सत्यमेव जयते

Two Days Training Module On

NATURAL FARMING

For Master Trainers

National Centre For Organic and Natural Farming

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1. Introduction

Natural Farming is a holistic farming system which helps in improving soil regeneration, water and air quality, enhance ecosystem biodiversity, produce nutrient-rich food and store carbon to help mitigate the effects of climate_change. The farmers in local groups /clusters will be mobilized to work in harmony with nature, while also maintaining and improving economic viability.

- **Techniques and practices of Natural farming**
  - ✓ **Minimize the physical, biological, and chemical disturbance of the soil.** Farmers practicing natural farming often minimize tilling their land, or under certain conditions (horticulture & plantations) forgo tilling all together to prevent the problems of soil erosion which ultimately promotes soil conservation.
  - ✓ **Keep the soil covered with vegetation or natural material.** Instead of tilling the land, natural farming practices include mulching, planting cover crops for providing benefits like soil improvement through water retention, weed suppression, and erosion prevention and keeping the land as green throughout the year.
  - ✓ **Bio diversity.** Biodiversity helps build healthy soils to better trap water and nutrients, can provide other sources of revenue for the farm, and can benefit pollinators and wildlife. Natural farms incorporate variety of crop rotations, plant multiple species of cover crops together, grow diverse forage in pastures, and maintain permanent vegetation (conservation cover) in some areas of the farm.
  - ✓ **Integrate animals into the farm as much as possible.** Cow dung including available livestock manure can add valuable nutrients to the soil, reducing the need for fertilizers, and permanent pastures can trap large amounts of carbon and water, reducing farm emissions and polluted runoff. Practices include rotational grazing—moving livestock frequently between grass pastures to allow plants time to regenerate—or grazing cover crops.
  - ✓ **Use of on farm inputs/ bio formulations-** On farm inputs based on Traditional Indian Knowledge which includes the usage of desi cow dung and urine are widely practiced in natural farming. Inputs like Jeevamrit and Beejamrit are used for nutrient management and soil enrichment while botanical concoctions like neemastra, Brahmastra etc are used as potential plant protection.
- **Overview of challenges arising in conventional agriculture:**
  - ✓ The development of agriculture during the past centuries and particularly in last decades has entailed depletion of substantive soil carbon stocks which has not only caused soil degradation and reduction in crop yields but also leads to reduction in the carbon content of agro-ecosystems, resulting in loss of biodiversity.
  - ✓ Unsustainable practices like excessive use of heavy machinery for extensive tilling, removal of organic matter followed by overuse of fertilizers and pesticides to maximize food production, has contributed significantly towards loss of O.C., soil fertility, increase in air pollution and soil degradation.
  - ✓ With existing farming practices and by next 50 years, there may not be enough soil left to feed the world.
  - ✓ High input agriculture often resulted in losses of around 5-10 tonnes of carbon per hectare per year (t C/ha/an) from soils. In India, the high intensive use of agro-chemicals in some states is showing even less than 0.5 % of organic carbon.

- ✓ Carbon levels in most agricultural soils have declined over the past 100 years, from some 5 percent to less than 1 percent in many places due to which soil structure, productivity, capacity to infiltrate, retain and sustain water to cool climates has severely reduced.
- ✓ Reports suggests that conventional agriculture is currently responsible for 19–29% of total greenhouse gas (GHG) emissions.

- **Global Approach to various sustainable practices:**

World is nurturing the lands through adoption of various sustainable agricultural practices which may facilitate in mitigating the risks of climate change by reducing emissions from agriculture and by taking carbon dioxide out of the atmosphere and storing it back in plant biomass and soils. Some of the sustainable agricultural practices followed worldwide are:-

1) **Climate Smart Agriculture-** Climate-smart agriculture (CSA) is an approach that helps guide actions to transform agri-food systems towards green and climate resilient practices. It aims to tackle three main objectives:-
   a. Sustainably increasing agricultural productivity and incomes
   b. adapting and building resilience to climate change
   c. reducing and/or removing greenhouse gas emissions, where possible.

   Countries like Brazil, China, Philippines, in various European countries as well as in developing nations are adopting Climate Smart Agriculture. EU expecting impact of adopting CSA by additional 20% farmers by the year 2030**.**

2) **Regenerative Agriculture-** Regenerative agriculture is a holistic farming system that focuses on soil health, food quality, biodiversity improvement, water quality and air quality. It improves soil health through practices that increase soil organic matter, biota and biodiversity. It also aims at enhancing water-holding capacity and carbon sequestration. Countries like USA is widely practicing regenerative agriculture. Baseline here is organic farming and after successful O.F. second step is Reg. Agri.
3) **Natural Farming in Korea-** Korean is also practicing natural farming that involves the culturing and application of indigenous microorganisms (IMO) like bacteria, fungi, nematodes and protozoa in place of inorganic fertilizers to nutrient depleted soils.
4) **Sustainable Development Goals (SDGs):**Sustainable Development Goal no. 12viz., "Ensure Responsible Consumption and Production"calls for an urgent action by all United Nations Member States for promoting sustainable agriculture production practices for ensuring availability of safe and sufficient food for all without disturbing the ecosystem and mitigating the effects of climate change.

According to FAO, soils can sequester around 20,000 lakh tons C in 25 years, more than 10 % of the anthropogenic emissions through identification, promotion and implementation of improved practices in the form of sustainable or regenerative agriculture.

- **India's Strategy to combat the issues of climate change and restoring fertility of soil**
  - ➢ **Adopting Natural Farming:-**

Natural Farming is a chemical-free alias traditional farming method. It is considered as agroecology based diversified farming system which integrates crops, trees and livestock with functional biodiversity.

- **Why Natural Farming**
  - ✓ Natural Farming is considered a form of regenerative agriculture as a prominent strategy to save the planet.
  - ✓ Research indicates that all the major nutrients required for plant growth are available around the root zone and plants are able to take up nearly 98 to 98.5% nutrients from air, water & solar energy and the remaining 1.5% nutrients from soil.
  - ✓ Natural farming is largely based on on-farm biomass recycling with major stress on biomass mulching, use of on-farm cow dung-urine formulations followed by diversifying crop rotations in symbiosis with Nitrogen fixing leguminous crops for efficient recycling of nutrients.
  - ✓ Natural farming helps in increasing farmers income through cost reduction and by reducing risks of crop failure
  - ✓ Natural farming promotes the usage of on-farm prepared inputs from agro-waste thus making the farmers self-reliant
  - ✓ Natural farming eliminates application of synthetic chemical inputs thus provides safe and healthy food which can be affordable to all.
  - ✓ Natural farming enhances resilience byreducing vulnerability to drought, pests, diseases and other climate-related risks and shocks; and therefore improves capacity to adapt and grow in the face of longer-term stresses like shortened seasons and erratic weather patterns.
  - ✓ Natural farming helps in restoration of organic carbon levels in the soil and regenerate the degraded soils and bio-systems thus rejuvenates soil health
  - ✓ Natural farming if practiced professionally can generate employment on account of natural farming input enterprises, value addition, certification and marketing in local areas, etc.
  - ✓ Natural Farming helps in reducing water consumption in which mulch and diverse crops cover the soil to prevent unnecessary water loss through evaporation, thus it optimizes the amount of 'crop per drop'.
  - ✓ Recent researches conducted in UAS Dharwad India revealed that following organic and natural farming have significantly enhanced the carbon content by 2-3g and 1-2g/kg of soils, respectively.

- **Definition of Natural Farming**

  The Ministry of Agriculture and Farmers' Welfare-Definition of Natural Farming (NF) A chemical-free natural farming system wherein use of low-cost inputs (cow dung/urine and plant extract based) coupled with recommended agronomic practices like mulching and intercropping are promoted.

  According to NITI Aayog, Natural Farming can be defined as "chemical- free and live stock based farming". This definition is based on the prevailing practices. Soundly grounded in agro-ecology, it is a diversified farming system that integrates crops, trees and livestock, allowing the optimum use of functional biodiversity.

- **Different Methods of Chemical Free Farming**

  - ✓ Organic Farming
  - ✓ Natural Farming

- **Comparisons with Organic Agriculture**

Organic farming and natural farming are forms of agroecological practices. Sometimes the terms are used interchangeably by farmers in India. Practically, in organic farming, farmers also use off-farm purchased inputs such as biofertilizers, however it is not mandated to use ex-situ inputs in Organic Farming. Natural farming emphasise on the use of bio-inputs prepared in-situ from farm and local ecosystems rather than purchased from outside.

Similarities:

- Natural farming and organic farming are chemical free farming methods.
- Both practices promote non chemical, biological insect and pest control methods.

Differences:

In organic farming, organic fertilisers and manures like compost, vermin-ncompost, cow dung manure, etc. are used and added to farmlands from external sources.

In natural farming, neither chemical nor organic fertilisers are added to the soil. Locally available Plant and Livestock biomass are used to prepare bio-stimulants that are applied to the soil to improve the biochemical properties of soil and to increase the activity of beneficial microorganisms resulting in improved nutrient availability.

Cost of cultivation inorganic farming is still expensive due to the requirement of bulk manures, and it has an ecological impact on surrounding environments; whereas, natural agriculture is an extremely low-cost farming method, completely moulding with local biodiversity.

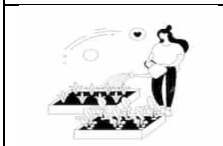
- **Principle of Natural Farming**
  a) Principle of care and maintenance of Panchamahabooth (Soil, Air, Water, Akash and fire/energy)
  b) Principle of Soil as living entity
  c) Principle of integrating plants, animal and human beings.
  d) Principle of Bio diversity, and Sustainable Agriculture
  e) Principle of climate resilient practices

- **Significance of Natural Farming**
  - According to natural farming principles, plants get 98% of their supply of nutrients from the air, water, and sunlight. And the remaining 2% can be fulfilled by good quality soil with plenty of friendly microorganisms. (Just like in forests and natural systems)
  - The soil is always supposed to be covered with organic mulch, which creates humus and encourages the growth of friendly microorganisms.
  - Farm made bio-cultures named ‘Jeevamrit, Beejamrit etc.’ are added to the soil instead of any fertilizers to improve microflora of soil. Jeevamrit, Beejamrit are derived from very little cow dung and cow urine of desi cow breed.
  - It holds the promise of enhancing farmers’ income while delivering many other benefits, such as restoration of soil fertility and environmental health, and mitigating and/or reducing greenhouse gas emissions.
  - The system requires cow dung and cow urine (Gomutra) obtained from Indian breed cow only. Desi cow is apparently the purest as far as the microbial content of cow dung, and urine is considered.
  - In natural farming, neither chemical nor organic fertilizers are added to the soil. In fact, no external fertilizers are added to soil or given to plants whatsoever.

- In natural farming, decomposition of organic matter by microbes and earthworms is encouraged right on the soil surface itself, which gradually adds nutrition in the soil, over the period.
- In natural farming there is no ploughing, no tilling of soil and no fertilizers, and no weeding is done just the way it would be in natural ecosystems.
- Natural, farm-made pesticides like Dashparni ark and Neem Astra are used to control pests and diseases.
- Weeds are considered essential and used as living or dead mulch layer.
- Multi-cropping is encouraged over single crop method.

2. Ecosystem services and Natural Farming

- **Benefits of Natural Farming**

	➢ **Improve Yield:** Farmers practicing Natural Farming reported similar yields to those following conventional farming. In several cases, higher yields per harvest were also reported.
	➢ **Ensures Better Health:** As Natural Farming does not use any synthetic chemicals, health risks and hazards are eliminated. The food has higher nutrition density and therefore offers better health benefits.
	➢ **Environment Conservation:** Natural Farming ensures better soil biology, improved agrobiodiversity and a more judicious usage of water with much smaller carbon and nitrogen footprints.
	➢ **Increased Farmers' Income:** Natural Farming aims to make farming viable and aspirational by increasing net incomes of farmers on account of cost reduction, reduced risks, similar yields, incomes from intercropping.
	➢ **Employment Generation:** Natural farming generates employment on account of natural farming input enterprises, value addition, marketing in local areas, etc. The surplus from natural farming is invested in the village itself.
	➢ **Reduced Water Consumption:** By working with diverse crops that help each other and cover the soil to prevent unnecessary water loss through evaporation, Natural Farming optimizes the amount of 'more crop per drop'.
	➢ **Minimized Cost of Production:** Natural Farming aims to drastically cut down production costs by encouraging farmers to prepare essential biological inputs using on-farm, natural and home-grown resources.
	➢ **Eliminates Application of Synthetic Chemical Inputs:** The overuse of synthetic fertilizers, especially urea, pesticides, herbicides, weedicides etc. alters soil biology and soil structure, with subsequent loss of soil organic carbon and fertility.
	➢ **Rejuvenates Soil Health:** The most immediate impact of Natural Farming is on the biology of soil—on microbes and other living organisms such as earthworms. Soil health depends entirely on the living organisms in it.
	➢ **Livestock Sustainability:** The integration of livestock in the farming system plays a important role in Natural farming and helps in restoring the ecosystem. Ecofriendly bio-inputs, such as Jeevamrit and Beejamrit, are prepared from cow dung and urine, and other natural products.
Ref: https://ncof.dacnet.nic.in/BenefitsNaturalFarming	

- **Ecosystem services and natural farming**

ECOSYSTEMS

living elements which interact with each other and their non-living environments – provide benefits, or services, to the world.

ECOSYSTEM SERVICES

Ecosystem services make human life possible by, for example, providing nutritious food and clean water, regulating disease and climate, supporting the pollination of crops and soil formation, and providing recreational, cultural and spiritual benefits.

BIODIVERSITY

Biodiversity includes diversity within and among species and ecosystems. Changes in biodiversity can influence the supply of ecosystem services. Biodiversity, as with ecosystem services, must be protected and sustainably managed.

Since agriculture, livestock, forestry and fisheries both benefit from and influence ecosystem services, impact goes both ways. These impacts from agriculture, livestock, forestry and fisheries on ecosystem services can be positive or negative, for example:

Positive impact on ecosystem services	**Negative impact on ecosystem services**	**Natural Farming on the balance in comparison to Chemical farming**
Agriculture provides habitats to wild species and creates aesthetic landscapes	Pesticides, as well as landscape homogenisation, can decrease natural pollination	
Forests help maintain healthy aquatic ecosystems and provide reliable sources of clean water	Deforestation or poor management can increase flooding and landslides during cyclones/ mansoon	
Animal excreta can be an important source of nutrients, seed dispersal and can maintain soil fertility in grazed grasslands	Excess of animal excreta and poor management can lead to water pollution and threaten aquatic biodiversity	
Ref:https://www.fao.org/ecosystem-services-biodiversity/en		

- **Ecosystem services and relevance to natural farming**

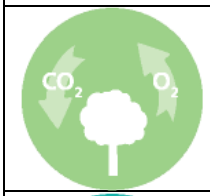
1. Provisioning services

Water, food, wood and other goods are some of the material benefits people obtain from ecosystems called ´**provisioning services**´. Many provisioning services are traded in markets. However, in many regions, rural households also directly depend on provisioning services for their livelihoods. In this case, the services value may be much more important than is reflected in the prices they fetch on local markets.

	**Food** Virtually all ecosystems provide the conditions for growing, collecting, hunting or harvesting food.
	**Raw materials** Ecosystems provide a great diversity of materials including wood, biofuels, and fibers from wild or cultivated plant and animal species
	**Freshwater** No water, no life. Ecosystems play a vital role in providing the flow and storage of fresh water.
	**Medicinal resources** Natural ecosystems provide a variety of plants and mushrooms which offer effective cures for many kinds of health problems. They are used in popular and traditional medicine, and for developing pharmaceuticals.

2. Regulating services

Maintaining the quality of air and soil, providing flood and disease control, or pollinating crops are some of the '**regulating services**' provided by ecosystems. They are often invisible and therefore mostly taken for granted. When they are damaged, the resulting losses can be substantial and difficult to restore.

	**Local Climate Air Quality** Ecosystems influence the local climate and air quality. For example, trees provide shade whilst forests influence rainfall and water availability both locally and regionally. Trees or other plants also play an important role in regulating air quality by removing pollutants from the atmosphere.
	**Carbon sequestration and storage** Ecosystems regulate the global climate by storing greenhouse gases. For example, as trees and plants grow, they remove carbon dioxide from the atmosphere and effectively lock it away in their tissues.
	**Moderation of extreme events** Ecosystems and living organisms create buffers against natural disasters. They reduce damage from floods, storms, tsunamis, avalanches, landslides and droughts.
	**Waste-water treatment** Ecosystems such as wetlands filter effluents, decompose waste through the biological activity of microorganisms, and eliminate harmful pathogens.

	**Erosion prevention and maintenance of soil fertility** Vegetation cover prevents soil erosion and ensures soil fertility through natural biological processes such as nitrogen fixation. Soil erosion is a key factor in the process of land degradation, loss of soil fertility and desertification, and contributes to decreased productivity of downstream fisheries.
	**Pollination** Insects and wind pollinate plants and trees which is essential for the development of fruits, vegetables and seeds. Animal pollination is an ecosystem service mainly provided by insects but also by some birds and bats. In agro-ecosystems, pollinators are essential for orchard, horticultural and forage production, as well as the production of seed for many root and fibre crops. Pollinators such as bees, birds and bats affect 35 percent of the world's crop production, increasing outputs of around 75% of the leading food crops worldwide.
	**Biological control** The activities of predators and parasites in ecosystems that act to control populations of potential pest and disease vector.
	**Regulation of Water Flow** Water flow regulation is a key service provided by land cover and configuration, but its dynamics are poorly understood by most policy makers and land management organizations.

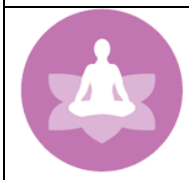
3. Supporting services

Providing living spaces for plants or animals and maintaining a diversity of plants and animals, are '**supporting services**' and the basis of all ecosystems and their services.

	**Habitat for species** Ecosystems provide living spaces for plants and animals; they also maintain a diversity of complex processes that underpin the other ecosystem services.. Some habitats have an exceptionally high number of species which makes them more genetically diverse than others; these are known as 'biodiversity hotspots'
	**Maintenance of genetic diversity** Genetic diversity (the variety of genes between, and within, species populations) distinguishes different breeds or races from each other, providing the basis for locally well-adapted cultivars and a gene pool for developing commercial crops and livestock.

4. Cultural services

The non-material benefits people obtain from ecosystems are called '**cultural services**'. They include aesthetic inspiration, cultural identity, sense of home, and spiritual experience related to the natural environment. Typically, opportunities for tourism and for recreation are also considered within the group. Cultural services are deeply interconnected with each other and often connected to provisioning and regulating services: Small scale fishing is not only about food and income, but also about fishers' way of life. In many situations, cultural services are among the most important values people associate with Nature – it is therefore critical to understand them.

