Lecture :- HIGH EXTERNAL INPUT SUSTAINABLE AGRICULTURE (HEISA) AND LOW EXTERNAL INPUT SUSTAINABLE AGRICULTURE (LEISA)

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One of the most promising paradigms that has emerged for the benefit of small scale resource-poor farmers is Low External Input Sustainable Agriculture (LEISA), which can enable such farmers to achieve higher income and attain sustainability by:

1. Optimizing the use of locally available resources, thereby achieving a synergetic effect among the various components of the farming system (soil, water, animals, plants, etc.) so that they complement each other in the production of output.

2. Minimizing the use of external inputs, except where there is a serious deficiency and where the effect on the system will be to increase recycling of nutrients.

The aim is not to maximize short-term production, but to attain an adequate and sustainable level over the longer term.

Low External Input Sustainable Agriculture (LEISA) is receiving increased attention, both as a sustainable alternative to Green Revolution-like strategies making intensive use of external inputs, and as a strategy of sustainable agriculture in resource-poor environments where no or very few external inputs are used.

To achieve these goals, LEISA must tap the most viable indigenous knowledge and practices and ecologically friendly technologies in a given ecological and socio cultural setting, since the experience in one agro-ecological setting may not be appropriate in other areas. There are many cases of farmers using LEISA under different agro-ecological zones in different countries. These experiences should be documented to learn more of the principles, constraints, and potentials in order to provide policy-makers, development workers and farmers with alternative and viable strategies to develop sustainable farming systems.

Low-External Input Sustainable Agriculture (LEISA) is a series of practices which serve to reinforce ecological principles that are in line with local ecosystems.

Practices such as recycling of plant nutrients (nitrogen and others), minimizing crop losses due to insects and pests, and securing favourable soil conditions for plant growth are just the tip of the hat. An integral component of LEISA is in ensuring that this environmental awareness remains connected to the daily lives, needs and concerns of farmers who rely on these ecosystems for their livelihoods. With regards to LEISA practices, CPAR’s work in farming communities focuses on:

- Maximizing the use of locally available plants and tree species
- Reducing the use of non-renewable fuels and energy sources
• Acknowledging the right of local communities to control, manage and benefit from natural resources
• Ensuring that agricultural practices help to shape positive landscapes and sustained ‘life support systems’ for small-scale who rely on favourable environmental conditions for their survival

The continuous use of chemicals to obtain high yields had its adverse impacts on both the natural environment as well as the economy of the farmer in the medium term. The shift from Low External Input and Sustainable Agriculture (LEISA) to High External Input Agriculture (HEIA) was proved to be neither sustainable nor high income yielding in the longer term. It is in this context that attention was focused on the need for LEISA generating higher yields. Towards this, Integrated Pest Management (IPM) practices and use of organic manure replacing or minimizing the use of chemical fertilizer came to be experimented with from around mid 1980’s.

Low-External Inputs and Sustainable Agriculture (LEISA). It is included the technical, social and economic options open to farmers who seeks to improve productivity and income in a ecologically friendly way. Low-External Inputs and Sustainable Agricultural principals teach us the optimal use of local resources and natural processes and if necessary the safe and efficient use of external inputs such as chemical fertilizer and artificial pesticides.

Appropriate and desired plans to achieve sustainability while maintaining productivity at optimum level based on personal preferences are essential for farmers to get self satisfaction and socio-economic benefits. The role of extensionists, researchers and trainers is to facilitate the farmers to improve productivity and farm income, through reducing dependency on external inputs and increasing use of local available resources.

LOW EXTERNAL INPUT AND SUSTAINABLE AGRICULTURE (LEISA)

LEISA is based on the following ecological principles

Creating a favourable condition for growth and sustenance of plant-by stimulating of soil micro organisms as far as possible and adding organic matter sufficiently.

• Maintaining nutrient content at optimum level assuring the balance of nutrients in the soil by Nitrogen fixation, utilization of nutrients available in the deep soil layers, promotion of recycling process and addition of external fertilizer as and when necessary to complement deficient nutrients.

• Controlling the micro climatic conditions to minimize loss of resources, due to sunlight, air and water. Use of biological and mechanical methods to prevent soil erosion.

• Minimizing loss of resources caused by pests and diseases. Integration of pest control methods giving priority to natural biological control of pests by natural enemies on the principle that prevention is better than eradication.
• Promoting biodiversity and complexity Stimulating synergetic and symbiotic conditions between plants/plants and plants/animals.

