Organic Farming

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Lesson Number	Lesson Name
Lesson 1	Introduction, Concept, Relevance in Present Context
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If there's farming, there's life; if there's a farmer, there's India

Course Name	Organic Farming
Lesson 1	Introduction, Concept, Relevance in Present Context
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Designed and developed under the aegis of NAHEP Component-2 Project "Investments In ICAR Leadership In Agricultural Higher Education"
Division of Computer Applications, ICAR-Indian Agricultural Statistics Research Institute

Objectives

1. To Introduce the concept of Organic Farming
2. To understand the importance of Organic Farming in present scenario

1. Definitions

- Organic agricultural methods are internationally regulated and legally enforced by many nations, based in large part on the standards set by the **International Federation of Organic Agriculture Movements (IFOAM)**, an international umbrella organization for organic organizations established in 1972.
- IFOAM defines the overarching goal of organic farming as follows: *"Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved".*
- According to national organic standards board of the U.S. defines 'organic farming is an ecological production management system that promotes and enhances bio diversity, biological cycles and soil biological activity '.
- As per the definition of the USDA study team on organic farming "*organic farming is system which avoids or largely excludes the use of synthetic inputs (such as fertilizers, pesticides, hormones, feed additives etc) and to the maximum extent feasible rely upon crop rotations, crop residues, animal manures, off-farm organic waste, mineral grade rock additives and biological system of nutrient mobilization and plant protection*".
- In another definition FAO suggested that "*Organic agriculture is a unique production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity, and this is accomplished by using on-farm agronomic, biological and mechanical methods in exclusion of all synthetic off-farm inputs*".

2. Concept of organic farming

This concept of organic farming is based on the following:

- Nature is the best role model for farming, since it does not use any inputs nor demand unreasonable quantities of water.
- The entire system is based on intimate understanding of nature's ways. The system does not believe in mining of the soil of its nutrients and do not degrade it in any way for today's needs.
- The soil in this system is a living entity
- The soil's living population of microbes and other organisms are significant contributors to its fertility on a sustained basis and must be protected and nurtured at all cost.
- It concentrates on building up the biological fertility of the soil so that the crops take the nutrients they need from steady turnover within the soil nutrients produced in this way and are released in harmony with the need of the plants.
- The total environment of the soil, from soil structure to soil cover is more important
- Control of pest, diseases and weeds is achieved largely by the development of an ecological balance within the system and by the use of bio-pesticides and various cultural techniques such as crop rotation, mixed cropping and cultivation.
- Organic farmers recycle all wastes and manures within a farm, but the export of the products from the farm results in a steady drain of nutrients.
- Enhancement of the environment in such a way that wild life flourishes.

3. Objectives of organic farming

Organic farming principles have all these features with major objectives as follows.

1. Production of high quality food, fiber and other products in sufficient quantity in harmony with natural systems and cycles
2. Enhancing biological/ natural cycles within the farming system involving microorganisms, soil flora and fauna, plants and animals in the entire production system

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3. To recognize the wider social and ecological impact of, and within the organic production and processing system
4. To maintain and encourage agricultural and natural biodiversity on the farm and surroundings through the use of sustainable production systems and the protection of plant and wildlife habitats
5. To maintain and increase long-term fertility and biological activity of soils using locally adopted cultural, biological and mechanical methods as opposed to reliance on external inputs
6. To maintain and conserve genetic diversity through attention to on-farm management of genetic resources
7. To use, as far as possible, renewable resources in production and processing systems and avoid pollution and waste
8. Promoting healthy use with proper care of water resources and all life therein
9. To utilize biodegradable, recyclable and recycled packaging materials
10. Creating harmonious balance between crop production and animal husbandry
11. Minimizing all forms of pollution
12. To provide everyone involved in organic farming and processing with a quality of life that satisfies their basic needs, within a safe, secure and healthy working environment.
13. To support the establishment of an entire production, processing and distribution chain which is both socially and ecologically responsible.
14. To recognize the importance of, and protect and learn from, indigenous knowledge and traditional farming systems.