	**Recreation and mental and physical health** Nature-based opportunities for recreation play an important role in maintaining mental and physical health, e.g. walking and playing sports in parks and urban green spaces.
	**Tourism** Enjoyment of nature attracts millions of travelers worldwide. This cultural ecosystem service includes both benefits to visitors and income opportunities for nature tourism service providers.
	**Aesthetic appreciation and inspiration for culture, art and design** Animals, plants and ecosystems have been the source of inspiration for much of our arts, culture, and design; they increasingly inspire science as well.
	**Spiritual experience and sense of place** Nature is a common element in most major religions. Natural heritage, spiritual sense of belonging, traditional knowledge, and associated customs are important for creating a sense of belonging.

Ref: https://www.fao.org/ecosystem-services-biodiversity/en/

3. Soil Health & Nutrient Management

- **What is Soil?**

Technically, the soil is a mixture that contains minerals, organic matter, and living organisms. But broadly speaking, soil can refer to any loose sediment. Moreover, there are many types of soil that are distributed around the world and these are generally classified into the following:

1. Clay Soil
2. Sandy soil
3. Loamy Soil
4. Silt Soil

Typically, the soil consists of 45% minerals, 50% empty spaces or voids and 5% organic matter. Furthermore, soil performs many important functions such as:

5. Providing a growth medium for the plants
6. Acts a modifier of the earth's atmosphere
7. One of the most crucial components of the biosphere
8. Provides habitat for organisms

- **Structure of soil**

The clumping of the soil textural components of sand, silt and clay causes aggregates to form and the further association of those aggregates into larger units creates soil structures called peds. Soil structure affects aeration, water movement, conduction of heat, plant root growth and resistance to erosion. Water, in turn, has its strongest effect on soil structure due to its solution and precipitation of minerals and its effect on plant growth. Texture is defined by the mineral component of a soil and is an innate property of the soil that does not change with agricultural activities, soil structure can be improved or destroyed by the choice and timing of farming practices.

- **Soil Types: Shape and arrangement of peds**

Platy: Peds are flattened one atop the other 1-10 mm thick. Found in the A-horizon of forest soils and lake sedimentation.

Prismatic and Columnar: Prism like peds are long in the vertical dimension, 10-100 mm wide. Prismatic peds have flat tops, columnar peds have rounded tops. Tend to form in the B horizon in high sodium soil where clay has accumulated.

Angular and sub-angular: Blocky peds are imperfect cubes, 5-50 mm, angular have sharp edges, sub-angular have rounded edges. Tend to form in the B-horizon where clay has accumulated and indicate poor water penetration.

Granular and Crumb: Spheroid peds of polyhedrons, 1-10 mm, often found in the A-horizon in the presence of organic material. Crumb peds are more porous and are considered ideal.

- **Soil Water or Soil Moisture**

Water affects soil formation, structure, stability and erosion but is of primary concern with respect to plant growth. Water is essential to plants for four reasons:

- It constitutes 80% - 95% of the plant's protoplasm. It is essential for photosynthesis.
- It is the solvent in which nutrients are carried to, into and throughout the plant.
- It provides the turgidity by which the plant keeps itself in proper position.
- In addition, water alters the soil profile by dissolving and re-depositing minerals, often at lower levels, and possibly leaving the soil sterile in the case of extreme rainfall and drainage.

- In a loam soil, solids constitute half the volume, gas one-quarter of the volume, and water one quarter of the volume of which only half will be available to most plants.

- **Soil Health Management**

Agriculture, globally as well as in India, has witnessed several technological advancements. However, today sustainability of agricultural production systems vis-à-vis environment is a major concern. Soil and crop management practices affect the relationship between soil processes and agro-ecosystem function to a great extent, and thus affect the sustainability of agricultural production systems (Jernigan et al. 2020 and White et al. 2012).

- **Soil health and present day concerns with Soil**

Soil is a fundamental and essential natural resource for existence of all living organisms.

- Soil health or quality is defined as the capacity of a soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality and promote plant and animal health
- A healthy soil would ensure proper retention and release of water and nutrients, promote and sustain root growth, maintain soil biotic habitat, respond to management and resist degradation
- Healthy soil is the foundation of productive, profitable and environment friendly agricultural systems
- Intensive crop cultivation using broadly using imbalanced fertilizer, high nutrient mining through monoculture, decline in organic matter status, deficiencies of secondary and micronutrients, etc. have deteriorated the soil health across the country, resulting into declining crop productivity growth.
- There are 6 major soil types in India- Alluvial soil, Red soil, Black soil, Laterite soil, Arid soil and Forest & mountain soil. Each soil type has its own characteristics in terms of physical and chemical properties, like Alluvial soil is highly fertile, with high phosphorus and potash content. Laterite soil is acidic in nature, while Black soil is rich in potash and magnesium, but poor in phosphorus. Red soil has high iron and potash content but lacks phosphate.
- **Nutrient deficiencies in Indian soils:** Overall, about 59 and 36 per cent of Indian soils are low and medium in available N, respectively. Similarly, soils of about 49 and 45 percent area are low and medium in available P, respectively; while soils of around 9 and 39 per cent area are low and medium in available K, respectively (Chaudhari et al., 2015). Among various soil characteristics that affect the availability and uptake of micronutrients, soil pH and organic carbon content are the two most important factors.

- **Role of Micro-organisms in Nutrient Management**

Microbes can make nutrients and minerals in the soil available to plants, produce hormones that spur growth, stimulate the plant immune system and trigger or dampen stress responses. In general, a more diverse soil microbiome result in fewer plant diseases and higher yield.

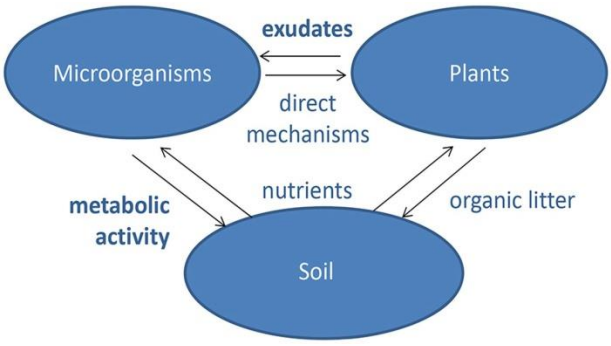
- Soil microorganisms play an active role in soil fertility as a result of their involvement in the cycle of nutrients like carbon and nitrogen, which are required for plant growth.

- For example, soil microorganisms are responsible for the decomposition of the organic matter entering the soil (e.g. plant litter) and therefore in the recycling of nutrients in soil.
- Certain soil microorganisms such as mycorrhizal fungi can also increase the availability of mineral nutrients (e.g. phosphorus) to plants.
- Other soil microorganisms can increase the amount of nutrients present in the soil. The group of bacteria called rhizobia live inside the roots of legumes and fix nitrogen from the air into a biologically useful
- **The microorganisms, which improve the fertility status of the soil and contribute to plant growth, have been termed 'biofertilizers'**
- Several microorganisms have been found to produce compounds (such as vitamins and plant hormones) that can improve plant health and contribute to higher crop yield. These microorganisms are called 'phyto-stimulators'
  Certain native microorganisms present in the soil are antagonistic to pathogenic microorganisms and can prevent the infection of crop plants.
- **Other soil microorganisms produce compounds that stimulate the natural defense mechanisms of the plant and improve its resistance to pathogens. Collectively, these soil microorganisms have been termed 'biopesticides'**
- Azospirillum induces the proliferation of plant root hairs which can result in improved nutrient uptake.
- Mycorrhizae or root fungi form a dense network of thin filaments that reach far into the soil, acting as extensions of the plant roots they live on or in. These fungi facilitate the uptake of water and a wide range of nutrients, thereby improving plant growth and overall health.

- **Beneficial Functions of Soil Organisms:**

Scientists have discovered that soil organisms perform a number of important functions essential for good crop production including:

- Decompose and turn crop residues into fertilizer, humus, carbon dioxide and water and release their nutrients slowly for efficient plant use.
- Improve water absorption, retention, drainage and aeration of the soil creating a better environment for root growth.
- Release insoluble or "tied up" soil and fertilizer minerals and nitrogen,biologically transforming them into forms readily available for plant use.
- Fix atmospheric nitrogen into the soil which plants can use.
- Produce vitamins, amino acids, enzymes, plant growth regulators (auxins, gibberellins, cytokinins) and other biological factors important in crop production.
- Increase the buffering capacity of the soil to hold nutrients and reduce the toxicity of soil and fertilizer salts.
- Produce antibiotic substances that inhibit potential disease producing organisms in the soil.



- **SOM is the prime indicator of soil health**
  - Food source for soil microorganisms
  - Highly decomposed organic matter (humus) provides a storehouse for the exchangeable and available cations.
  - Acts as a buffering agent which checks rapid chemical changes in pH and soil reaction
  - Index of the productivity of the soil
  - Creates a granular condition of soil which maintains favorable condition of aeration and permeability
  - Increases water holding capacity of soil and reduces surface runoff, erosion etc.

- **What is Humus?**

  Humus is dark, organic material formed by decay of plant and animal matter.

- **Process of humus formation:**

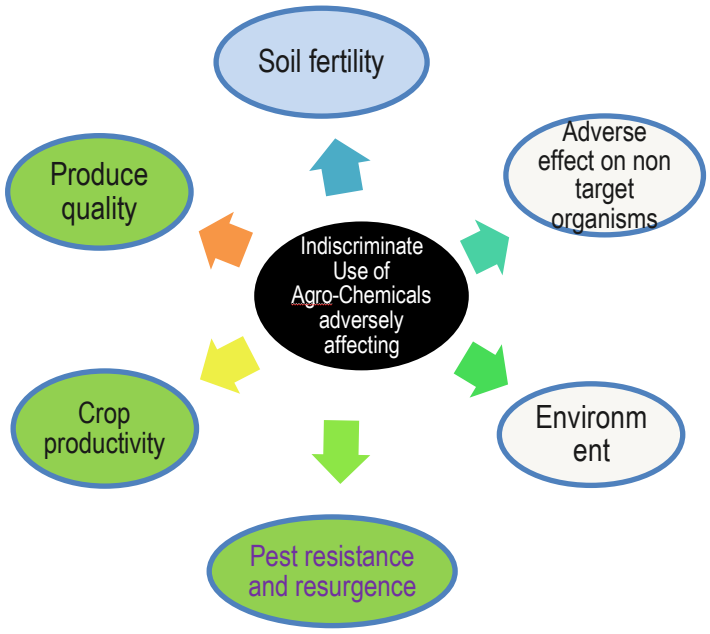
Plants drop leaves, twigs, and other material to the ground. These materials pile up. and form leaf litter. When animals die, their remains add to the litter. Over time, all this litter decomposes/breaks down, into its most basic chemical elements through the process known as **humification**. The thick brown or black substance that remains after most of the organic litter has decomposed is called humus.The humus produced by humification is thus a mixture of compounds and complex biological chemicals of plant, animal, or microbial origin that has many functions and benefits in soil.

- **Humification:**
  - Plant remains, including those that animals digested and excreted, contain organic compounds: sugars, starches, proteins, carbohydrates, lignins, waxes, resins, and organic acids.
  - These organic matters areacted upon by saprotrophic fungi, bacteria, microbes and animals such as earthworms, nematodes, protozoa, and arthropods,
  - Decay in the soil begins with the decomposition of sugars and starches from carbohydrates.
  - Cellulose and lignin decompose more slowly.
  - Proteins, organic acids, starches, and sugars decompose rapidly.
  - Crude proteins, fats, waxes, and resins remain relatively unchanged for longer periods of time.

- **Benefits of Humus:**

  - Makes the soil fertile as it contains many useful nutrients for healthy soil. One of the most important is nitrogen. Nitrogen is a key nutrient for most plants.
  - It helps in suppression of soil –borne diseases
  - It helps the soil retain moisture by increasing microporosity
  - Encourages the formation of good soil structure.
  - Increases availability of plant nutrients
  - Humus are additional sources of nutrients for microbes.

- Humus holds the nutrients present in soiland prevent them from being leached by rain or irrigation.
- Humus can hold the equivalent of 80–90% of its weight in moisture, and therefore increases the soil's capacity to withstand drought.
- The biochemical structure of humus enables it to moderate, i.e. buffer, excessive acidic or alkaline soil conditions.
- During humification, microbes secrete sticky, gum-like mucilages; these contribute to the crumby structure (tilth) of the soil by adhering particles together and allowing greater aeration of the soil.
- Humus can contribute to climate change mitigation through its carbon sequestration potential.



- **Macro and micro fauna, Soil microbes, Soil enzymes**

Soil biological properties viz. microbial populations, enzymatic activity and soil bio-diversity are important indicators of soil quality, and they help in stimulating plant growth by influencing nutrient availability and soil hydro-thermal regime. Soil microorganisms play an essential role in decomposing organic matter, cycling nutrients and fertilizing the soil. Soil microbial activity that reflects microbiological processes of soil microorganisms is the potential indicator of soil quality, as plants rely on soil microorganisms to mineralize organic nutrients for growth and development. Soil microorganisms also process plant litter and residues into soil organic matter, a direct and stable reservoir of carbon and nitrogen that consists of living and dead organic materials subject to rapid biological decomposition. Soil microbes are also important for the development of healthy soil structure. Changes in farming practices are foremost reflected in the changes in biological properties such as microbial populations and soil enzymatic activity. These occupy a pivotal role in reactions associated with organic matter decomposition and nutrient cycling. Soil enzymes have been suggested as one of the important indicator of soil quality, and for evaluating the degree of alteration and assessing the effect of different cropping systems on nutrient dynamics and soil quality (Dick et al.

1994; Bandick and Dick 1999). The soil microorganisms help in replenishing soil fertility, as they are involved in nutrient (Sreenivasa et al. 2009).

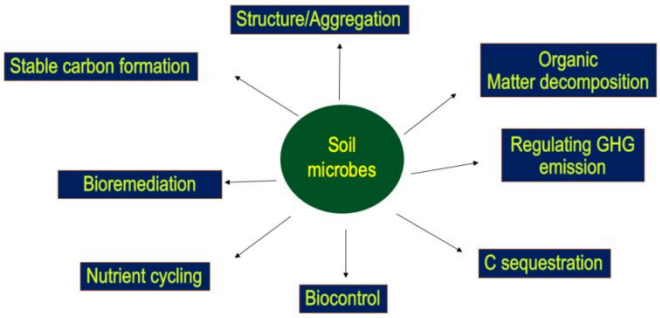
Microbes provide crucial ecosystem services. The microbiota in the soils in which these grow provide nitrogen, phosphorus and other essential nutrients. Microbes in the oceans produce 50% of the oxygen we breathe, and remove roughly the same proportion of carbon dioxide from the atmosphere. They also remove up to 90% of methane from the world's oceans. *Nicole et al (2015), Nature 526, 631–634.*

Beneath the imprint of one's foot, extending down into the soil, are 300 miles of mycorrhizal fungal hyphae. In healthy soil, these fungi together with the full coteries of soil microbes help in regeneration, resilience and revitalization of soil system making all needed nutrients available to the plants through fixation, decomposition, solubilization and mineralization (Phillips 2017)

Non-symbiotic nitrogen fixation appears to be the major source for crop N uptake. An estimated 48% (737Tg) of crop N, equal to 29, 38, and 25 kg ha^{-1} yr^{-1} for maize, rice, and wheat, respectively, was contributed by sources other than fertilizer- or soil-N. Around 370 Tg or 24% of total N in the crop has been estimated to through Non-symbiotic nitrogen fixation, corresponding to 13, 22, and 13 kg ha^{-1} yr^{-1} for maize, rice, and wheat, respectively (Ladha et al 2016).

- **Biogeochemical Functions of Soil Microbes (Jacoby et al 2017)**

  - Plants are part of a rich ecosystem including numerous and diverse microorganisms in the soil.
  - It has been long recognized that microbes play important roles in plant nutrition.
  - However, the full range of microbes associated with plants and their potential to replace synthetic agricultural inputs has only recently started to be uncovered.



- **Role of Earthworms in Nutrient Management**

Earthworm consume biodegradable materials and convert it into rich manure. **Earthworms** "plow" and mix up the soil. Their tunneling loosens the soil so water and nutrients **can** go downward. The nutrients in **worm** castings enrich the soil. The slime they secrete contains nitrogen, an important nutrient for plants.

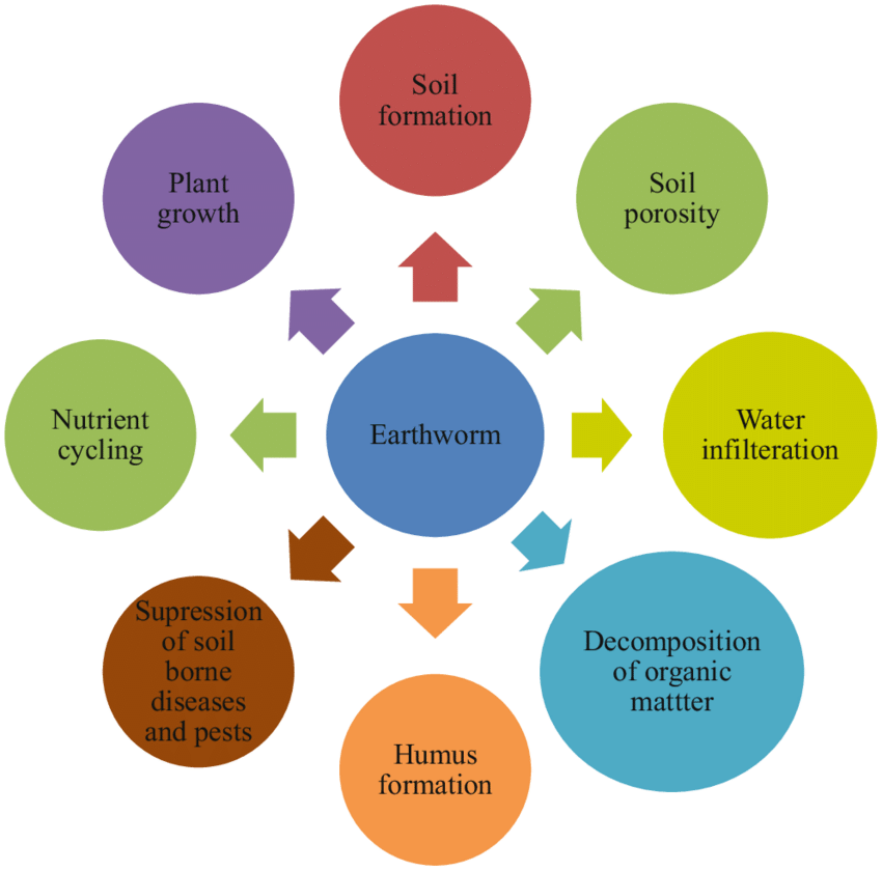
- **Improved nutrient availability**
  Worms feed on plant debris (dead roots, leaves, grasses, manure) and soil. Their digestive system concentrates the organic and mineral constituents in the food they eat, so their casts are richer in available nutrients than the soil around them. Nitrogen in the casts is readily available to plants. Worm bodies decompose rapidly, further contributing to the nitrogen content of soil.