The objective of LEISA system is to maintain the agricultural production at an optimum level using less external inputs in a eco-friendly environment. To achieve this objective the LEISA practices concentrated heavily on the following factors

1. Maintaining a living soil
2. Creating of bio-diversity
3. Recycling of resources.
4. Natural pest Management

6.2 Maintaining a living soil

Maintaining Biological characteristics of the soil. The climate, animals, plants and humanbeing influence on the physical, chemical and biological characteristics of the soil.

Adequate amount of water, air and nutrients in the soil is essential to maintain crop production at a sustainable level.

Favourable soil structure is essential to retain water, nutrients and the growth of root systems of the plants.

The soil temperature should exist for maintenance of living soil.

It is important that soil should be free from poisonous substances.

The soil contains clay, gravel, air, water, organic matter and humus.

Biological activities including breeding of many micro and macro organisms taking place in the soil is an

Important characteristic.

1. Soil organisms

All animals and plants living in the soil are considered as soil organisms. Based on the sizes the soil organisms can be classified as follows.

Microflora - Bacteria, fungus and Algae

Microfauna - Protozoa
Mesofauna - Nematodes

Macro animals - Weevils, Centipede, Termites, Rats, Worms, Snakes

**HIGH EXTERNAL INPUT AGRICULTURE (HEIA)**

The basic aspect of conventional agriculture was to maintain subsistence level production by using locally available resources. All resources had been naturally recycled and reused without wasting. But due to pressure of increasing population in developing countries steps were taken to expedite food production deviating from the traditional pattern.

The pressure of world population explosion exerted more on the people of developing countries. In order to confront the pressure of world population explosion the farmers as well as the Researchers and Extensionists were compelled to join the “Seed – Manure” revolution born with the label “Green Revolution”. The aim of this “Revolution” was to provide food for the increasing population by enhancing the harvest per unit and the intensification of the number of cultivation seasons. The “Green Revolution” introduced during the early part of the 6th decade of the 20th century accelerated food production of Sri Lanka.

**The advantages of High External Input Agriculture (HEIA)**

Agricultural Production could be rapidly increased to meet the demand for food for the increasing population.

- As a result of availability of adequate food stuffs many problems related to diseases caused by mal-nutrition and deficiency were prevented or reduced.
- New improved varieties gave yields within a short period of time.
- Mechanization solves the problem of Labour shortage.
- Income and profit margins of the products were increased
- Productivity of land increased.
- Increased market facilities for production.

**2. Soil enrichment and conservation**

The forest demonstrates the natural method of receiving nutrients into the soil.

The soil obtain the most of nutrients through recycling of plants and animal parts and wastes.
Soil micro organisms are continuously active for decomposition of organic matter into humus.

In a farm it is necessary to provide conditions to stimulate microbial activities to decompose organic matter into available forms to plants. In addition provision of partly or completely decomposed nutrients to the soil in sufficient quantities is necessary for rapid growth of the plants and to keep up soil fertility.

3. Application of green manure

In conventional agriculture, green manuring was one of the major activities carried out to enrich the soil. Particularly in paddy cultivation green manure was used to improve physical, chemical and biological properties of the soil. Besides providing nutrients green manure helps to conserve moisture.

Live fence, wind blockade trees, alley crops, and cover crops can be used as sources of green manure in farms.

4. Animal waste

From the ancient times animal wastes have been used to enrich soils.

Partly or completely decomposed animal wastes are used to conserve soil moisture, to get nutrients and to stimulate microbial activities.

5. Cultivation of Nitrogen fixing plants

The legume crops grown in farms fix Nitrogen in the soil. Green gram, cowpea, soya, ground nut and beans are suitable legume crops for Nitrogen fixation. Gliricidia and wild sunflower are suitable legume trees for live fences and wind blockades.

6. Compost fertilizer

The fertilizer produced from the decomposition of residues of plants and animals is called compost fertilizer. Composting is done by micro organisms in the soil. Efficiency of the system depends on the maintenance of moisture, air and temperature at optimum level.

Micro organisms obtain oxygen and moisture from the atmosphere and food from organic matter and release carbon dioxide and energy. The energy released in the process is used to increase the temperature of compost and to perform biological activities of micro organisms. The increased temperature affects on organic matter to undergo a series of changes to form humus. The ultimate product is a complex mixture of humus, undecomposed organic matter, dead soil organisms and living organisms.
Biological restructuring of organic matter takes place in the composting process. The micro organisms can conveniently utilize the sugar in organic matter and cellulose and hemicelluloses decompose slowly through enzymic activities.

7. Conserving soil resources

In order to ensure sustainability of living soil, attention should be paid for methodical protection of soil particles, air, moisture, organic matter, humus, micro organisms and energy. Biological and physical methods could be used to keep a living soil with optimum fertility.

