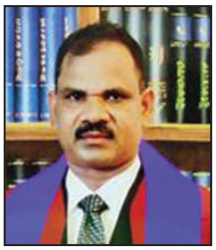
Jak (*Artocarpus heterophyllus*) indigenous yams and durion (*Durio zibethinus*) are considered to be underutilized plants. These plants can easily be made popular and will provide a suitable solution to food deficits and malnutrition.

Farm management has to be made sustainable and using modern technologies agriculture can be made profitable and its sustainability ensured. This will result in successfully strengthening the methods of food conservation too. Failure to conserve food leads to food shortage.

It is possible to ensure food security in Sri Lanka by improving the sustainable agriculture industry. To achieve this end it is necessary to identify the existing agricultural, climatic, economic and social conditions in Sri Lanka and also suitable agricultural principles. Thereby through the production of quality agricultural products which satisfy the local and foreign demand it is possible to ensure the food security in Sri Lanka and improve sustainable agriculture.

Jak (*Artocarpus heterophyllus*)

Durion (*Durio zibethinus*)



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