  Improved drainage
  The extensive channelling and burrowing by earthworms loosens and aerates the soil and improves soil drainage. Soils with earthworms drain up to 10 times faster than soils without earthworms. In

zero-till soils, where worm populations are high, water infiltration can be up to 6 times greater than in cultivated soils. Earthworm tunnels also act, under the influence of rain, irrigation and gravity, as passageways for lime and other material.

- **Improved soil structure**
  Earthworm casts cement soil particles together in water-stable aggregates. Upon cast deposition, microbial products, in addition to earthworm mucilages, bind soil particles and contribute to the formation of highly stable aggregates These are able to store moisture without dispersing.
  Research has shown that earthworms which leave their casts on the soil surface rebuild topsoil. In favourable conditions they can bring up about 50 t/ha annually, enough to form a layer 5 mm deep.

- **Improves activities of soil microorganisms**
  They concentrate nutrients and resources that are further used by soil microorganism communities.In addition to this mixing effect, mucus production associated with water excretion in the earthworm gut is known to stabilize SOM through its incorporation and protection in their casts
- **Increase soil pH**
  An important role of EWs is the dramatic increase in soil pH by incorporating organic matter into the soil.



- **What is a Soil Health Card?**

SHC is a printed report that a farmer will be handed over for each of hisholdings.It will contain the status of his soil with respect to 12 parameters,namely N,P,K (Macro-nutrients) ; (Secondary-nutrient) ; Zn, Fe, Cu, Mn, Bo(Micro - nutrients) ; and pH, EC, OC (Physical parameters). Based on this, the SHC will also indicate fertilizer recommendations and soil amendment required for the farm.

- **Importance of Soil Health Card:**

The card will contain an advisory based on the soil nutrient status of a farmer's holding. It will show recommendations on dosage of different nutrients needed. Further, it will advise the farmer on the fertilizers and their quantities he should apply, and also the soil amendments that he should undertake, so as to realize optimal yields.

It will be made available once in a cycle of 3 years, which will indicate the status of soil health of a farmer's holding for that particular period. The SHC given in the next cycle of 3 years will be able to record the changes in the soil health for that sub sequent period.

- **Procedure of sampling:**

Soil samples will be drawn in a grid of 2.5 ha in irrigated area and 10 ha in rain-fed area with the help of GPS tools and revenue maps. Soil Samples will be collected by a trained person from a depth of 15-20cm by cutting the soil in a "V" shape. It will be collected from four corners and the centre of the field and mixed thoroughly and a part of this picked up as a sample. Areas with shade will be avoided. The sample chosen will be bagged and coded. It will then be transferred to soil test laboratory for analysis.

The State Government collect samples through the staff of their Department of Agriculture or through the staff of an outsourced agency. Soil Samples are taken generally two times in a year, after harvesting of Rabi and Kharif Crop respectively or when there is no standing crop in the field.

- **Soil test laboratory:**

It is a facility for testing the soil sample for 12 parameters as indicated in reply to question number 2.This facility can be static or mobile or it can even be portable to be used in remote areas.

The soil sample will be tested as per the approved standards for all the agreed 12 parameters in the following way:

i. At the STLs owned by the Department of Agriculture and by their own staff.
ii. At the STLs owned by the Department of Agriculture but by the staff of the outsourced agency.
iii. At the STLs owned by the outsourced agency and by their staff.
iv. At ICAR Institutions including KVK sand SAUs.
v. At the laboratories of the Science Colleges / Universities by the students under supervision of a Professor / Scientist.

- **Software for generation of soil health cards:**

National Informatics Center (NIC) has developed a web-portal (www.soilhealth.dac.gov.in) for generation of uniform soil health card and fertilizer recommendation.

Information taken from: www.soilhealth.dac.gov.in

4. BIO-INPUTS

Bio inputs are products made from beneficial organisms such as bacteria, fungi, viruses, and insects, or natural extracts obtained from plants, that can be used in agricultural production to control pests, or promote the development of plants. They are products that do not leave toxic residues in the environment and whose use does not imply risks to the health of farmers and consumers.

India is naturally endowed with various types of naturally available organic form of nutrients. This considerably helps in organic cultivation of crops. The potential of biopesticides and biofertilizers for promoting sustainable agriculture has been known for many years. Recycling nitrogen on the farm by using manure and nitrogen fixing plants enhances soil quality, much neglected and least understood soil biology while providing nutrients to the plants. Plants use nutrients from organic sources through mineralization and billions of microorganisms are available in soil for this job. This is the predominant technique of organic and low external input agriculture.

- **Significance of Bio-inputs**

- On farm inputs enable a stable level of organic matter in the soil, which provides many benefits such as:
- Improvement of the soil structure
- Stimulation of the biological activity
- Increase in water retention
- Tillage facilitation
- Plant health
- They can also play a role in protecting crops from pests and diseases (repellent, stimulator of the plant natural defence mechanisms etc)
- The contribution of on farm inputs is an important agro-ecological lever to preserve the agricultural soil quality.

- **Types of Bio-inputs**
  - ✓ **Bio-inputs for Soil Health and Nutrient Management**
  - ✓ **Bio-inputs for Pest & Disease Management**

- **Bio-inputs for Soil Health and Nutrient Management**

There are number of formulations which farmers can prepare on their farm such as:

A. BIJAMRIT

➢ **<u>Ingredients</u>**
- ✓ Cow Dung- 5kg
- ✓ Cow urine- 5L
- ✓ Cow milk- 1L
- ✓ Lime- 50g
- ✓ Water- 20L
- ✓ Healthy soil-50g

➢ **<u>Methodology:</u>**
- ✓ Take 20 litres water.

- ✓ Then take 5 Kg Desi cow dung.
- ✓ Mix it by the fingers.
- ✓ Take it in a cloth and bound it by small rope as a small bundle
- ✓ Hang this bundle of cow dung in the taken 20-litre water for a night (12 hours).
- ✓ Take one litre water and add 50 gm lime in it, let it stable for a night.
- ✓ Then next morning, squeeze this bundle of the cow dung in that water thrice continuously, so that all essence of cow dung will accumulate in that water.
- ✓ Then add a handful of soil in that water solution and stir it well.
- ✓ Then add 5 litre Desi cow urine or human urine in that solution
- ✓ Then add the lime water and stir it well.
- ✓ Keep it overnight for proper fermentation.
- ✓ Now Bijamrita is ready to treat the seeds.

Source:TNAU, Coimbatore and CSKHPKV, Palampur

B. JIVAMRIT

- **Ingredients**
  - ✓ Cow dung- 10kg
  - ✓ Cow urine- 10L
  - ✓ Jaggery- 2kg
  - ✓ Flour of gram (Tur, Moong, Cowpea, Urad) – 2kg
  - ✓ Live soil (Healthy soil)- one handful
  - ✓ Water- 200L

- **Methodology:**
  - ✓ Take 200 litres water in a barrel for one acre crop utilization.
  - ✓ Add 10 kg Cow dung in that water. Mix the desi cow dung in that water by the tips of your fingers well.
  - ✓ Stir it well by a stick clock wise.
  - ✓ Then add broken small pieces of Jaggery.
  - ✓ Again stir it well.
  - ✓ Then Add Pulses flour in that solution.
  - ✓ Then add Desi cow urine
  - ✓ Add handful soil from the bund or forest in that solution.
  - ✓ Stir it well.
  - ✓ Keep the cover of jute bag on the barrel.
  - ✓ Keep this solution quite stable for three days to ferment.

During fermentation, the poisonous gases like Ammonia, Methane, Carbon-mono-oxide, Carbon dioxide, are emitted. Through the holes of jute bag these gases are evacuated in the atmosphere and aerobic fermentation process is going on with the high speed. For that purpose, we have utilized jute bag to cover the barrel.

Stir this solution by the branch of tree thrice a day.

Keep the barrel in shade or shadow. Do not expose Jiwamrita to straight sunlight or rain.

Now *Jiwamrita* is ready for utilization.

- **Uses**

Promoting growth and flowering along with acting as a yield enhancer (@5-10% spray with water)
Soil fertility enhancer (applied along with irrigation water)

Application of Jeevamrit: This mixture should be applied every fortnight. It should be either sprayed directly on the crops or mixed with irrigation water. In the case of fruit plants, it should be applied on individual plants. The mixture can be stored for up to 15 days.

In summer, spray to be done in the early morning or evening. In winter any time of the day can be sprayed. It can also be applied by hand whenever there is a water scarcity problem or no sprayer available, still we can use jeevamrit.

Application

■ First spray one month after seed sowing or transplanting of seedling. Take 100-litre water and add 5 litres of filtered Jeevamrit.

■ Second spray – 21 days after the first spray. 150 litres of water plus 10 litres of filtered jeevamrit.

■ Third spray – 21 days after the second spray, 200 litres of water plus 20 litres of filtered jeevamrit.

■ Fourth spray – When fruits are beginning to show up. 200 litres of water plus 6 litres sour buttermilk can be sprayed for one acre.

Application Method and preparation of semi-solid state jeevamrit

Requirements for semi solid jeevamrit are100 kg cow dung, 5 litre urine, 1 kg jaggery, 1 kg pulse, one handful of soil from the same land. Mix these with a small amount of water. Make small balls out of the mixture. Keep these balls in full sunlight to dry. Now, these dried balls can be kept near the mouth of a dripper or near the sprinkler. When the water falls on the semi-solid jeevamrit, microbes get activated again.

- **Science behind the technique**

Natural Farming argues that the dung of indigenous cows/livestock and undisturbed soil from the field has a huge number of diverse microorganisms which help in increasing the bioavailability of nutrients to the plants. Soil is a complex ecosystem hosting bacteria, fungi, plants, and animals. Soil microbes metabolise recalcitrant forms of soil-borne nutrients to liberate these elements for plant nutrition. In natural ecosystems, most nutrients such as N, P, and S are bound in organic molecules and are therefore minimally bio available for plants. To access these nutrients, plants are dependent on the growth of soil microbes such as bacteria and fungi, which possess the metabolic machinery to depolymerise and mineralize organic forms of N, P, and S have isolated many different bacterial genera such as Citrobacter koseri, Enterobacter aerogenes, Escherichia coli, Klebsiella oxytoca, Klebsiella pneumoniae, Kluyvera spp., Morgarella morganii, Pasteurella spp., Providencia alcaligenes, Providencia stuartiiand Pseudomonas spp. from cow dung found that many cow dung microorganisms have shown natural ability to increase soil fertility through phosphate solubilisation. Isolated 219 bacterial strains from cow dung, among which 59 isolates displayed nematicidal activity against >90 percent of the tested nematodes. Cow dung has an antifungal substance that inhibits the growth of coprophilous fungi.

Source: TNAU, Coimbatore, CSKHPKV, Palampur and UAS, Bangalore

C. GHANAJIVAMRIT

- **<u>Ingredients</u>**
  - ✓ Cow dung- 100 kg
  - ✓ Cow urine- As needed
  - ✓ Jaggery- 1kg
  - ✓ Flour of gram (Tur, Moong, Cowpea, Urad) – 2kg
  - ✓ Live soil (Healthy soil)- one handful

- **<u>Methodology:</u>**
  - ✓ Take 100 Kg Desi cow dung.
  - ✓ Take 1 Kg Jaggery and Make its powder.

- ✓ Then mix it well in that cow dung.
- ✓ Then take 2 Kg flour of pulse and mix it in that cow dung properly.
- ✓ Then mix handful soil from the bund of the farm in it.
- ✓ Then mix this mixture properly.
- ✓ Add some desi cow urine in it if required.
- ✓ Keep it in the shadow for drying for 48 hours.
- ✓ Cover it by gunny Jute bag. Do not expose it to sunlight while drying. Dry it in the shadow.
- ✓ After 48 hours let it to dry in the shadow. After drying crush it properly and then sieve it and store in the gunny bags.
- ✓ Utilize this 200 Kg GhanJivamrit per acre either by spreading out before sowing OR by sowing it with the seeds.

➢ **Application:**

At the sowing period, use 200kg Ghanjeevamrit per acre. Again during the flowering period of the crop, add 50 kg of Ghanjeevamrit in between two crop lines on the soil per acre. It helps the soil to activate their available nutrients, microorganisms to make them available for the crop sown in that particular area. It increases the count of earthworms in soil which is beneficial for soil fertility. Jeevamrit has a large number of nutrients like nitrogen, phosphorus, calcium, and other micronutrients. This will ensure higher yield by enhancing the availability of nutrients through faster decomposition of bulky organic manures by boosting the microbial activity in the soil. Many of these formulations are rich in beneficial micro flora and can act as efficient plant growth promoters.

- **Research Validation : Jeevamrit & Beejamrit**

Jeevamrutham & Beejamrit are is those organic fertilizers which are prepared by using cow dung of indigenous cows. Cow dung of indigenous cows has a huge number of diverse microorganisms which help in increasing the bioavailability of nutrients to the plants.

Cow dung microorganisms have shown natural ability to increase soil fertility through phosphate solubilization. isolated 219 bacterial strains from cow dung, among which 59 isolated is played nematicidal activity against >90 percent of the tested nematodes. Cow dung has an antifungal substance that inhibits the growth of coprophilous fungi.

Jeevamrit has number of nutrients like nitrogen, phosphorus, calcium, and other micronutrients. This will ensure higher yield by enhancing the availability of nutrients through faster decomposition of bulky organic manures by boosting the microbial activity in the soil. Many of these formulations are rich in beneficial micro flora and can act as efficient plant growth promoters. Jeevamrut is a liquid organic manure which is an excellent source of natural carbon and biomass that contains macro and micro nutrients required by crops. that fixes the nitrogen and solubilize phosphorus and also it is a rich source of carbon, nitrogen, phosphorus, potassium and many micronutrients.

- **Bio-inputs for Pest & Disease Management**

A. BRAHMASTRA (broad spectrum botanical pesticide)

➢ **Ingredients**

- ✓ Neem Leaves - 3 Kg
- ✓ Karanj Leaves - 2 Kg
- ✓ Custard Apple Leaves - 2 Kg .
- ✓ Papaya Leaves - 2 Kg
- ✓ Guava Leaves - 2 Kg
- ✓ Cow Urine - 10 Litre

- **Methodology:**

  - ✓ Take 10 liters of cow urine
  - ✓ Add 03 kg of crushed green leaves of neem.
  - ✓ Add 02 kg crushed Karanj Leaves.
  - ✓ Add 02 kg crushed Custard Apple Leaves.
  - ✓ Add 02 kg crushed Papaya Leaves.
  - ✓ Add 02 kg crushed Guava Leaves.
  - ✓ Now dissolve all this mixture in cow urine and and boil it.
  - ✓ After 3-4 boils, take it down from the fire.
  - ✓ Let it cool for 48 hours and then filter the solution with a cloth.
  - ✓ Now Solution is ready to spray on the crop.

- **How to Use?**

  - ✓ 2-3% Spray with water

- **Uses**

  - ✓ For the control of sucking insects and pod/fruit borer.

Source: NCONF, Ghaziabad (2011-12)

B. NEEMASTRA (broad spectrum botanical pesticide)

- **Ingredients**
  - ✓ Neem Leaves - 5 Kg
  - ✓ Cow Urine - 5 Litre
  - ✓ Cow Dung - 1 Kg
  - ✓ Water - 100 Litre

- **Methodology:**

  - ✓ Take five kg of green leaves of neem or take five kg of dried fruits of neem and keep the leaves or fruits crushed.
  - ✓ Add this crushed neem or fruit powder in 100 liters of water.
  - ✓ Put 5 liters of cow urine in it and mix one kg of cow dung.
  - ✓ Stir it with wood and keep it covered for 48 hours.
  - ✓ Dissolve thrice a day and after 48 hours filter the solution with a cloth. Now spray on the crop.

- **How to Use?**

  - ✓ 2-3% Spray with water

- **Uses**

  - ✓ For the management of sap sucking insects and small caterpillars.

Source: NCONF, Ghaziabad (2011-12)

C. AGNEYASTRA

- **Ingredients**

- ✓ Neem Leaves - 5 Kg
- ✓ Green Chilli - 0.5 Kg
- ✓ Garlic - 0.5 Kg.
- ✓ Cow Urine - 20 Litre

➢ **Methodology**

- ✓ Take 20 liters of cow urine
- ✓ Add 05 kg of crushed green leaves of neem.
- ✓ Add 0.5 kg crushed Green Chilli.
- ✓ Add 0.5 kg crushed Garlic.
- ✓ Now dissolve all this mixture in cow urine and and boil it.
- ✓ After 3-4 boils, take it down from the fire.
- ✓ Let it cool for 48 hours and then filter the solution with a cloth.
- ✓ Now Solution is ready to spray on the crop.

➢ **How to Use?**

- ✓ 2-3% Spray with water

➢ **Uses**

- ✓ For insects living in tree trunks or stalks, all types of large bollworms and caterpillars.

- **SOME OTHER PEST CONTROL FORMULATIONS**

Many organic farmers and NGOs have developed large number of innovative formulations which are effectively used for control of various pests. Although none of these formulations have been subjected to scientific validation but their wide acceptance by farmers speak of their usefulness. Farmers can try these formulations, as they can be prepared on their own farm without the need of any purchases. Some of the popular formulations are listed below:

Cow urine

Cow urine, popularly known as "gomutra," is well known for its germicidal, antibiotic, antimicrobial, and medicinal properties that have been evident since ancient times. Nutrient-rich cow urine with nitrogen, potassium, and phosphorous is highly beneficial to soil for dilution and direct application or with formulations and indirect applications. Besides macronutrients, the presence of sulfur, sodium, manganese, iron, enzymes, and chlorine make cow urine an integral natural pest repellent that requires low external input for sustainable agriculture.

Cow urine diluted with water in ratio of 1: 20 and used as foliar spray is not only effective in the management of pathogens & insects, but also acts as effective growth promoter for the crop.

Fermented curd water

In some parts of central India fermented curd water (butter milk or Chaach) is also being used for the management of white fly, jassids aphids etc.

Dashparni extract

Crush neem leaves 5 kg, Vitex negundo leaves 2 kg, Aristolochia leaves 2 kg, papaya (Carica Papaya) 2 kg, Tinospora cordifolia leaves 2 kg, Annona squamosa (Custard apple) leaves 2 kg, Pongamia pinnata (Karanja) leaves 2 kg, Ricinus communis (Castor) leaves2 kg, Nerium indicum 2 kg, Calotropis procera leaves 2 kg, Green chilly paste 2 kg, Garlic paste 250 gm, Cow dung 3 kg and Cow Urine 5 lit in 200 lit water ferment for one month. Shake regularly three times a day. Extract after crushing and filtering. The extract can be stored up to 6 months and is sufficient for one acre.

