1.6 AGRO ECOSYSTEMS

- An agroecosystem is the basic unit of study in agroecology, and is somewhat arbitrarily defined as a spatially and functionally coherent unit of agricultural activity, and includes the living and nonliving components involved in that unit as well as their interactions.
- An agroecosystem can be viewed as a subset of a conventional ecosystem. As the name implies, at the core of an agroecosystem lies the human activity of agriculture.
- However, an agroecosystem is not restricted to the immediate site of agricultural activity (e.g. the farm), but rather includes the region that is impacted by this activity, usually by changes to the complexity of species assemblages and energy flows, as well as to the net nutrient balance.
- Traditionally an agroecosystem, particularly one managed intensively, is characterized as having a simpler species composition and simpler energy and nutrient flows than "natural" ecosystem. Likewise, agroecosystems are often associated with elevated nutrient input, much of which exits the farm leading to eutrophication of connected ecosystems not directly engaged in agriculture.
- Some major organizations are hailing farming within agro ecosystems as the way forward for mainstream agriculture. Current farming methods have resulted in over-stretched water resources, high levels of erosion and reduced soil fertility.
- According to a report by the International Water Management Institute and the United Nations Environment Programme, there is not enough water to continue farming using current practices; therefore how critical water, land, and ecosystem resources are used to boost crop yields must be reconsidered.
- The report suggested assigning value to ecosystems, recognizing environmental and livelihood tradeoffs, and balancing the rights of a variety of users and interests, as well addressing inequities that sometimes result when such measures are adopted, such as the reallocation of water from poor to rich, the clearing of land to make way for more productive farmland, or the preservation of a wetland system that limits fishing rights

- Forest gardens are probably the world's oldest and most resilient agroecosystem.Forest gardens originated in prehistoric times along jungle-clad river banks and in the wet foothills of monsoon regions.
- In the gradual process of a family improving their immediate environment, useful tree and vine species were identified, protected and improved whilst undesirable species were eliminated.
- Eventually superior foreign species were selected and incorporated into the family's garden.
- One of the major efforts of disciplines such as agroecology is to promote management styles that blur the distinction between agroecosystems and "natural" ecosystems, both by decreasing the impact of agriculture (increasing the biological and trophic complexity of the agricultural system as well as decreasing the nutrient inputs/outflow) and by increasing awareness that "downstream" effects extend agroecosystems beyond the boundaries of the farm .
- In the first case, polyculture or buffer strips for wildlife habitat can restore some complexity to a cropping system, while organic farming can reduce nutrient inputs.
- Efforts of the second type are most common at the watershed scale. An example is the National Association of Conservation Districts' Lake Mendota Watershed Project, which seeks to reduce runoff from the agricultural lands feeding into the lake with the aim of reducing algal blooms.
- Agroecosystems are often more difficult to study than natural ecosystems because they are complicated by human management which alters normal ecosystem structures and functions.
- There is no disputing the fact that for any agroecosystem to be fully sustainable, a broad series of interacting ecological, economic, and social factors and processes must be taken into account. Still, ecological sustainability is the building block upon which other elements of sustainability depend.
- An agroecosystem is created when human manipulation and alteration of an ecosystem take place for the purpose of establishing agricultural production. This

introduces several changes in the structure and function of the natural ecosystem and as a result, changes in a number of key system level qualities. These qualities are often referred to as the emergent qualities or properties of systems , qualities that manifest themselves once all of the component parts of the system are organized.

Agro Ecosystem Analysis :

- Agro ecosystem analysis is a thorough analysis of an agricultural environment which considers aspects from ecology, sociology, economics, and politics with equal weight.
- There are many aspects to consider; however, it is literally impossible to account for all of them. This is one of the issues when trying to conduct an analysis of an agricultural environment.
- In the past, an agro ecosystem analysis approach might be used to determine the sustainability of an agricultural system.
- It has become apparent, however, that the "sustainability" of the system depends heavily on the definition of sustainability chosen by the observer.
- Therefore, agro ecosystem analysis is used to bring the richness of the true complexity of agricultural systems to an analysis to identify reconfigurations of the system (or holon) that will best suit individual situations.
- Agro ecosystem analysis is a tool of the multidisciplinary subject known as Agroecology. Agro ecology and agro ecosystem analysis are not the same as sustainable agriculture, though the use of agro ecosystem analysis may help a farming system ensure its viability.
- Agro ecosystem analysis is not a new practice, agriculturalists and farmers have been doing it since societies switched from hunting and gathering (hunter-gatherer) for food to settling in one area.
- Every time a person involved in agriculture evaluates their situation to identify methods to make the system function in a way that better suits their interests, they are performing an agro ecosystem analysis.