Mulching

Mulching is the use of plant or non living materials to cover the soil surface with the objective of protecting the soil from the adverse impact of rainfall, and sunlight, controlling weeds or moisture loss and fertilizing the soil. Mulching is not suitable for the soils where moisture content is too high. Generally 3.4 tons of mulch over for one hectare of land is suitable. There are different methods of mulching in agriculture as described below.

In situ mulching

The residues of cultivated crops and weeds can be used as a mulch to protect the soil from erosion and over exposure to sunlight. When there is no competition between the existing crop and the root systems of the previous crop, the remaining parts of the previous crop can be used as a mulch.

Eg:- Using paddy straw and stubble as a mulch Residues of maize crop.

Cover Crops

Cover crops are extensively used in agriculture to give protection to the soil. Selected categories of annual legume crops are more suitable for cover cropping. In addition to covering the soil, legume crops fix nitrogen in the soil. These crops also add organic matter into the soil.

Calopogonium mucunoides and Centrosema pubescens are examples of legume cover crops.

When the fields are in fallow period sunhemp (sesbania) seeds can be sown in the field. At the flowering stage sunhemp crop is ploughed or cut into pieces and incorporated to the soil. This crop fix Nitrogen in the soil in addition to providing organic matter.

In mix cropping live mulches are often used. Legume cover crops are cultivated as runner crops with the main crop. Eg. In rubber and coconut plantation legume cover crops are
used. However the cover crops should be selected considering their less competitiveness with the main crop for moisture, space, sunlight and nutrients.

**Good cover crops should have the following characteristics**

- Convenience in cultivation, having horizontal growth, ability to cover the soil surface rapidly.
- Ability to compete with weeds
- Ability to provide a dense mulch
- Ability to fix Nitrogen
- Inacting as a host plant of pests and diseases of the main crop.
- Tolerance to shade.
- Ability to produce seeds for the next cultivation.

Examples for cover crops

Pueraria phaseoloids, Centrosema pubescens, Phaseolus radiatus. Calopogonium mucunoids, Desmodium gyroides.

**Alley cropping farming**

Alley Cropping means growing annual or seasonal crops between rows of trees or shrubs, often leguminous. Before planting annual crops in the space between rows the vegetative parts of the trees and shrubs are pruned to use as much around annual crops and also as fodder and fuel wood. During the dry periods the trees and shrubs provide shade to annual crops and help to maintain favourable micro climate.

**Characteristics of good trees and shrubs in alley cropping.**

- Rapid growth
- Rapid regrowth after pruning
- Ability to provide more organic matter at least 5 tons of biomass per hectare per prune if the trees and shrubs are planted at the space of 4-5 meters between rows and 0.5 meters in the row.
- Ability to fix Nitrogen
Suitable trees and shrubs for alley cropping

Eg: Gliricidia maculata, Tephrosia noctiflora, Tephrosia vogelii, Sesbania cannabina

**Advantages of mulching**

- Create bio chemical and physical changes in the soil. Stimulate the soil microorganisms.
- Conserve soil moisture, reduce runoff and wind erosion. Reduce evaporation and facilitate infiltration of water into the soil.
- Help to maintain soil temperature at optimum level. In mulched soil, temperature is 5\(^{-}\)10\(^{\circ}\) C lesser than in exposed soils.
- Control weeds, reduce competition between weeds and growing crops.
- Improve soil structure
- Improve cation exchange capacity

**Disadvantages of (HEIA)**

Collapse of environmental balance due to lack of biodiversity by planting a few cash crops.

- Increase in soil erosion due to constant furrowing by machinery.
- Dependence on imported machinery, chemical fertilizer, pesticides, hybrid seeds and other inputs.
- Extensive use of pesticides disturbed the natural mechanism of controlling pest and diseases as the artificial pesticides kill both pests and their natural enemies.
- Use of artificial agro-chemicals adversely affected the soil PH, cation exchange capacity, soil structure, soil texture and soil organisms. Consequently the microbial activities of the soil tend to reduce forming dead soil.
• Although the need for high capital investment, the large scale farmers benefited while small scale farmers who were short of capital ran into debt.

• Neglecting environment-friendly traditional varieties of seeds and their genetic resources faced extinction due to introduction of hybrid varieties. Conventional agricultural knowledge and techniques were neglected and extinguished.

• The farmers in developing countries had to encounter a series of environmental, social economic and political problems as a result of the use of High External Input Agricultural practices. The following case study taken from an Indian experience illustrates the problems faced by farmers who practiced high external input Agriculture.