Neem-Cow urine extract

Crush 5 kg neem leaves in water, add 5lit cow urine and 2 kg cow dung, ferment for 24 hrs with intermittent stirring, filter squeeze the extract and dilute to 100 lit, use as foliar spray over one acre. Useful against sucking pests and mealy bugs.

Mixed leaves extract

Crush 3 kg neem leaves in 10 lit cow urine. Crush 2 kg custard apple leaf, 2 kg papaya leaf, 2kg pomegranate leaves, 2 kg guava leaves in water. Mix the two and boil 5 times at some interval till it becomes half. Keep for 24 hrs, then filter squeeze the extract. This can be stored in bottles for 6 months. Dilute 2-2.5 lit of this extract to 100 lit for 1 acre. Useful against sucking pests, pod/fruit borers.

Chilli-garlic extract

Crush 1 kg Ipomea (besharam) leaves, 500 gm hot chilli, 500 gm garlic and 5 kg neem leaves in 10 lit cow urine. Boil the suspension 5 times till it becomes half. Filter squeezes the extract. Store in glass or plastic bottles. 2-3 lit extract diluted to 100 lit is used for one acre. Useful against leaf roller, stem/fruit/pod borer.

Broad spectrum formulation - 1 –

In a copper container mix 3 kg fresh crushed neem leaves and 1 kg neem seed kernel powder with 10 lit of cow urine. Seal the container and allow the suspension to ferment for 10 days. After 10 days boil the suspension, till the volume is reduced to half. Ground 500 gm green chillies in 1 lit of water and keep overnight. In another container crush 250gm of garlic in water and keep overnight. Next day mix the boiled extract, chilli extract and garlic extract. Mix thoroughly and filter. This is a broad spectrum pesticide and can be used on all crops against wide variety of insects. Use 250 ml of this concentrate in 15 lit of water for spray.

Broad spectrum formulation - 2

Suspend 5 kg neem seed kernel powder, 1kg
Karanj seed powder, 5 kg chopped leaves of besharam (Ipomea sp.) and 5kg
chopped neem leaves in a 20lit drum. Add 10-12 lit of cow urine and fill the drum with water to make 150 lit. Seal the drum and allow it to ferment for 8-10 days. After 8 days mix the contents and distil in a distiller. Distillate will act as a good pesticide and growth promoter. Distillate obtained from 150lit liquid will be sufficient for one acre. Dilute in appropriate proportion and use as foliar spray. Distillate can be kept for few months without any loss in characteristics.

Tutikadarasam

Tutikadarasamis prepared from Datura leaves and cow urine. The leaves are boiled in cow urine for 2-3 hours, cooled and then filtered using cloth.

Sonthastra

Take 2 litres of water, add 200 grams of ginger powder (Sonth) and mix it and cover with a lid. Now boil it till it reduces to half of the solution. Keep this solution for cooling. Take 2 litre milk in another container and boil it slowly on low flame. After boiling milk, allow it to cool down, remove the cream from the milk. Now take 200 litres of water, add a solution of ginger powder and milk without cream. Mix it properly and cover this solution with gunny bags for two hours. During this process ion exchange will occur, filter it with muslin cloth and spray this solution within 48 hours.

Jungle Ki Kanddi

Take kanddi powder (powder of indigenous cow's dung also known as jungle ki kanddi) and keep it in muslin cloth. Tie one end of this bag in the centre of a wooden stick in such a way so that this bag hangs above the centre of the drum filled with 200 litres of water. After this, keep 5 Kg kanddi powder

bags into 200 litres of water drum and leave for 48 hours. Stir this solution two times in a day for 2-3 minutes in the clockwise direction. The colour of the solution will change to a reddish brown colour (Katha/brass colour). After 48 hours, take out this bag and squeeze it, dip it again and then squeeze. Repeat this process three times. Stir this solution properly. Spray this solution within 48 hours. Before spraying, filter this solution.

Reference:

1. **A study on role of jeevamruth in natural farming: a replacement for synthetic fertilizers**

Allu Vishnu Vardhan Reddy1 , Dr. Sandeep Menon2 1M.Sc. Ag. (Agronomy), 2P.H.D in Agronomy 1Department of Agronomy, 1 Lovely Professional University, Punjab, India

2. **Panchagavya and Jeevamrutha : Organic Helpers**

Savan M. Bedva, Harsh S. Hathi*, Shivam A. Purohit and Ankit B. Babariya College of Horticulture, SardarkrushinagarDantiwada Agricultural University, Jagudan, Gujarat, India.

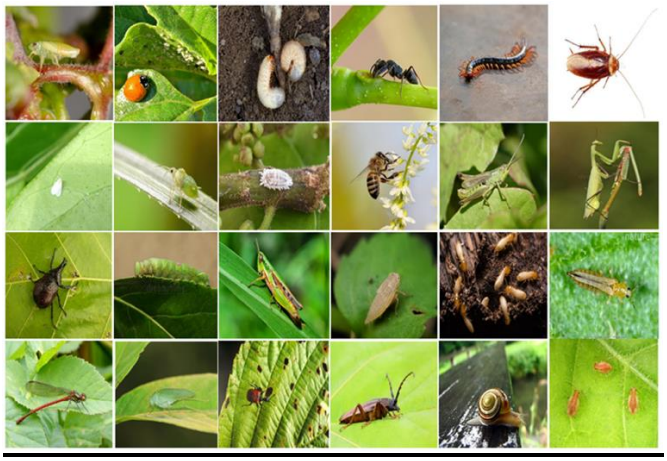
5. Pest and Disease Management in Natural Farming

- **Pest identification**

The major aim for the natural farmer is to create conditions, which keep a plant healthy as a healthy plant is less vulnerable to pest and disease (biotic and abiotic stress) infestation. The way to healthy plant is a healthy soil. A diverse cropping system will not allow an insect to build up to the level where it causes economic damage.

Type of Pests

1. Regular pest- Frequently- Rice stem borer, Pod borer.
2. Occasional – Case worm in rice, Mango stem borer.
3. Seasonal Pests- Red Hairy Caterpillar, Cotton pink bollworm, Mango Hopper.
4. Persistent pests- Round the year- Thrips, Mealy bug, cotton ball worm.



- **<u>Classification based on feeding habit</u>**

1. Polyphagous pests – Helicoverpa/cotton pod borer (Which Feeds on All Type of Plants)
2. Monophagous – Brinjal shoot and fruit borer (BSF) (Which Feeds on Specific Type of Plants)

- **<u>Causes for outbreak of pests</u>**

1. Destruction of forest or bringing forest area under cultivation.
2. Indiscriminate use of pesticides leads to destruction of natural enemies, pest resistance, pest resurgence.
3. Intensive cultivation.
4. Introduction of new crops and verities (many high yielding varieties are more susceptible to insects)
5. Improved agronomic practices (higher ‘N’, close, spacing, weed control etc. improved crop growth and reduced competition for food to the insects)
6. Introduction of new pest in a new area.
7. Accidental introduction of foreign pests (.
8. Large scale storage of food grains (outbreak of stored product pests, rat problem)

http://ecoursesonline.iasri.res.in/mod/page/view.php?id=12435

- **Natural pest management**

Baseline for insect-pest management in natural farming

- A well-managed ecosystem is a successful way of reducing the level of pest or disease population.
- Certain crop varieties have more effective mechanisms than others due to the adaptive nature to the environment and therefore have a lower infection risk.
- Monocropping increases the risk of pest infestation.
- The health condition of a plant depends to a large extent on the fertility of the soil.
- When nutrition and pH is well balanced, the plant becomes stronger and is therefore less vulnerable to infection.
- Climatic conditions, such as suitable temperatures and sufficient water supply, are further factors which are crucial for a healthy plant. If one of these conditions is not suitable, the plant can become stressed.
- Stress weakens the defence mechanisms of plants and makes them easy targets for pests and diseases.
- One of the most important points for a Natural farmer is to grow diverse and healthy plants, which avoids many pest and disease problems.

- **Insect pest management approaches in natural farming**

1. Preventive Measures:

- Selection of varieties which are well adapted to the local environmental conditions (temperature, nutrient supply, pests and disease pressure), as it allows them to grow healthy and makes them stronger against infections of pests and diseases.
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- Selection of safe seeds/ planting material which have been inspected for pathogens and weeds at all stages of production.
- Mixed cropping systems can limit pest and disease pressure as the pest has less host plants to feed on and more beneficial insect life in a diverse system.
- Application of suitable soil cultivation methods facilitates the decomposition of infected plant parts, regulates weeds which serve as hosts for pests and diseases and protects the micro-organisms which regulate soil borne diseases.
- Use of good water management:
- Conservation and promotion of natural enemies
- Most pests or diseases attack the plant only in a certain life stage; therefore, it's crucial that this vulnerable life stage doesn't correspond with the period of high pest density and thus that the optimal planting time is chosen.
- Sufficient distance between the plants reduces the spread of a pest.
- Remove infected plant parts

2. Monitoring:

Regular monitoring of pests, is the basis for effective management. To be able to manage pests, information is needed on the specific pests, present in the region, village or crop fields and the associated damage they cause.

a) Typical signs of pest attacks on crop plants:

Most crop pests belong to the insects, mites and nematodes. Insect damage can be categorized by biting and chewing (e.g. caterpillars, weevils), piercing and sucking (e.g. aphids, psyllids) and boring (e.g. borer, leaf miner) species. Some are slow moving (e.g. caterpillars), fast moving (e.g. fruit flies), hidden (e.g. stem borer), or easy to observe (e.g. caterpillars, weevils).

Pest damage is often species-specific:

- leaves with holes or missing parts is an indication of caterpillar or weevil damage; curled leaves is an indication of aphids; damaged or rotten fruits are often caused by larvae of fruit flies; withering plants can also be caused by larvae of stem borer; and branches or trunks with holes may be an attack by lignivorous insects.
- Mites are very small and cannot be seen with the naked eye. If mites are present on plants, leaves and fruits become yellowish.
- Nematodes are also very small and therefore, they are not easy to observe with the naked eye. They mostly attack plant roots; plants become yellow, wither and die.

3. Curative methods:

A. Promoting & managing natural enemies

The natural enemies of pests are other organisms (fungi, bacteria, viruses, insect predators, and insect parasitoids) which kill pest. Therefore, the natural farmer should try to conserve natural enemies already present in the crop environment and enhance their impact.

This can be achieved with the following methods:

- Minimize the application of natural pesticides
- Allow some pests to live in the field which will serve as food or host for natural enemies.
- Establish a diverse cropping system (e.g. mixed cropping).
- Include host plants providing food or shelter for natural enemies (e.g. flowers which adult beneficial insects feed on).

There are many possibilities to enhance floral diversity within and along the boundaries of crop fields

- **Hedges -** Use indigenous shrubs known to attract pest predators and parasitoids by offering nectar, pollen, alternative hosts and/or preys. Most flowering shrub species have this property. However, care should be taken to not use plant species known to be alternative hosts of pests or diseases.
- **Beetle banks -** Strips of grass in the neighbourhood of crop fields harbour different natural pest enemy groups like carabids, staphylinid beetles and spiders. In order to lower the risk of weeds and plants known as host plants of crop pests and diseases, one to three native grass species can be sown in strips of 1 to 3 m.
- **Flower strips -** Three to five native flowering plant species can be sown in well-prepared seed beds, arranged in strips of 1 to 3 m on the boundary of the crop field. After flowering, seeds can be collected to renew the strip or create new ones.
- **Companion plants -** Natural pest enemies can also be attracted by companion plants within a crop. These companion plant species can be the same as used in the flower strips. A few (1 or 2 per 10 m2) flowering companion plants within a crop serve as a ‘service station’ for natural pest enemies.

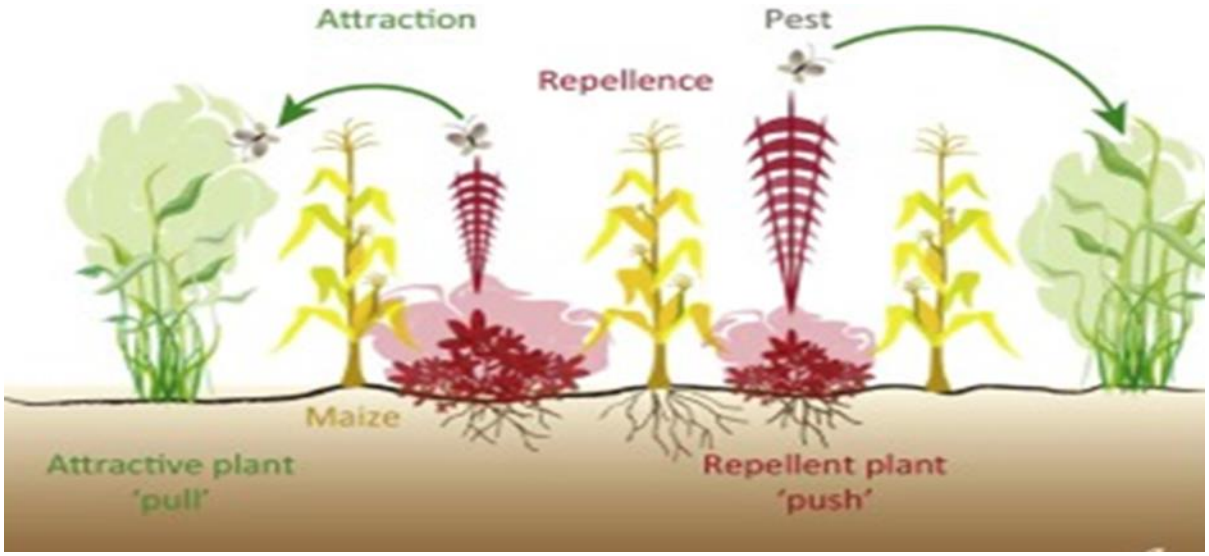


Fig: Enhancing Biological Control

B. Mechanical control:

Mass-trapping of pests is an additional control measure. They often can easily be built with cheap material. Some examples include:

- Light traps can be used to catch moths such as armyworms, cutworms, stem borers and other night flying insects. Light traps are more efficient when placed soon after the adult moths start to emerge but before they start laying eggs. However, light traps have the disadvantage of attracting a wide range of insect species. Most of the attracted insects are not pests. In addition, many insects that are attracted to the area around the light traps (sometimes from considerable distances) do not actually fly into the trap. Instead, they remain nearby, actually increasing the total number of insects in the immediate area.

- Colour and water traps can be used to monitor adult thrips. In some cases,thrips can even be reduced by mass trapping with coloured (blue, yellow or white) sticky traps or water traps in the nursery or field. The colour spectrum of the boards is important for the efficacy of the sticky traps. Bright colours attract more thrips than darker ones. Sticky traps with cylindrical surfaces are more efficient that flat surfaces. They are best placed within a meter of crop level. Traps should not be placed near the borders of fields or near shelter belts. Water traps should be at least 6 cm deep with a surface area of 250 to 500 cm2, and preferably round, with the water level about 2 cm below the rim. A few drops of detergent added to the water ensure that thrips sink and do not drift to the edges and escape. Replace or add water regularly.

- Yellow sticky traps can be used to control whiteflies, aphids and leaf mining flies. Yellow plastic gallon containers mounted upside down on sticks coated with transparent car grease or used motor oil, is one such trap. These should be placed in and around the field at about 10 cm above the foliage. Clean and re-oil when traps are covered with flies. Yellow sticky boards have a similar effect. To use, place 2 to 5 yellow sticky cards per 500 m2 field area. Replace traps at least once a week. To make your own sticky trap, spread petroleum jelly or used motor oil on yellow painted plywood (size 30 cm x 30 cm). Place traps near the plants but faraway enough to prevent the leaves from sticking to the board. Note that the yellow colour attracts many insects. Note that the yellow colour attracts many insect species, including beneficial insects, so use yellow traps only when necessary.

- Bait traps can be used to trap fliesFor example, PE-bottles with small holes can be half- filled with water, some cattle urine, fruit flesh or a small dead fish and a drop of detergent or soapy water. These bottles are then hung in trees and checked every three days.

- Fruit bagging prevents fruit flies from laying eggs on the fruits. In addition, the bag provides physical protection from mechanical injuries (scars and scratches). Although laborious, it is cheap, safe and gives a more reliable estimate of the projected harvest. Bagging works well with melon, bitter gourd, mango, guava, star fruit, avocadoes and banana (plastic bags used).

PLANT BASED CONCOCTIONS AND DECOCTIONS FOR PEST AND DISEASE MANAGEMENT,

If pests and diseases cannot be prevented or controlled by cultural and physical means, it may be necessary to use plant based concoctions and decoctions. Many growers have developed ways of making their own sprays from plants such as garlic, chillies, marigolds and many others. These are inexpensive and have proved to be very effective.

Neemastra:

Neemastra is used to prevent or cure diseases, and kill insects or larvae that eat plant foliage and suck plant sap. This also helps in controlling the reproduction of harmful insects. Neemastra is very easy to prepare and is an effective pest repellant and bioinsecticide for Natural Farming.

Preparation

Crush 5 kg neem leaves in water, add 5 lit cow urine and 2 kg cow dung, ferment for 24 hours with intermittent stirring, filter squeeze the extract and dilute to 100 lit, use as foliar spray over one acre, useful against sucking pests and mealy bugs.

Bramhastra:

This is a natural insecticide prepared from leaves which have specific alkaloids to repel pests.

Preparation

-
- Crush 3 kg neem leaves in 10 lit cow urine.
- Crush 2 kg custard apple leaf, 2 kg papaya leaf, 2 kg pomegranate leaves, 2 kg guava leaves in water.
- Mix the two and boil 5 times at some interval till it become half
- Keep for 24 hrs, then filter squeeze the extract. This can be stored in bottles for 6 months.
- Useful against sucking pests, pod/fruit borers.
- Dilute 2-2.5 lit of this extract to 100 lit for 1 acre.

Dashparni Extract

Dashaparni ark acts as substitute for Neemastra, Bramhastra, and Agniastra. It is used to control all types of pests and used depending on the level of infestation.