Elements of Agroecology:

There are ten elements of agroecology,

1.Diversity

2. Co-creation and sharing of knowledge

3.Synergies

4.Efficiency

5.Recycling

6. Resilience

7.Human and social values.

8. Culture and food traditions

9.Responsible Governance

10.Circular and Solidarity economy

Some of the key emergent qualities of ecosystems, and how they are altered as they are converted to agro ecosystems, are as follows:

- **Energy Flow**

Energy flows through a natural ecosystem as a result of complex sets of trophic interactions, with certain amounts being dissipated at different stages along the food chain, and with the greatest amount of energy within the system ultimately moving alongthe detritus pathway . Annual production of the system can be calculated in terms of net primary productivity or biomass, each component with its corresponding energy content. Energy flow in agroecosystems is altered greatly by human interference. Although solar radiation is obviously the major source of energy, many inputs are derived from human-manufactured sources and are most often not self-sustaining. Agroecosystems too often become through-flow systems, with a high level of fossil fuel input and considerable energy directed out of the system at the time of each harvest. Biomass is not allowed to otherwise accumulate within the system or contribute to driving important internal ecosystem processes (e.g. organic detritus returned to the soil serving as an energy source for microorganisms that are essential for efficient nutrient cycling). For sustainability to be attained, renewable sources of energy must be maximized, and energy must be supplied to fuel the essential internal trophic interactions needed to maintain other ecosystem functions.

- **Nutrient Cycling**

Small amounts of nutrients continually enter an ecosystem through several hydrogeochemical processes. Through complex sets of interconnected cycles, these nutrients then circulate within the ecosystem, where they are most often bound in organic matter .Biological components of each system become very important in determining how efficiently nutrients move, ensuring that minimal amounts are lost from the system. In a mature ecosystem, these small losses are replaced by local inputs, maintaining a nutrient balance. Biomass productivity in natural ecosystems is linked very closely to the annual rates at which nutrients are able to be recycled. In an agroecosystem, recycling of nutrients can be minimal, and considerable quantities are lost from the system with the harvest or as a result of leaching or erosion due to a great reduction in permanent biomass levels held within the system. The frequent exposure of bare soil between crop plants during the season, or from open fields between cropping seasons, creates "leaks" of nutrients from the system. Modern agriculture has come to rely heavily upon nutrient inputs derived or obtained from petroleum-based sources to replace these losses. Sustainability requires that these “leaks” be reduced to a minimum and recycling mechanisms be reintroduced and strengthened. Ultimately, human societies need to find ways to return nutrients consumed in agricultural products back to the fields – the agroecosystems that consumed and produced them in the first place.

- **Population Regulating Mechanisms**

Through a complex combination of biotic interactions and limits set by the availability of physical resources, population levels of the various organisms are controlled, and thus eventually link to and determine the productivity of the ecosystem. Selection through time tends toward the establishment of the most complex structure biologically possible within the limits set by the environment, permitting the establishment of diverse trophic interactions and niche diversification. Due to human directed genetic selection and domestication, as well as the overall simplification of agroecosystems (i.e. the loss of niche diversity and a reduction in trophic interactions),populations of crop plants or animals are rarely self-reproducing or self-regulating. Human inputs in the form of seed or control agents, often dependent on large energy subsidies, determine population sizes. Biological diversity is reduced, natural pest control systems are disrupted, and many niches or microhabitats are left unoccupied. The danger of catastrophic pest or disease outbreak is high, often despite the availability of intensive human interference and inputs. A focus on sustainability requires the reintroduction of the diverse structures and species relationships that permit the functioning of natural control and regulation mechanisms. We must learn to work with and profit from diversity, rather than focus on agroecosystem simplification.