Preparation

Crush following plant parts in a 500-lit drum. Take Neem leaves–5 kg, *Vitexnegundo* leaves-2 kg, Aristolochia leaves - 2 kg, Papaya (*Carica papaya*)-2 kg, *Tinosporacordifolia* leaves-2kg, *Annona squamosal* (Custard apple) leaves-2 kg, *Pongamiapinnata* (Karanja) leaves-2 kg, *Ticinuscommunis* (Castor) leaves- 2 kg, *Neriumindicum*- 2 kg, *Calotropisprocera* leaves-2 kg, Green chilly paste-2 kg, Garlic paste-250 g, Cow dung-3 kg, Cow urine-5 lit, Water-200 lit. Crush all the ingredients and ferment foe one month. Keep the drum in shade and covered with gunny bag. Shake regularly three times a day. Extract after crushing and filtering. The extract can be stored up to 6 months and is sufficient for one acre.

Agniastra:

It is used to control all sucking pests and caterpillars.

Preparation

Step 1: Add 200 litre cow urine to a container. Then add 2 kg neem leaves paste, 500 gram tobacco powder, 500 gram green chilli paste, 250 gram garlic paste and 200 grams turmeric powder .

Step 2: Stir the solution in clockwise direction and cover it with a lid and allow it for boiling till we get foam.

Step 3: Remove from fire and keep the vessel under shade, away from direct sunlight for cooling up to 48 hours During this fermentation period stir the components twice a day.

Step 4: After 48 hours, filter with a thin muslin cloth and store it. It can be stored for 3 months.

Application: 6-8 litres of agniastra should be taken and diluted in 200 litres of water for spraying. The following ratio are to be followed based on the severity of pest attack.

- 100 litres of water+ 3 litresofagniastra
- 15 litres of water+ 500 litres of agniastra
- 10 litres of water+ 300 litres of agniastra

Cow urine:

old cow urine diluted with water in ratio of 1:20 and used as foliar spray is not only effective in the management of pathogens & insects, but also acts as effective growth promoter for the crop.

Fermented curd water:

in some parts of Central India fermented curd water (butter milk or Chaah) is also being used for the management of white fly, jassids, aphids etc.

Some Other Formulations which can be used for Pest and Disease Management:

A solution can be made from marigold using water and soap. The liquid acts as a crop strengthener to help potatoes, beans, tomatoes and peas resist blight, mildew and other fungal diseases. It also repels aphids, caterpillars and flies.

Garlic spray is particularly good against army worms, Colorado Beetle, False codling moth, Khapra beetle, Mexican bean beetle and Imported cabbage worm. Garlic can also kill nematodes if soil or batches of soil are drenched with garlic liquid.

- **Non-Insect Pests:**

Other than insects, there are a group of animals known as non-insect pests viz., rodents, birds, mollusks, monkeys, mites, snails, slugs and wild animals are all included that cause significant output losses in agricultural crops.

Management of Non-Insect Pests:

***Cultural control* :** Regular monitoring of crop for pest incidence is essential.

***Mechanical control* :**An effective tool to manage the mites and other small bodied arthropods. A forceful stream of water should be used on where the mite population are high while on the sturdy plants take measures to avoid damage. Mechanical Traps and sound deterrents can be used for managing wild animals and birds.

Use of Deterrents Decoctions: Deterrent and test altering decoctions prepared from bitter smelling and test botanicals and livestock byproducts can be used to protect the crop from non-insect pests.

Mollusks, snails & slugs

Rats, Mice and Rodents

Nematodes

Birds

Wild Animals

Monkeys

Non-Insect Pests

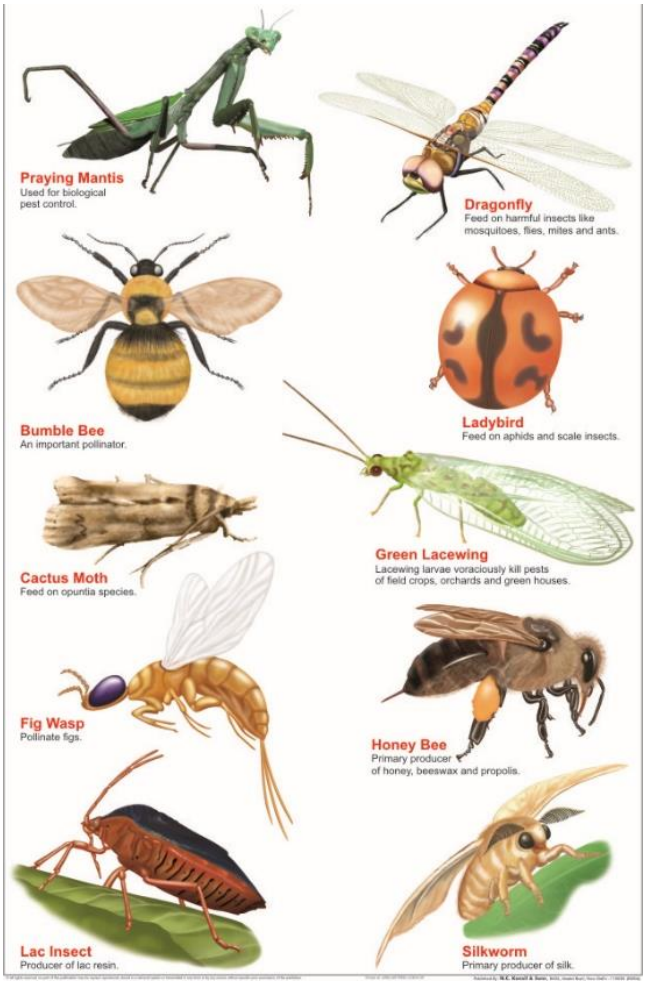
Beneficial Insects:

Beneficial insects belong to three categories: predators, parasitoids, and pollinators.

Predators capture and eat other organisms such as insects or mites. Predators include ladybird beetles andwasps.

Parasitoids are insects that parasitize other insects. The immature stages of parasitoids develop on or within its host, eventually killing it..

Pollinators include honeybees, other wild bees, butterflies, moths and other insects that visit flowers to feed on nectar and pollen. Pollinators transfer pollen in and between flowers of the same species (pollination) which is essential to seed and fruit production for plants.



Beneficial Insects

Plant immunity

Pests and diseases are part of the natural environmental system. In this system there is a balance between predators and pests. This is nature's way of controlling populations. The creatures that we call pests and the organisms that cause disease only become 'pest and diseases' when their activities start to damage crops and affect yields. If the natural environmental system is imbalanced then one population can become dominant because it is not being preyed upon. The aim of natural control is to restore a balance between pest and predator and to keep pests and diseases down to an acceptable level. The aim is not to eradicate them altogether, as they also have a role to play in the natural system. Once a pest or disease has started to attack a crop, the damage cannot be repaired and control becomes increasingly difficult. Where possible, use techniques to avoid or prevent pest and disease attack in the first place.

Resistant varieties and genetic diversity

Within a single crop there can be many differences between plants. Some may be tall, some may be able to resist particular diseases.

There is most variety in the traditional crops grown by farmers. These have been grown and selected over many centuries to meet the requirements of the farmer. Although many of these are being replaced by modern varieties, seeds are often still saved locally.

Crops which have been bred by modern breeding methods tend to be very similar and if one plant is susceptible to a disease, all the other plants are as well. Although some new modern varieties may be very resistant to specific pests and diseases they are often less suited to the local climate and soil conditions than traditional varieties. It can therefore be dangerous to rely too much on any one of them.

A wide variety or "genetic diversity" between the plants within a single crop is important. This helps the crop to resist pests and diseases and acts as an insurance against crop failure in unusual weather such as drought or flood. It is important to remember this when choosing which crops to grow.

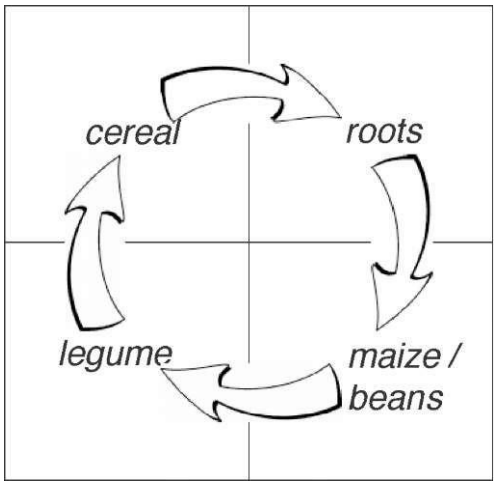
Crop rotation

Growing the same crops in the same site year after year can encourage a build up of pests and diseases in the soil. These will transfer from one crop to the next. Crops should be moved to a different area of land each year, and not returned to the original site for several years. For vegetables a 3 to 4 year rotation is usually recommended as a minimum.

Crop rotation also helps a variety of natural predators to survive on the farm.

A typical 4 year rotation would include a cycle with maize and beans, a cereal and a root crop with either of the following;

1. Grass or bush fallow (a fallow period where no crops are grown).
2. A legume crop where a green manure, which is a plant grown mainly for the benefit of the soil, is grown.



Crop rotation helps to control pests and diseases

With crops such as brassicas and onions which are usually grown in a vegetable garden the whole year round, the populations of certain pests and diseases can keep increasing because there is always a suitable host plant for them. Breaking the cycle can help to solve the problem. This can be done through rotation within the vegetable garden.

Good hygiene

If infected plant material, live or dead, is left lying around, pests and diseases can be passed on to future crops. Debris should be cleared up and disposed of. This can be done by composting the debris. The composting process will kill some pests and diseases and produce compost which is a good soil improver and fertilizer. Some diseases may survive being composted. If in doubt, the infected material should be burnt.

Soil tillage

Many pests spend part of their lives as larvae or pupae in the soil. Ploughing or digging when the soil is dry can reveal the pest and they will dry out and die in the sun, or they can be picked off the ground by hand or birds or other predators. Ploughing can also push the pest deep down into the ground where they will not be able to survive. Ploughing and disturbing the soil should be carefully considered against the harmful effects it may have such as destroying the structure of the soil and causing soil erosion.

Soil pH

The pH (acidity or alkalinity) of a soil can affect some diseases. Changing the pH can reduce the problem.

For example, potato scab is less severe in more acid (pH below 7) soils. A layer of grass mowings added to the bottom of the potato trenches at planting time will make the soil more acid and reduce the disease.

Clubroot is less severe in alkaline conditions (pH above 7) therefore liming the soil to make it more alkaline can reduce the problem.

Timely sowing

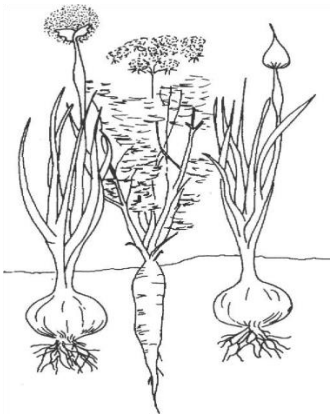
It is often the young of many pests (larvae, caterpillar), rather than the adults, that cause damage to crops. Problems can be avoided by delaying sowing until the egg laying period of a pest is over, or by protecting the plants during this period. It is therefore important to know the life cycle of pests, so that timely sowing can be carried out.

In Ghana, for example, farmers in the forest zone only plant maize in the main rainy season. In the lesser rainy season, the maize is attacked by stem borers.

Companion planting

Companion planting means growing certain plants to protect other plants from pests or diseases. This may be because the pest is deterred by the companion plant, or because it is attracted to the companion plant rather than the crop.

For example onions planted either side of a row of carrots help to deter carrot flies. You need to sow 4 rows of onions for 1 row of carrots. This effect will only last as long as the onions are growing leaves. Many pests avoid garlic, so this can be used very effectively for companion planting with most crops.



Growing onions with carrots to help deter carrotfly

Plants to attract predators and parasites

Similarly to companion planting, which seeks to deter pests from the main crop, attractant plants can be grown to attract predatory insects.

Areas of natural habitat

Bushes and trees are a home for many useful insects and birds. They provide resting areas, shelter and food. Areas of natural habitat can be left around the edges of fields where crops are grown. If these areas are destroyed then there is likely to be an imbalance between the populations of predator and pest.

Specific plants to attract beneficial insects

There are many plants that can be grown to attract natural predators and parasites which will help to keep down pests and diseases.

Flowers such as marigolds *(Tagetes)*, mint *(Mentha)*, sunflower *(Helianthus annus)*,sunhemp *(Crotalaria juncea)* as well as local legumes are useful attractant plants. Hoverflies, whose larvae feed on greenfly are attracted to the flowers of herbs and vegetables such as fennel, celery, dill, carrots and parsnips *(Umbelliferae* family). The nectar and pollen that these flowers provide will help to increase the number of eggs that these insects lay. Umbellifers will also provide food to various parasitic wasps whose young live on aphids and some caterpillars.

Red hot pokers *(Kniphofiauvaria)* are used in parts of Africa to attract birds that eat aphids.

Barriers

Barriers are physical structures put in place to prevent a pest from reaching a plant. They keep pests away from a plant but do not kill them. Here are some examples that you can adapt, depending on the resources available to you:

Crawling insects

Cut the top off a transparent plastic bottle and place it firmly into the ground, over a young plant.

This stops pests such as slugs from reaching the plant.

Using an old plastic bottle to protect a young plant

Climbing insects

To help protect trees from attack by insects, grease bands can be used. Wrap a piece of plastic or a long leaf around the trunk of the tree. Spread any kind of thick grease on top of this. Fold over the top of the foil or plastic to form an overhang to protect the grease from being washed away by rain. Check the grease every week to ensure that the grease is intact. This prevents crawling insects such as ants, fruit fly larvae, slugs, snails, beetles or caterpillars from damaging trees, especially fruit trees, or grain stores.

Termites

Digging a 70-100cm trench around buildings and nurseries can prevent attack from subterranean species of termites. This is a good method of control however it is hard work. Alternatively, barriers can be built. These should be partially above and below ground and should be made from material that is impenetrable to termites such as basalt, sand or crushed volcanic cinders. Particle size of the material is critical, they should not be too large for the

termites to carry away, and not so small that termites can pack the particles to create a continuous passage through which they can move

Bait traps

The use of baits and traps are traditional methods which have become neglected because of the increasing use of chemical pesticides. Here are some examples:

Cutworms

Method one

Mix equal quantities of hardwood sawdust, bran, molasses and enough water to make the solution sticky. Spread around the base of the plants in the evenings. The molasses attract the cutworms and as they try to pass through it they get stuck. The substance dries out in the sun and the pest dies.

Method two

Mix 100 grams (g) of bran, 10g of sugar, 200g of water, 5g of pyrethrum powder. Spread around the base of the plants. The cutworms eat the substance and die.

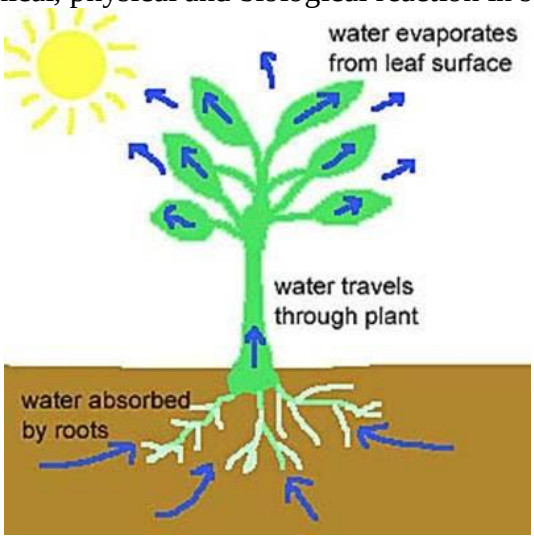
Spread bait around the base of plants to trap cutworms

6. Water management

Where and in which form water exists?,

For Agriculture purpose, water exists in:
Ground Water: Groundwater is the water present beneath Earth's surface in rock and soil pore spaces and in the fractures of rock formations. About 30 percent of all readily available freshwater in the world is groundwater
Surface water: Surface water is water in a river, lake or fresh water wetland. Surface water is naturally replenished by precipitation (Rainfall) and naturally lost through discharge to the oceans, evaporation, evapotranspiration and groundwater recharge. The only natural input to any surface water system is precipitation (Rain fall) within its watershed (Catchment area).
Importance of water in Agriculture and Crop Production:

1. Water is a constituent of protoplasm
2. Water acts as a solvent. Plants can absorb nutrients when these nutrients are dissolved in water
3. Water is used for transpiration carrier of nutrients from the soil to green plant tissues.
4. They are used for photosynthesis and the end product is also conveyed through water to various plant parts
5. Water forms over 90% of the plant body by green or fresh weight basis.
6. Plants can synthesis food through photosynthesis only in the presence of water in their system.
7. Water helps to maintain the turgidity of cell walls. Water helps in cell enlargement due to turgor pressure and cell division which ultimately increase the growth of plant.
8. Water is essential for the germination of seeds, growth of plant roots, and nutrition and multiplication of soil organism.
9. Water is essential in hydraulic process in the plant. It helps in the conversion of starch to sugar.
10. Water helps in the transpiration, which is very essential for maintaining the absorption of nutrient from the soil.
11. Water regulates the temperature and cools the plant.
12. Water helps in the chemical, physical and biological reaction in soil.



So, water is applied externally, if availability seems limited through soil, not sufficient to meet the requirement due to drought or excess losses. We call the external application of water to the soil to supplement the requirement as `**Irrigation**'.
Life in rain-fed areas & water

Rainfed agriculture or area is a type of farming or area that relies on rainfall for water.

- Rain-fed areas produce nearly **90% of millets, 80% of oilseeds and pulses, 60% of cotton** and support **nearly 40% of our population** and **60% of our livestock.**
- These facts present an existing vulnerability to ensuing climate change. The only option we have is being prepared, adapt, and mitigate climate change.
- Rain-fed areas are ecologically fragile and hence vulnerable to climate change and they are also largely inhabited by poorer farmers. But at the same time, rain-fed areas provide nutrition security through millets, pulses and oilseeds.
- Most of the endemic and cultivable land races of these regions are ephemerals. The word 'ephemeral' denotes all plants lasting a very short period of time and they inhabit rain-fed areas.
- Whenever rains come, dormant seeds sprout, flower, seed and disperse their seeds in a short time. Productivity of most of the rain-fed crops is meagre as compared to their irrigated cousins and hence traits of resilience and improved productivity are screened for under rain-fed crop improvement programs
- India is a subtropical country with **15 agro-climatic zones** and primarily dependent on the south-west monsoon.
- Of India's 329 million hectares of geographical area, nearly 140 million hectares are net sown area and out of it 70 million hectares is rain-fed. The average size of Indian farm holdings is about one hectare.

Challenges of Rainfed Agriculture

- **Frequent Droughts:** Droughts and famines are the general features of rainfed agriculture in India.
- **Soil Degradation:** Since the **Green Revolution** of the 1960s, the national agricultural policy is driven by the need to maximize crop yield, using irrigation and intensive use of HYVs, chemical fertilizers, and pesticides.This has been a major challenge in preserving soil in the drier regions and rainfed farming systems.
- To improve production and thus rural livelihoods in rainfed areas, rainfall-related risks need to be reduced, which means that investments in water management are an entry point to unlock the potential in rainfed agriculture.

How do we harvest and retain rainfall in the soil?,

What is rain water harvesting?

The principle of collecting and using precipitation from a catchments surface.

Artifical recharge to ground water:

Artificial recharge to ground water is a process by which the ground water reservoir is augmented at a rate exceeding that obtaining under natural conditions or replenishment. Any man-made scheme or facility that adds water to an aquifer may be considered to be an artificial recharge system or water harvesting system.

Why rain water harvesting :

Surface water is inadequate to meet our demand and we have to depend on ground water.

- Due to rapid urbanization, infiltration of rain water into the sub-soil has decreased drastically and recharging of ground water has diminished.
- Irrigation requirements

Rain water harvesting techniques :

There are two main techniques of rain water harvestings.

- Storage of rainwater on surface for future use.
- Recharge to ground water.

Techniques for water Harvesting :

Pits :- Recharge pits are constructed for recharging the shallow aquifer. These are constructed 1 to 2 m, wide and to 3 m. deep which are back filled with boulders, gravels, coarse sand.

Trenches:- These are constructed when the permeable stram is available at shallow depth. Trench may be 0.5 to 1 m. wide, 1 to 1.5m. deep and 10 to 20 m. long depending up availability of water. These are back filled with filter. materials.

Dug wells:- Existing dug wells may be utilised as recharge structure and water should pass through filter media before putting into dug well.

Hand pumps :- The existing hand pumps may be used for recharging the shallow/deep aquifers, if the availability of water is limited. Water should pass through filter media before diverting it into hand pumps

Recharge wells :- Recharge wells of 100 to 300 mm. diameter are generally constructed for recharging the deeper aquifers and water is passed through filter media to avoid choking of recharge wells.

Diversion of run off into existing surface water bodies

Construction activity in and around the city is resulting in the drying up of water bodies and reclamation of these tanks for conversion into plots for houses.

Free flow of storm run off into these tanks and water bodies must be ensured. The storm run off may be diverted into the nearest tanks or

depression, which will create additional recharge.

Natural resource management

- Crop production is the resultant effect of interaction between different natural resources such as soil, water and weather as well as external inputs like seed fertilizer, energy, management etc.

- Temperature variation in productivity is often witnessed depending upon how these resources are used and managed as reflected in wide spatial and temporal fluctuations with marked peaks and through among different agro-ecological situations or even within the same ecosystem.

- Over exploitation beyond the resource capability or an imbalanced use not in harmony with local situation in an attempt to augment rapid production for meeting the immediate mounting demands of the burgeoning human and animal population with out long term perspective leads to unabated degradation of resource base, loss of biodiversity, decline in total factor productivity in the farming system, and environment deterioration.

- With shrinking per capita land, water, the prevalent increasing demographic trend is putting further enormous strain on the already overburdened resource base.

Natural farming is Farming System which:

- Improves soil quality, while reducing erosion, Stalinization and other forms of degradation to achieve greater resilience to drought, better fertilizer efficiency, and reduced greenhouse gas emissions
- Prohibits use of Synthetic and Market Inputs.
- Employ environmental management systems to ensure proper treatment of solid waste, manure and waste water
- Maintain habitats to support wildlife and conserve biodiversity.

Water and moisture management,

Biological measures (agronomic/agricultural and agroforestry) are applicable in the landscape of ≤ 2 percent slope. These measures reduce the impact of raindrops through the covering of soil surface and increasing infiltration rate and water absorption capacity of the soil resulting in reduced runoff and soil loss through erosion. These measures are cheaper, sustainable, and may be more effective than structural measures. Important agronomic measures favoring soil and water conservation are described below:

Contour farming

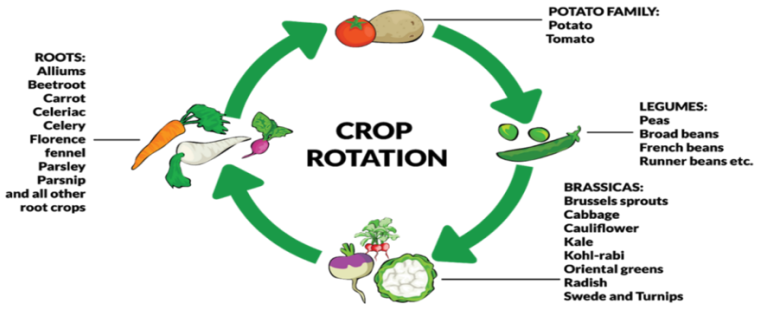
Contour farming is the most common agronomic measures for soil and water conservation in hilly agro-ecosystems and sloppy lands. All the agricultural operations viz. ploughing, sowing, inter-culture, etc. are practiced along the contour line.

The ridges and furrows formed across the slope build a continual series of small barriers to the flowing water which reduces the velocity of runoff and thus reduces soil erosion and nutrient loss. It conserves soil moisture in low rainfall areas due to increased infiltration rate, whereas in high rainfall areas, it reduces the soil loss. In both situations, it reduces soil erosion, conserves soil fertility and moisture and thus improves overall crop productivity. The effectiveness of this practice depends upon rain fall intensity, soil type and topography of a particular locality.

Choice of crops

The selection of the right crop is crucial for soil and water conservation. The crop should be selected according to the intensity and critical period of rainfall, market demand, climate and resources of the farmer. The crop with good biomass, canopy cover, and extensive root system protects the soil from the erosive impact of rainfall and creates an obstruction to runoff and there by reduces soil and nutrient loss.

Crop rotation



Crop rotation is the practice of growing different types of crops in succession on the same field to get benefits for soil and crop systems. Beneficial effects include lower incidence of weeds, insects, and plant diseases, as well as improvements of soil physical, chemical, and biological properties.

Mulching

Mulching is defined as covering of soil surface using eitherlive crops or straw (dead plantbiomass) to conserve moisture, increase infiltration, lower soil temperature around plant roots,prevent soil erosion,improve soil structure, reduce runoff andweed growth.Mulchingprevents the formation of hard crust after each rain.

7. Farming systems and Seed System

Diversity (through integrated farming system)

Introduction:

Diversified farming practices where plant cultivation is preferred in combination with animal/birds/insect rearing, dairy production and or fungal propagation (mostly mushroom production) are referred as Integrated Farming System (IFS). It is also an essential feature of organic and natural farming and is aimed to maximize the net profit out of intensive use of available natural resources. IFS has been adopted and practiced across the globe since the eras as a main source of livelihood. It may also be seen in the wild life with natural integration of flora, fauna, wild mushrooms and microorganisms. Integration of lives in turn proves to be symbiotic, sustainable, complementary, economic and creditable. In the modern time it is being adopted with systematic approaches relying more on scientific evidences of net monetary benefits, sustainability, social obligation and ease of work with use of modern technology, improved inputs and market driven requirements.

Advantages of IFS:

- Higher food production to equate the demand of the exploding population of our nation
- Increased farm income through proper residue recycling and allied components
- Sustainable soil fertility and productivity through organic waste recycling
- Integration of allied activities will result in the availability of nutritious food enriched with protein, carbohydrate, fat, minerals and vitamins
- Integrated farming will help in environmental protection through effective recycling of waste from animal activities like piggery, poultry and pigeon rearing
- Reduced production cost of components through input recycling from the by-products of allied enterprises
- Regular stable income through the products like egg, milk, mushroom, vegetables, honey and silkworm cocoons from the linked activities in integrated farming
- Inclusion of biogas &agro forestry in integrated farming system will solve the prognosticated energy crisis
- Cultivation of fodder crops as intercropping and as border cropping will result in the availability of adequate nutritious fodder for animal components like milch cow, goat / sheep, pig and rabbit
- Firewood and construction wood requirements could be met from the agroforestry system without affecting the natural forest
- Avoidance of soil loss through erosion by agro-forestry and proper cultivation of each part of land by integrated farming
- Generation of regular employment for the farm family members of small and marginal farmers.

Scope of IFS

Post Green Revolution – environmental concerns emerged due to excessive use of chemical inputs and their subsequent declining effect and stagnation in the yields have paved the way for introduction of integrated approaches in farming sector. Integrated methods are the requirement of time and being employed in medical, veterinary and forest sectors also. ICAR and SAUs have demonstrated and documented the success of IFS through their studies in different agro-climatic zones.

SCOPE OF INTEGRATION

Crop Husbandry, Pasture Development, Vegetable Cultivation, Flower Cultivation, Fruit Orchards, Forestry, Mushroom Production, Animal Husbandry, Dairy Production, Fisheries, Bee Keeping, Sericulture, Poultry etc, the major fields of farming may be integrated as per the requirement and profitability.

Some Popular and ICAR recommended IFS models

- Agriculture + Animal Husbandry
- Agriculture + Poultry + Goat/Sheep Husbandry
- Horticulture + Fisheries + Poultry
- Piggeries + Fisheries + Duck Farming
- Agricultural + Silvipasture
- Sericulture + Fisheries
- fish culture + Sericulture
- Agricultural(rice) + Fisheries + Mushroom Production
- Agricultural + Duck Farming + Poultry
- Poultry + Fisheries
- Rice + Fisheries + Vegetable
- Rice + Fisheries + Poultry
- Piggeries/poultry + Fisheries +Vegetable

Source: MPKV

Seed and seed selection

Seed is a basic and vital input for sustained growth in agricultural productivity and production since ninety percent of the food crops are grown from seed (Schwinn, 1994). The seeds that are used to cultivate new crops have to be selected very carefully and of high quality. The good quality seeds can either be bought from different sources or farmers can produce by their own. The selection of seeds is used to improve the quality of yields. During time of sowing a seed in the ground microorganisms (fungi, bacteria, virus etc.) and soil insects tend to exploit it as a food source. Some of these microbes/insects can injure the seed or plant by causing disease and economic damage to plant stands and the plant in general (Taylor and Harman, 1990).

Seed Selection

Mixed seed can lower the market value of the crop. Hence, the source from which the seed is obtained is critical. Good quality seeds are pure, with high germination capacity, uniform seed size, colour and weight, besides being free from seed-borne diseases. The seed viability determines the germination capacity, the stand of the crop and its ultimate yield.

Fig: Different types of seeds

Use of healthy seeds and planting materials, and robust and/or improved cultivars can make a big change in crop production. This practice may require some information on selection of seeds and planting materials including availability of improved varieties and seed treatments. Generally, locally-adapted seeds are preferred because of their resilience to local conditions.

Personally selected seeds or get organic or untreated seeds are to be used. Origin of the seeds to be verified, making sure that they do not come from neighbouring farmers where GM crops are grown, or from farms surrounded by GM crops (minimum distance of at least 1 km). Check for the breeding habits of the specific crops you are interested in. Most cross breeding species such as maize can disperse by wind or bees to distances of up to 1 to 3 km. Seeds of some crops can survive for 5 to 20 years in the soil. Therefore, precautions must be taken that no GM crops have been planted on land that shall be used for organic production. Create protective safety (buffer) zones around your fields to reduce the risk of GMO pollen dispersal, if GM crops are cultivated in this region.

Seed Treatment

Seed treatment is a term that describes both products and processes. Seed treatment refers to the application of certain agents physical, chemical or biological to the seed prior to sowing in order to suppress, control or repel pathogens, insects and other pests that attack seeds, seedlings or Plants. The usages of specific products and specific techniques can improve the growth environment for the seed, seedlings and young plants.

Mode of seed treatment

1) Seed disinfection: Seed disinfection refers to the eradication of fungal spores that have become established within the seed coat, or in more deep-seated tissues.
2) Seed disinfestation: Seed disinfestation refers to the destruction of surface-borne organisms that have contaminated the seed surface but not infected the seed surface. Dips, soaks, seed disinfectant must applied as dust, slurry or liquid have been found successful.
3) Seed Protection: The purpose of seed protection is to protect the seed and young seedling from organisms in the soil which might otherwise cause decay of the seed before germination.

Conditions under which seed must be treated:

i) Injured Seeds: Any break in the seed coat of a seed affords an excellent opportunity for fungi to enter the seed and either kill it, or awaken the seedling that will be produced from it. Seeds suffer mechanical injury during combining and threshing operations, or from being dropped from excessive heights. They may also be injured by weather or improper storage.

ii) Diseased seed: Seed may be infected by disease organisms even at the time of harvest, or may become infected during processing, if processed on contaminated machinery or if stored in contaminated containers or warehouses.

iii) Undesirable soil conditions: Seeds are sometimes planted under unfavourable soil conditions such as cold and damp soils, or extremely dry soils. Such unfavourable soil conditions may be favourable to the growth and development of certain fungi spores enabling them to attack and damage the seeds.

iv) Disease-free seed: Seeds are invariably infected, by disease organisms ranging from no economic consequence to severe economic consequences. Seed treatment provides a good insurance against diseases, soil-borne organisms and thus affords protection to weak seeds enabling them to germinate and produce seedlings.

Benefits of Seed Treatment:

The purpose of any seed treatment is to improve seed performance in one or more of the following ways:

- To eradicate seed-borne pathogens or protect from soilborne pathogens,
- To optimize ease of handling and accuracy of planting (reduce gaps in stand or the need for thinning of seedlings, particularly when mechanical planters are used),
- To improve germination rates.
- Provides protection from storage insects.
- Controls soil insects.

Seed treatment methods:

A. Physical seed treatment

I. Hot water treatment

Method:

- Before hot water treatment, loose seeds are to be pre-warmed in a cheese cloth for 10 minutes at 20^0C water.
- The amount of seed should be just sufficient to allow thorough and immediate wetting.
- Place pre-warmed seed in water bath that will hold the recommended temperature.
- Length of treatment must be 'exact'. It must be carefully and accurately done.
- A few degrees cooler or hotter than recommended may not control the disease or may kill the seed.
- After treatment, dip bags in cold water to stop heating action. Once seeds have cooled, spread them thinly on a sheet to allow drying (Jindal *et al*., 1991).

II. Dry heat treatment:

Dry heat treatment (DHT), a powerful and agrochemical free means of inactivating seed-borne virus and other pathogens.

B.Indigenous methods for seed treatment

I. Panchagavya based Seed treatment

Soaking seeds in 2% Panchagavyawill break the dormancy

II. Biogas slurry based seed treatment:

Seeds should be bundled using a thin cotton cloth and soaked in the biogas slurry for 12 hours prior to the sowing. This will kill all the disease causing microbes and also enhance the seed vigor.

III. Cow dung based seed treatment

Soaking the seeds in cow dung extract enhances the germination capacity.

IV. Cow urine based seed treatment

Soak seeds in a solution of cow's urine (1-part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit the seed borne diseases.

V. Curd based seed treatment :

Soak seeds of pigeon pea / chickpea in curd for 24 – 48 hours before sowing to control wilt disease.

VI. Cow milk based seed treatment:

for good germination and yield.

C. Beejamrit based seed treatment

Add Beejamrit to the seeds of any crop; coat them, mixing by hand; dry them well and use them for sowing. For leguminous seeds, which may have thin seed coats, just dip them quickly and let them dry.

8. Indigenous Traditional Knowledge and Models

Definition:

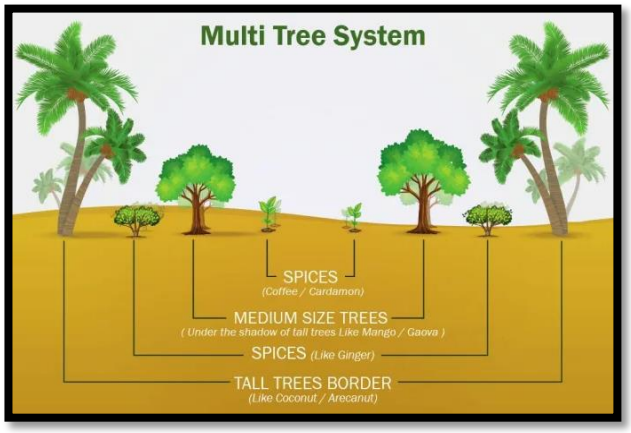
Indigenous Technical Knowledge (ITK) is specifically concerned with actual application of the thinking of the local people in various operations of agriculture and allied areas. Indigenous Knowledge refers to the unique, traditional, local knowledge existing within and developed around the specific conditions of women and men indigenous to a particular geographic area. Indigenous knowledge is the local knowledge - knowledge that is unique to a given culture or society.

Types of multi-cropping models:

Five Layer Model:

Separate one section of land into a break even with squares of 36ft X 36ft. In each, piece of 36ft X 36ft (which is additionally separated into four 9ft X 9ft sub-squares). The sub square portion can be used to grow around 170 trees comprising of 1 banana tree, 4 arecanut trees, 4 black pepper creepers getting on the arecanut trees, 2 coffee plants, 2 gliricidia trees and 32 ginger plants in each 9ft X 9ft space.

Layer 1	Mango and /or Sapota	Trees-Can grow upto 90 feet in height and 80 feet in width	Qty 4 per 36X36 Sq ft plot. We can divide the 1 acre into plots leaving the walking space in between.
Layer 2	Gooseberry/ Oranges/Guava	Trees/Shrubs- Max can grow up to 50 ft.	Qty 1 in centre
Layer 3	Custard Apple/Pomegranate /Lemon	Shrubs-This is even smaller. No more than 20 feet	Qty 20
Layer 4	Castor+ Beans to climb	Plants-Even smaller just 6 ft in height	Qty 20
Layer 5	Drumstick+ Creeper vegetables	Trees must be pruned when 8-12 ft in height	Qty 16 drumstick trees will help in nitrogen fixation for each 9X9 Sq ft plot as subdivided in the 36X36 layered plot.



The five layer model ensures usage of every inch of land and giving forest type resemblance with its five layers.

Multicropping Model:

In multi cropping system, farmers grow **two or more crops** on farmland in one calendar year (unlike mono-cropping, that involves planting only one crop on a field). It includes inter-cropping, mixed-cropping and relay cropping.

- ✓ **Intercropping:** Is growing two or more crops simultaneously in a definite cropping pattern.
- ✓ **Relay cropping:** Relay cropping involves growing of two or more crops on the same field with the planting of the second crop after the first one has reached its reproductive stage.
- ✓ **Mixed intercropping:** It involves growing more than one crop simultaneously **without any distinct row arrangement.**

Multi cropping system is common in **tropical regions** having more rainfall, higher temperatures, and a longer growing season.

Economical Benefits

- **Higher Productivity:** Multiple cropping system is seen as a way to maximize land productivity in a small area by improving the intensity of land and labor use for better profit and stabilizing farm income.
- **Fodder Stock:** Growing multicrops or polycrops ensures enough fodder stocks for cattles.
- **Food Security:** In multi-cropping system, even if one or two crops fail, farmers still be able to harvest other crops to guarantee food throughout the year.
- **Multiple Uses:** Crops don't just yield grains but also fodder and fuel wood.