- **Dynamic Equilibrium**

The species richness or diversity of mature ecosystems permits a degree of resistance to all but very damaging perturbations. In many cases, periodic disturbances ensure the highest diversity, and even highest productivity. System stability is not a steady state, but rather a dynamic and highly fluctuating one which permits ecosystem recovery following disturbance. This promotes the establishment of an ecological equilibrium that functions on the basis of sustained resource use which the ecosystem can maintain indefinitely, or can even shift if the environment changes. At the same time, rarely do we witness what might be considered large-scale disease outbreaks in healthy, balanced ecosystems. But due to the reduction of natural structural and functional diversity, much of the resilience of the system is lost, and constant human derived external inputs must be maintained. An over-emphasis on maximizing harvest outputs upsets the former equilibrium, and can only be maintained if such outside interference continues. To reintegrate sustainability, the emergent qualities of system resistance and resiliency must once again play a determining role in agroecosystem design and management. We need to be able to analyze both the immediate and future impacts of agroecosystem design and management so that we can identify the key points in each system on which to focus the search for alternatives or solutions to problems. We must learn to be more competent in our agroecological analysis in order to avoid problems or negative changes before they occur, rather than struggle to reverse the problems after they have been created. The agroecological approach provides us one such alternative.

Why AESA is needed:

It improves decision –making skils,through a field situation analysis by observing ,drawing and discussing.

The methodology of AESA (Agro ecosystem analysis):

A. Field Observations:

a) Enter the field at least 5 ft. away from the bund. Select a site with a dimension of 1 sq. mt. randomly.

b) Record visual observations in following sequence:-

(i) Flying insects (both pests & defenders)

(ii)Close observation on pests and defenders which remain on the plants.

(iii)Observe pests like Spodoptera litura and defenders like ground beetle/ rove beetle/ earwigs by scrapping the soil surface around the plants.

(iv) Record disease and its intensity.

c) Record parameters like number of leaves, branches, plant height and reproductive parts of the selected plants which should be flagged for making observation in the following weeks.

d) Record the types of weeds, their size and population density in relation to crop plant.

e) Record soil conditions viz. flooded, wet or dry.

f) Observe rodent live burrows.

g) Repeat the step (a) to (f) in four sites randomly selected.

h) Record the climatic factors viz. sunny, partially sunny, cloudy, rainy etc. for the preceding week.

B. Drawing:

First draw the plant with actual number of branches/ leaves etc. at the centre on a chart. Then draw pests on left side and defender on the right side. Indicate the soil condition, weed population, rodent damage etc. Give natural colours to all the drawing, for instance, draw healthy plant with green colour diseased plant/ leaves with yellow colour. While drawing the pests and the defenders on the chart care should be taken to draw them at appropriate part of the plant, where they are seen at the time of observation. The common name of pest and defenders and their population count should also be given along with diagram. The weather factor should be reflected in the chart by drawing the diagram of sun just above the plant if the attribute is sunny. If cloudy, the clouds may be drawn in place of sun. In the case of partially sunny, the diagram of sun may be half masked with clouds.

C. Group Discussion and Decision making:

The observations recorded in the previous and current charts should be discussed among the farmers by raising questions relating to change in pest and defender population in relation to crop stages, soil condition weather factors such as rainy, cloudy or sunny, etc. The group may evolve a strategy based upon weekly AESA, ETL and corresponding change in P: D ratio and take judicious decision for specific pest management practices.

D. Strategy for decision mating:

i) When large number of egg masses and early instar larvae of Spodoptera / Helicoverpa are observed, the group may advocate application of NPV.

ii) Some of the defenders like lady bird beetles, groundnut beetles,rove beetles and wasps play useful role in arriving at P: D ratio.

Figure1.6.1AESA Based IPM Skills

[Source:https://static.vikaspedia.in/media/images_en/agriculture/crop-production/integrated-pest-managment/IPMSkills.jpg]