Agronomic Benefits

- **Pest Management:** Growing a variety of crops together minimizes pest problems and makes efficient use of soil nutrients, water and land.
- **Leguminous** crops when intercropped with other crops, particularly those that require plenty of nitrogen (e.g. young maize plants and sorghum), results into decrease in demands of nitrogen.
- **Weed Management:** It helps to suppress weeds, as weeds find it difficult to grow alongside some crops.
- **Sustainable crop production systems:** This reduces the application of chemical fertilizers and pesticides.

System of Rice Intensification (SRI) Method of Rice Cultivation:

System of Rice Intensification (SRI) is a methodology for increasing the productivity of irrigated rice by changing the management of plants, soil, water and nutrients particularly by eliciting greater root growth.

Nursery area, seed rate and its management:-

- ✓ Nealry, 7-8 kg of seed is required for 1 ha arable field.
- ✓ Nursery should be raised in an area of 100m^2/ha.
- ✓ Raised beds of size 1 x 5 m and 20 in numbers are required for producing rice seedlings sufficient for 1 ha field.
- ✓ Use well decomposed good quality FYM judiciously. Seed treatment can be done with *Pseudomonas* @ 10g/kg seed while consortium of *Azotobacter*, *Azospirillum* and *Phosphobacterium* @75 g /kg seeds should be applied.
- ✓ Uniformly spread 375 g of seeds in each 5 sq.m. nursery bed.
- ✓ Watering through rose can is advisable.
- ✓ Cover the seed bed using locally available mulching materials like coirpith/straw

Seedling age

- ✓ Fourteen days old seedlings were recommended for transplanting (3 leaves stage)
- ✓ If the nursery bed is properly prepared with sufficient organic manure, the seedling growth will be good.

Main field preparation

- ✓ Plough the land during summer to economize the water requirement for initial preparation of land.
- ✓ Flood the field 1 or 2 days before ploughing and allow water to soak in. Keep the surface of the field covered with water.
- ✓ Keep water to a depth of 2.5 cm at the time of puddling.
- ✓ Good leveling of the main field is essential in SRI. Field drainage is an important component in SRI.

Water Management

- ✓ Irrigate only to moist the soil in the early period of 10 days.
- ✓ Restoring irrigation to a maximum depth of 2.5cm after development of hairline cracks in the soil until panicle initiation.
- ✓ Increasing irrigation depth to 5.0 cm after Panicle initiation one day after disappearance of ponded water.
- ✓ SRI method is suitable for dry season with assured irrigation, however difficulties have been observed in crop establishment in areas with heavy downpour.

Seed rate in Field

- ✓ 7- 8 kg / ha for single seedling per hill

Transplanting

- ✓ The seedling along with the soil intact with the roots should be removed and plant them immediately.
- ✓ Fourteen days old seedlings were recommended for transplanting. At this stage the seedling will have 3 leaves.

- ✓ If the nursery bed is properly prepared with sufficient organic manure, the seedling growth will be good.

Plant spacing

- ✓ Square planting at 25 x 25cm ensures optimum space for efficient utilization of resources.
- ✓ Place single seedling at intersecting points marked with the marker.
- ✓ Place the seedling without plunging too deep into the soil.

Nutrient Management

- ✓ Apply 12.5 t of FYM or compost or green leaf manure @ 6.25 t/ha.
- ✓ Organic manures addition is recommended in SRI cultivation, as they are found to supply essential nutrients, and creates favorable conditions for soil microbes being a source of carbon.
- ✓ Apply fertilizer nutrients as per soil test recommendations.

Water Management

- ✓ Regular water application to keep soil moist but not saturated.
- ✓ Intermittent wetting and drying for adequate aeration during vegetative phase.
- ✓ Relatively frequent watering after vegetative phase.
- ✓ No water stagnation at any stage.

Differences between conventional and SRI method of cultivation

Practices	Component	Conventional	SRI
Nursery (to plant/ ha)	Area Seed rate (kg /ha)	800 m^2 Recommended: 60 kg/ha	100 m^2 7-8 kg/ha
		Farmers' practice: 125 – 150 kg/ha	
Planting	Seedling age	21+	14
	Number of seedlings/ hill	2-3 +	1
	Method	Recommended:Rectangular	Square
		Farmers' practice:Random	
	Spacing	Recommended: 15 x 10 cm (105 – 115 days crop) 20 x 10 cm (135-155 days crop)	25 x 25 cm
		Farmers' practice : Variable	
	No. of hills/ metre square	66 / 50 / ±	16
Irrigation	Recommended	Irrigate to 5 cm depth one day after the disappearance of ponded water	Irrigate to 2.5 cm depth (after hairline crack formation up to panicle initiation and after disappearance of Ponded water).
	Farmers' practice	Flooding (Variable depths)	
Weeding	Recommended	Pre-emergence herbicide + hand weeding at 30 DAT (or) hand weeding at 15,30 DAT	Using rotary / cono weeder in between rows in both directions at 10, 20, 30 and 40 DAT and hand removal of left out weeds.

Cost of Comparision
Cost of Cultivation

Sl.No	Details	Total Expenditure (Rs. / Ha)	
		Conventional	SRI
1.	Nursery	2100	681
2.	Main field preparations	2005	2005
3.	Manures and Fertilizers	7254	7254
4.	Transplanting	2400	3200
5.	Weeding	3200	3200
6.	Irrigation	300	240
7.	Plant Protection	660	660
8.	Harvest	3500	3500
	Total	**21419**	**19060**

Rice Fish System:

A rice-fish system is an integrated rice field or rice field/pond complex, where fish are grown concurrently or alternately with rice. Fish may be deliberately stocked (fish culture), or may enter fields naturally from surrounding water ways when flooding occurs (rice field fisheries), or a bit of both. Fish yields can range widely from of 1.5 to 174 kg/ha/season depending on the type of rice fish system, the species present, and the management employed.

Species of fish commonly found in rice-fish systems

The most common indigenous fishes found in Asian rice fields are the following:

White fish (small plant or plankton eating species) such as Danios (Rasbora), Barbs (Puntius), Snakeskin Gourami (Trichogaster), and Half beaks (Xenentodon). Black fish (often carnivorous air breathers that can survive low or no oxygen levels) such as Snakehead (Channa), Catfish (Clarias), Climbing Perch (Anabas), Spiny eels (Mastacembelus), and Sheatfish (Ompok). Also, exotic fish species such as Common Carp (Cyprinus), Tilapia (Oreochromis), and Silver carp (Hypophthalmichthys) along with other wild aquatic species such as crabs, shrimp, snails, and insects may also be harvested.

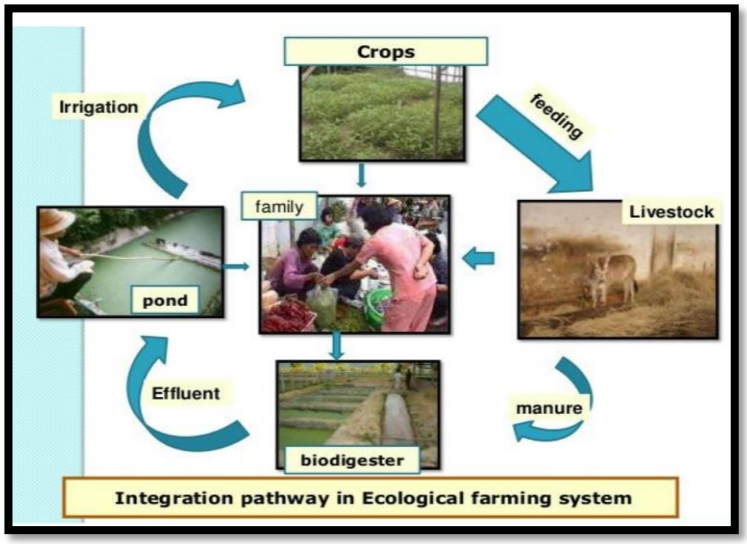
Management of rice field fisheries

Wild fish can be encouraged to enter rice fields by keeping entrances to fields open, and bunds low. They can be attracted by placing branches in the field which provide shelter for the fish or by placing buffalo or cow skins to attract catfish and eels. Wild fish may be harvested from rice fields by netting, hooking, trapping, harpooning, throwing nets, or by draining the field. As water levels fall, fish may be

channeled into adjacent trap pond areas where they can be held alive until required. Fish can be stocked at rates of 0.25−1 fish/m^2.

Integrated Farming with allied activities:

Integrated Farming System (IFS) also defined as biologically integrated farming system which integrates natural resources and regulation mechanisms into farming activities to achieve maximum replacement of off-farm inputs, secures sustainable production of high quality food and other products through ecologically preferred technologies, sustain farm income, eliminates or reduces sources of present environment pollutions generated by agriculture and sustains the multiple function of agriculture.



Options avaialble for agri-allied farming system are as follows:-

1. fruit orchard
2. dairy
3. goatery
4. poultry
5. piggery
6. aquaculture
7. mushroom
8. apiary
9. bio-gas
10. sericulture
11. roof –top gardening
12. compost yards
13. kitchen garden
14. boundary / bund plantation
15. agroforestry
16. horti – pasture
17. and processing and value addition of marketable surplus products.

These modules can be selected by the farmers based on the resource availability such as land, labour and capital for investment. By reduction of cost of production of component, the profitability per rupee invested is enhanced. Changes are compulsorily made in all components of farming systems by way of introducing new crops, livestock species and product or processing techniques aiming to increase the income of the family with external resource.

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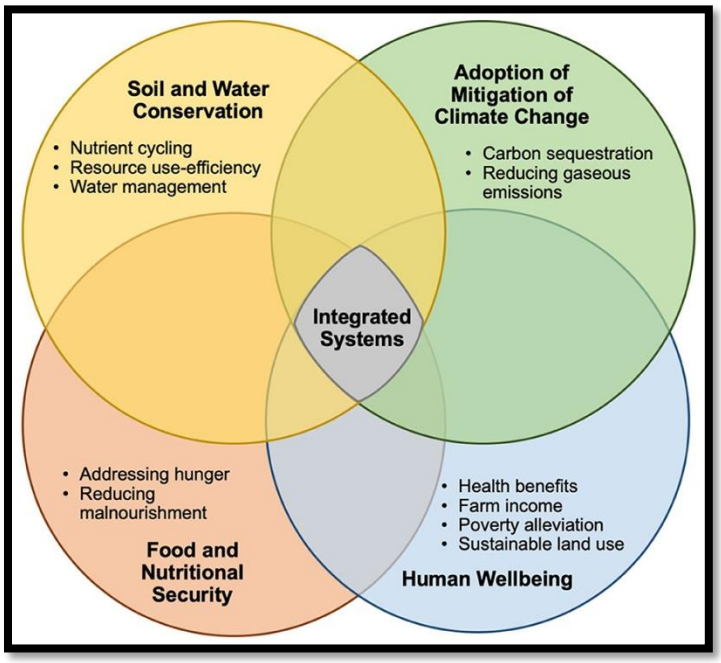
9. Crop and Livestock Integration

Crop and livestock integration - As a principle of agro-ecology, it consists of a range of resource-saving practices that favors an efficient recycling of natural resources by creating a beneficial synergy between crop and livestock production, thus using the outputs of one system as inputs or resources for the other system. This integration is based on four main pillars:



1) Feeds produced from crop production used in favor of animal production (forage crops, crop residues, fallow), etc.
2) Livestock as source of diverse food and nonfood products, such as milk, meat, honey, wool, leather and eggs, and sources of biogas fuel etc.

3) Transport and draught power in favor of crop production and other farming activities, such as tillage, irrigation, sowing, weeding, transport of harvest, etc.

4) Livestock as inputs for farming activities, such as manure, pasture management, and animal trampling enhancing soil structure by breaking up the hard soil crusts.

CRITICAL ASPECTS TO BE CONSIDERED IN CROP AND LIVESTOCK INTEGRATION

- **Suitability of the farm for Integrating Crop & Livestock**-Before engaging in any crop and livestock integration, there is need to assess farm suitability in terms of space for animal shedding and grazing, sufficient fodder or by-products to feed, sufficient know-how on keeping, feeding, and treating the specific kind of animals.
- **Benefice of the Integration**-Assess whether the integration allows the livestock to fulfil its input and output functions (utilization of animal manure, use of animal products for own consumption or sales).
- **Access to Livestock inputs**-It is important to have sufficient labor available inside and outside the farming system, enough fodder and water of good quality, veterinary support, and suitable breeds of animals.
- **Animal Population**-When defining the number of farm animals, keep in mind that the economic benefit will be higher when fewer animals are kept, and fed well.
- **Animal Selection**-The criteria of animal selection include feeding requirements, growth duration, production potential, adaptability to local conditions, use of livestock outputs for food and non food benefits.

AGRO-ECOLOGICAL PRINCIPLES FOR CROP AND LIVESTOCK INTEGRATION

- **Adapt Livestock Production to the Local Ecosystem**-Livestock productions whose requirements are suitable for the resources available locally, breeding of suitable local species, respectful of local agro-ecological and social conditions.

- **Promote Livestock System that uses Local Resources**-Production and use of animal feeds on the farming system, production of organic matters on the farm, possibility of livestock and crop diversification
- **Integrate Forage Crops and Trees in The Farming Systems**-Promote crop rotation, crop association and agroforestry that include production of animal feeds and forage crops and trees.

Crop and livestock integration presents the following agronomic, social, economic and ecologic advantages

- ✓ It improves space utilization and increases productivity per unit area
- ✓ It provides diversified products, thus enhancing food security and nutrition
- ✓ It provides coping and risk management strategies (animals as "banks on hooves" allow to raise money in times of need
- ✓ It improves soil fertility and soil physical structure from appropriate crop rotation and using cover crop and organic compost
- ✓ It reduce weeds, insect pests and diseases through animal grazing and crop rotation
- ✓ It recycles and utilizes crop residues and livestock wastes
- ✓ It strengthens farmer's autonomy (less reliance to external inputs – fertilizers, agrochemicals, feeds, energy, etc.)
- ✓ It allows higher net returns to land and labour resources of the farming family

Conclusion:

Livestock have been integrated into crop production systems for much of agriculture's history, providing fertility, weed and pest control, and residue breakdown. Livestock can also provide an additional revenue stream for farmers, creating cash flow year round or providing income in the years before a perennial crop starts producing. Livestock, however, can also introduce sources of contamination, creating food safety concerns, especially for farmers growing crops that are eaten fresh, like many fruits and vegetables.

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10. Health and Nutrition

Overview

Consuming a healthy diet throughout the life-course helps to prevent malnutrition in all its forms as well as a range of non-communicable diseases (NCDs) and conditions. However, increased production of processed foods, rapid urbanization and changing lifestyles have led to a shift in dietary patterns. People are now consuming more foods high in energy, fats, free sugars and salt/sodium, and many people do not eat enough fruit, vegetables and other dietary fibre such as whole grains.

The exact make-up of a diversified, balanced and healthy diet will vary depending on individual characteristics (e.g. age, gender, lifestyle and degree of physical activity), cultural context, locally available foods and dietary customs. However, the basic principles of what constitutes a healthy diet remain the same.

Dietary Diversity:-

Dietary diversity is a qualitative measure of food consumption that reflects household access to a variety of foods, and is also an estimation of nutrient adequacy of the diet of individuals.

Objective of dietary diversity:

- ✓ The household dietary diversity reflects the economic ability of a household to access a variety of foods. Studies have shown that an increase in dietary diversity is associated with socio-economic status and household food security.
- ✓ Individual dietary diversity aims to reflect nutrient adequacy. Studies in different age groups have shown that an increase in individual dietary diversity score is related to increased nutrient adequacy of the diet.
- ✓ Dietary diversity scores have been validated for several age/sex groups as estimation measures for macro and/ or micronutrient adequacy of the diet.

Healthy Diet Plan:

For adults, a healthy diet includes the following:-

- ✓ Fruit, vegetables, legumes (e.g. lentils and beans), nuts and whole grains (e.g. unprocessed maize, millet, oats, wheat and brown rice).
- ✓ At least 400 g (i.e. five portions) of fruit and vegetables per day, excluding potatoes, sweet potatoes, cassava and other starchy roots with less than 10% of total energy intake from free sugars which is equivalent to 50 g (or about 12 level teaspoons) for a person of healthy body weight consuming about 2000 calories per day, but ideally is less than 5% of total energy intake for additional health benefits. Free sugars are all sugars added to foods or drinks by the manufacturer, cook or consumer, as well as sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates. Similarly, less than 30% of total energy intake from fats. Unsaturated fats (found in fish, avocado and nuts, and in sunflower, soybean, canola and olive oils) are preferable to saturated fats (found in fatty meat, butter, palm and coconut oil, cream, cheese, ghee and lard).

Promoting healthy diets through establishment of nutri-gardens

Vegetable based nutri-garden is the richest source of nutrition and can play an active role in eradicating under-nutrition. Nutri-garden is advanced form of kitchen garden in which vegetables are grown as a source of food and income in a more scientific way. For small and marginal farmers, nutri-garden can contribute to the family diet and provide several other benefits, particularly for women. According to Indian Council of Medical Research (ICMR, 2010) recommendation for vegetable consumption includes consumption of 300 gm of vegetable per person per day which comprises 50 g leafy vegetables; 50 g root vegetables and 200 g other vegetables.

Setting up a nutri-garden

Usually a nutri-garden can be established in the backyard of house where there is enough water availability. In hills, nutri-gardens should be maintained near house so that it can be protected from animal damage which plays havoc in the region. A rectangular garden is preferred to a square plot. Nearly 200 m² land is sufficient to provide vegetables throughout the year for a family consisting of five members. Layout and crop allotment in nutri-garden can be modified depending on climatic and seasonal changes.

- Perennial vegetables should be allotted to one side of the garden so that they may neither create shade for the remaining plot nor they interfere with intercultural operations. Shade loving vegetables may be planted in perennial plots. Compost pits can be provided on the corner of nutri-garden for effective utilization of kitchen waste.
- After allotting areas for perennial crops, remaining portions can be divided into 6-8 equal plots for growing annual vegetable crops.
- By following scientific practices and crop rotation, two to three annual crops can be raised in the same plot. For effective utilization of plot accession cropping, inter cropping and mixed cropping can be followed.
- Walking path should be provided at the center as well as along four sides. Since fresh vegetables from garden are directly utilized for consumption, organic manure should be used which is abundant in villages. However, in order to harvest good crop free from pest and diseases, neem based formulations can be utilized in limited amount.
- It is important that preference should be given to long duration and steady yielding crop varieties than high yielding ones.
- A bee-hive may also be used for a plot of 200 m² for ensuring adequate pollination in crops besides obtaining honey.

Conclusion

- Nutri-gardens are cornerstone in traditional farming systems, since time immemorial but with time, it has lost its importance. Myriad coloured vegetables into the daily diet will enhance the

individual's ability to fight diseases and improve immunity. Also innumerable phytochemicals in a range of fresh fruits and vegetables act as anti-oxidant, anti-allergic, anti-carcinogenic, anti-inflammatory, anti-viral and anti-proliferative. Nutri-gardens are also very much essential in places and villages which are isolated and far from the local market. Awareness campaign regarding the proper nutrition, nutri-gardening, dietary habits, should be demonstrated in the rural and remote areas. Nutri-gardening is one of the advantageous ways to improve nutrition level in women with minimum investment.

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11. Farmer Field School

❖ What is Farmer Field School (FFS)?

Farmer Field School (FFS) is an agricultural school of farmer which is conducted by the farmers on their own fields. This is research based learning through non formal education. FFS provide opportunities for learning by doing. Because,

"If I hear it, I forget it. If I see it I remember it. If I discover it, I own it for life."

❖ Objectives

- Empowering farmers with knowledge and skills.
- Making farmers experts in their own fields.
- Empowering farmers to solve their field problems by themselves.
- Helping farmers how to organize themselves and their communities to become sound socially and economically.

❖ Essential Elements of FFS

a) The Group

The group consist of individuals (50-100 farmers) with common interests, forms the core of farmer field school.

b) The Field

The field is the trainer which has facilities of training materials like seed, on farm resources like cow dung, cow urine, pests and natural enemies, raw materials required for demonstration. In most cases, the groups provide a study site with a shaded area for follow-up discussion.

c) The Facilitator

The facilitator is a technically competent person who leads group members through the hands-on exercise. The facilitator can be an extension officer of ATMA, KVK, champion farmer, master trainer trained by MANAGE and NCONF. The facilitator facilitates the activities to arrive on conclusion.

d) The curriculum

The curriculum developed by NCONF consists the natural cycle of the Natural Farming, be it habitat, crop, animal, soil, on farm formulations, pest and disease etc. This allows all aspects of Natural Farming to be covered in parallel with what is happening in the FFS field.

e) Programme Leader

The programme leader is essential to support the training of facilitators, get materials organized in local language for the field, and solve problems in participatory ways and nurture facilitators. The programme leader should be good leader who empowers others.

❖ Steps in Conducting FFS

a) Ground Working Activities:

- Identify priority problems
- Identify solutions to identified problems

- Establish Farmers Practices
- Identify Field School participants
- Identify Field School Sites

b) Training of Facilitators (by MANAGE & NCONF):

- Crop / Livestock production and protection technologies in Natural Farming
- Preparation and application of different formulations and concoctions.
- Certification, Branding, Packaging and Marketing of produce.

c) Establishment and running FFS:

- With the guidance of facilitators, the group meets regularly throughout the season.
- Carries out experiments and field trials related to Natural Farming.
- And validates the test and trials carried by them.

d) Field Days:

- During the period of FFS, 1-2 field days are organized where the rest of the farming community is invited to share what the group has learned in the FFS. Farmers themselves facilitate during this day.

e) Graduations:

- This marks the end of the season-long FFS. It is organized by the farmers, facilitators and the coordinating office. Farmers are awarded certificates after 6-12 months.

f) Farmer run FFS:

- FFS farmer graduates now have the knowledge and confidence to run their own FFS.

g) Follow up by facilitators:

- The core facilitators will take follow up of FFS run by farmers.

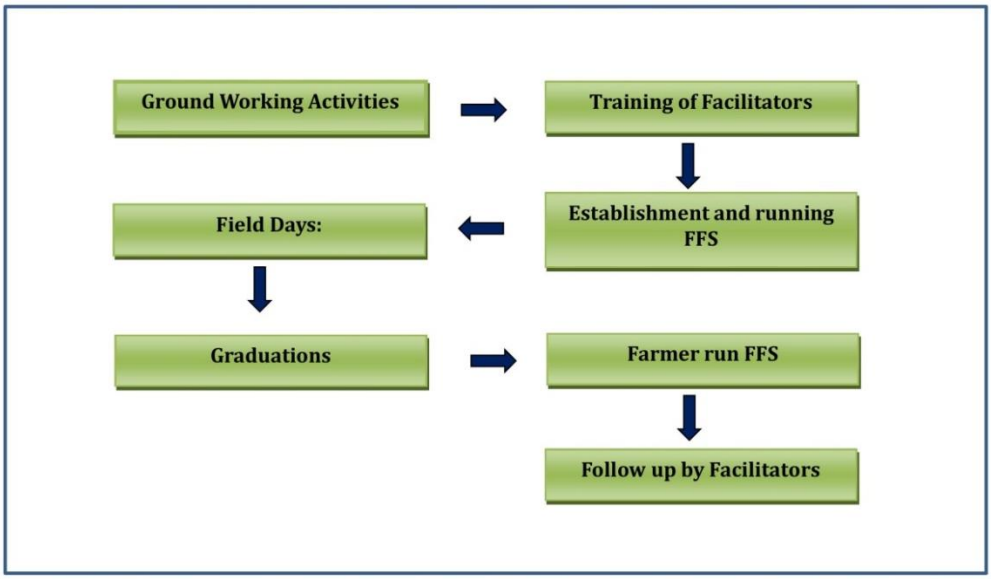

Fig. Steps in Conducting FFS

❖ **First visit**

- It is expected that the FFS facilitators will be establishing FFS in their own area of posting and hence they should be familiar with the villages profile based on the information that may have already, select potential villages for visiting

❖ **Criteria and steps for village selection**

- All approachable location/villages should be selected.
- Fairly easy access should be preferred
- Comfortable rapport between facilitators and farmers.
- Aware with the purpose of visit by the village leader.
- Request him to invite all growers (depending upon the crop chosen) for general meeting.
- Collect village profile.
- Area under crop cultivation.
- Number of farmers.
- Problems in previous crops.
- Request the village head to organize meeting in the following week.
- Women farmers' participation is also required.
- The date, time should be fixed in consultation with village leader or gram pradhan.
- Social and economic status of the farmers.

❖ **To identify potential farmers site selection during second visit:**

- This visit should be one week prior to the first visit.
- Organize the general meeting as planned.
- Ensure participation from farmers, women farmers.
- Discuss the important problems related to crop management.
- Discuss about FFS structure.
- Outline of FFS.
- Nature of training.
- No provision of honorarium for attending the FFS.
- There will be refreshment in each session.
- The facilitator should announce the interested farmers to work as farmer facilitator.

❖ **Criteria and steps for farmer's selection:**

- The farmers should be typical of that area in terms of crop cultivation.
- Active farmers should be preferred.
- Should be energetic and physically fit.
- SC/ST /Women farmers should be given preference.
- Willing to learn at their own.
- The village head or gram pradhan will help in choosing right farmers.
- Finalize the list of farmers.
- Request the selected farmers to attend the next meeting.
- Conduct this meeting at least two week before commencement of FFS.
- Conduct meeting with selected farmers.

- Hold participatory discussion to identify local problems related to total crop management.
- Identify local needs
- Explain FFS activities in detail.
- Discuss farmers practice.
- Ask the farmers for their own practices to follow in farmers practice plot.
- Explain the farmers about Natural Farming practices are to be followed in the plot.
- With the consensus of the farmers, select suitable FFS field and training site.
- Finalize the inaugural day for FFS and check out programme.

❖ **Criteria and steps for field selection**

- Select minimum of 1 ha.
- The field should be belonging to one farmer.
- It should be easily accessible and should not be too far from FFS village.
- The field should be close to the meeting place (gathering place).
- Some shady areas should be nearer to the field.
- No water stagnation in the field.
- No abnormalities in the field.
- Identify farmer who is willing to give the land for conducting field experiments.
- He should agree to follow the schedule of farming operations as finalized by the farmers.
- He should agree to meet all the expenditure involved for the fields planned for Natural Farming.
- He should agree to allow the farmer participants to work in that field to organize field day.
- At the planning meeting through participatory discussion with all selected farmers the facilitators should make verbal contact with FFS farmers.

12. Extension services

Introduction:

Extension is an informal educational process which offers advice and information to help the rural population in solving their problems.

Key features:

- Extension services change SHGs outlook toward their difficulties. It helps them to gain a clearer insight into the problems related to natural farming and also to decide how to overcome these problems.
- It helps to improve the productivity of their agriculture and also developing their abilities to direct their own future development.
- Extension also aims to increase the efficiency of the family farm and increase the standard of living of the farm family.
- Although farmers already have a lot of knowledge about their environment and the natural farming system, extension can bring them other knowledge and information which they do not have. For example, knowledge about the cause of the damage to a particular crop, the general principles of pest management or the ways in which natural inputs, manures are broken down to provide plant nutrients are some of the areas of knowledge that the lead farmer can usefully bring to farmers.

What is the objective of session?

- To spread information/awareness
- Training and capacity building
- Motivation
- Front line demonstration
- Provide technological back up for Natural farming
- Seeing is believing through Field visits
- Transfer of technology

What we will learn at the end of session?

- Extension Approach
- Organizational skills
- Skill to assess the economic aspects of technical advice given
- On farm management skills
- *Technical skill*
- *ICT*
- *Agri apps*

Information Delivery methods-

- Theory
- PPT
- Posters
- Videos

- Visit to Natural farms
- Homework: Farm visit evaluation

How to achieve Community Mobilization through Farmer to Farmer Extension (F2F)?

Introduction:

F2F approach is defined as provision of training by farmers to farmers. It helps in building the effective, farmer- centered extension systems and empowering farmers as change agents.

Objective:

To reduce the extension cost and workload of extension functionaries in a large country like India where extension worker and farmer ratio is very wide. Moreover, this approaches needscommunityaswellasgovernmentsupportforsustainabilityandscalability.

Steps:

1. ***Initiative of the process by the Institution***
   ATMA will form a planned structure, first to understand the underlying problems of the community related to adopting/practicing natural farming and the approaches to be followed to solve it.
2. ***Selection of the Lead farmers***
   The lead farmer *is one* who put efforts to make the initiative to reach the community.
   Criteria for selection of lead farmer:
   - Already practicing or interested in taking up Natural farming.
   - The lead farmer must be the one from the community itself.
   - Should have good agricultural background, basic literacy, and communicative skills, trustworthy.
   - Should actively participate in trainings and reachable very stakeholder in a village.
3. ***Training of Lead Farmer***
   ATMA will train lead farmers about the approach, the initiative (technology/tools/methods), and various extension methods.

4. Lead farmer will adopt natural farming on their respective farm first and develop the field as model demonstration farm

5. Further, they transfer the knowledge and skills to other farmers of the community through demonstration on model farm, practicals, trainings, etc.

Benefits of F2F Model

- Farmers play a key role in selecting farmer-trainers and monitoring and evaluating them. This helps make the programmes more accountable to the community or groups that they serve.
- Farmer-trainers (Lead Farmers) are ‘of the community’; they communicate in local languages and are more sensitive to local cultures, mannerisms, farming practices and farmers’ needs.
- Services are easily reachable to the larger population
- Cost-effective

- Farmers needs is well understandable
- Farmers learn best from peers
- Increase social networking

- Local problems will be better addressed

Meetings (SHG meetings/Group meeting)

- The group should meet regularly. Ideally, the meetings should be weekly or at least monthly.
- Compulsory attendance: Full attendance in all the group meetings will make it easy for the SHG to stabilise and start working to the satisfaction of all.
- Membership register, minutes register etc., are to be kept up to date by the group by making the entries regularly.

How to organize a meeting?

1. Define your objectives-

The first step to organizing a meeting is defining its purpose and the information you want to exchange during it. The meeting may be planned to convey information, make a decision with the group, solve a problem, develop co-worker relationships or share ideas.

2. Prepare the meeting agenda-

The agenda might include the meeting's title, time, date, location, discussion items and participant roles.

3. Decide the participant-

a) Who might provide valuable insight to discussions?
b) Who the topic may affect?
c) Who requires the information to complete their responsibilities?

4. Assign roles and responsibilities-

Designating specific responsibilities may improve the efficiency of the meeting and the engagement of participants. Here are some common roles that you might assign:

a) Leader: The leader is usually the Lead Farmer who plans the meeting. They are responsible for deciding the goals, agenda and participants of a meeting.

b) Facilitator: A facilitator guides the discussion during a meeting and makes sure the team addresses all parts of an issue. They help reduce confusion and ensure everyone listens to a speaker.

c) Recorder: A recorder takes notes during the meeting, capturing important ideas, decisions and conclusions. They compile notes in standard formatting and distributes them after the meeting.

d) Timekeeper: Timekeepers regulate the pace of the meeting, ensuring it stays within the scheduled time and moving the discussion at an efficient pace. They may also manage equipment or visual aids, such as whiteboards or slideshows.

e) Expert: Technical expert from ATMA are invited to share their knowledge on a specific topic related to Natural farming.

5. Select the location and time-

Survey the availability of SHG members when planning a time for the meeting.

Location depending on its size, accessibility, comfort and equipment capabilities.

6. Distribute materials in advance-

The meeting agenda and the expectations should be distributed few days or a week before the meeting. This helps SHG participants prepare to have productive conversations during the meeting.

7. Feedback-

Feedback of the participants may be collected for improvement of the further meetings.

13. Certification and Marketing of Natural Produce

Certification in the context of natural produce, is a process that validates and recognizes farmers who follow specific principles and practices of Natural Farming. The certification ensures that farmers are adhering to the standards and regulations of Natural Farming, and it allows them to gain recognition and market advantage for their produce.

Why Certification is Needed for Natural Produce:

Certification is essential for natural produce, such as products grown through Natural Farming, for several reasons:-

- ✓ **Quality Assurance:** Certification ensures that the produce meets certain quality standards and follows specific practices to maintain the natural integrity of the products.
- ✓ **Consumer Trust:** Certified natural produce helps build consumer trust, as consumers can rely on the certification mark to identify genuinely natural and chemical-free products.
- ✓ **Fraud Prevention:** Certification helps prevent fraud and misrepresentation in the market by distinguishing genuine natural produce from conventional products.
- ✓ **Market Advantage:** Certified natural produce gains a competitive advantage in the market due to the increased demand for natural and organic products.

Types of Certification for Natural Farming in India:

- ✓ **Third-Party Certification (NPOP):** The NPOP (National Programme for Organic Production) system is governed by APEDA (Agricultural and Processed Food Products Export Development Authority), Ministry of Commerce, and is primarily focused on organic agriculture produce for export purposes.
- ✓ **PGS-India Certification System:** Participatory Guarantee System for India (PGS-India) is a group-based organic certification system that involves farmers' participation and is mainly used for domestic organic produce.
- ✓ **Self-Certification:** Some states, like Himachal Pradesh, have developed innovative self-certification systems for natural produce. These systems enable farmers to evaluate and certify their practices based on defined parameters and guidelines.

About PGS-India Certification:

- ✓ Launched in 2011 by the Ministry of Agriculture and Farmers Welfare, it is an alternative to third-party certification.
- ✓ PGS-India is a farmer group-centric certification system meant for domestic purposes.
- ✓ The certification process is simpler and more cost-effective compared to NPOP. It involves a participatory approach, where farmers in a group verify each other's adherence to organic standards through peer appraisals and documentation.
- ✓ PGS-India-certified products can only be traded in the domestic market.
- ✓ PGS-India covers standards for crop production, animal production, food processing, handling, and storage.

- ✓ The certification process is facilitated by Regional Councils (RCs), legally registered organizations with experience in organic farming and certification. The RCs play a role in registration, training, documentation, inspection, residue analysis, and verification of certification.

Key Differences between NPOP and PGS Certification:

- ✓ NPOP is a third-party certification system, while PGS-India is based on a participatory guarantee system where farmers verify each other.
- ✓ NPOP-certified products can be traded both in domestic and international markets, whereas PGS-India-certified products are restricted to the domestic market only.
- ✓ NPOP is more suitable for large-scale operations and export-oriented organic producers, while PGS-India is more accessible and affordable for small farmers and local markets.

Steps in PGS India Certification:-

- Under the programme, farmers are aggregated into groups of minimum 5 farmers belonging to the same or nearby villages.
- Farmer group takes pledge for adopting standards and register the group on PGS portal with selection of Regional Council
- Endorsement by already existing Local Groups or State Govt. for scheme
- Regional Council accepts the registration after due diligence and endorsement by some authority or by any other PGS group.
- Training and Meetings
- Group starts farming as per PGS standards
- Every season, peers from the group undertake peer appraisal/ inspection of each and every member and submit peer appraisal summary report with recommendations to Regional Council through the portal
- Regional Council verifies the authenticity of claims and declarations made in peer appraisal report
- On being satisfied grants certification status.
- Group can generate the certificate from the portal
- Updating yield (actual)

Marketing of natural produce

Marketing natural fresh produce and products can be a rewarding endeavor for farmers and producer organizations. Implementing different marketing strategies and focusing on value addition can help enhance their market reach and profitability. Some of the ways for marketing of natural produce:

- ✓ **Individual Marketing (Family Doctor Vs Family Farmer):** Forming consumer groups through platforms like WhatsApp or local telephone networks can facilitate on-demand supply of fresh produce directly from farmers to consumers.

- ✓ **Innovative Marketing Platforms (Canopies):** Setting up portable canopies at common places, road sides, offices, and transportation hubs can attract consumers and increase sales.
- ✓ **Captive Outlets:** Establishing dedicated outlets at district or block headquarters, road sides, etc., can help sell surplus produce collected from various farmers or producer organizations.
- ✓ **Online Marketing (E-commerce):** Creating an e-commerce platform for marketing fresh produce directly to consumers can widen the market reach and facilitate direct sales.
- ✓ **Offline Marketing (Canopies, Shops):** Utilizing canopies, captive outlets, and shops at strategic locations can directly connect with consumers and promote the uniqueness of the produce.

For successful marketing, farmers and producer organizations should focus on aggregation, managing the supply chain efficiently, and value addition. Some important steps include:

- ✓ **Aggregation of Fresh Produce and Products:** Identify farmer interest groups (FIGs) and collection centers, catalog the produce, ensure quality assessment, arrange logistics, storage, packaging, labeling, establish market access, and promote the produce.
- ✓ **Supply Chain Management:** Focus on demand forecasting, effective communication and coordination, quality control, proper logistics, storage, inventory management, transparent financial management, compliance, and continuous improvement.
- ✓ **Value Addition:** Enhance the value of produce by processing and preserving, investing in packaging and branding, obtaining certifications, diversifying markets, differentiating products, adding convenience, offering value-added services, and exploring collaborations and export opportunities.

By following these strategies and steps, farmers and producer organizations can build sustainable businesses, connect with consumers, and promote environmentally conscious and socially responsible practices. Marketing natural fresh produce and products can lead to better economic opportunities while benefiting both farmers and consumers alike.

राष्ट्रीय जैविक एवं प्राकृतिक खेती केंद्र

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