4. Main Principles of Organic Farming

- The principles of organic agriculture serve to inspire the organic movement in its full diversity. They are the roots from which organic agriculture grows and develops.
- They express the contribution that organic agriculture can make to the world and a vision to improve all agriculture in a global context.

- The Principles of Organic Agriculture serve to inspire the organic movement in its full diversity.
- The International Federation for Organic Agriculture Movement's (IFOAM) definition of Organic agriculture is based on:
  1. The principle of health
  2. The principle of ecology
  3. The principle of fairness and
  4. The principle of care

4.1. Principle of health

- *Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible.*
- This principle points out that the health of individuals and communities cannot be separated from the health of ecosystems - healthy soils produce healthy crops that foster the health of animals and people.
- Health is the wholeness and integrity of living systems. It is not simply the absence of illness, but the maintenance of physical, mental, social and ecological well-being.

4.2. Principle of ecology

- *Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.*
- This principle roots organic agriculture within living ecological systems. It states that production is to be based on ecological processes, and recycling.
- Nourishment and well-being are achieved through the ecology of the specific production environment.
- For example, in the case of crops this is the living soil; for animals it is the farm ecosystem; for fish and marine organisms, the aquatic environment.

4.3. Principle of fairness

- *Organic Agriculture should build on relationships that ensure fairness with regard tothe common environment and life opportunities.*
- Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings.

- This principle emphasizes that those involved in organic agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties - farmers, workers, processors, distributors, traders and consumers.

4.4. Principle of care

- *Organic Agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment.*
- Organic agriculture is a living and dynamic system that responds to internal and external demands and conditions. Practitioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being.

In totality organic agriculture aims at a sustainable production system based on natural processes. Key characteristics of organic agriculture are:

- Relies primarily on local, renewable resources;
- Makes efficient use of solar energy and the production potential of biological systems;
- Maintains the fertility of the soil;
- Maximizes recycling of plant nutrients and organic matter;
- Does not use organisms or substances foreign to nature (e.g. GMOs, chemical fertilizers or pesticides);
- Maintains diversity in the production system as well as the agricultural landscape;
- Gives farm animal's life conditions that correspond to their ecological role and allow them a natural behavior.

Organic agriculture is also a sustainable and environmentally friendly production method, which has particular advantages for small-scale farmers.

5. The Main Pillars of Organic Farming

The main pillars of organic farming are as below –

- Organic threshold standards.
- Reliable mechanisms regarding certification and regulatory affairs.
- Technology packages.
- Efficient and feasible market network.

6. Scope and World Scenario

- At present in the world Australia at number one position with total 12,29,290 ha area under organic agriculture, in terms of percentage of total land Italy take first position with 9 per cent of total agriculture land cover under organic and with 17,557 number of organic farms Germany recorded highest organic farms in the world (Table 1).
- India stand on 14th rank in the world with 528,171 ha area comes under organic agriculture and it covers 0.3 per cent area under organic agriculture of total agriculture land and 44,926 total number of organic farms in the country.
- The Asian countries together currently account only 7 per cent of the total global organic land, China and India being major contributors (Musa et al., 2015).

Rank (on basis of total area)	Country	Area under organic agriculture (ha)	Percentage of total agriculture land	Number of organic farms
1	Australia	12,294,290	2.8	1550
2	China	2,300,000	0.4	1600
3	Argentina	2,220,489	1.7	1486
4	USA (2005)	1,620,351	0.5	8493
5	Italy	1,148,162	9.0	45,115
6	Uruguay	930,965	6.1	630
7	Spain	926,390	3.7	17,214
8	Brazil	880,000	0.3	15,000
9	Germany	825,539	4.8	17,557
10	UK	604,571	3.8	4485
11	Canada	604,404	0.9	3571
12	France	552,824	2.0	11,640
13	**India**	**528,171**	**0.3**	**44,926**
	World	30,418,261	0.65	718,744

(*Source*: Ramesh *et al.*, 2010)

Table 1. Ranking of Countries based on Total Area under Organic Farming

- According to APEDA 2013–14, India ranks 10th in the world in terms of cultivable land under organic certification.
- The certified area includes 15 per cent cultivable area with 0.72 million Hectare and rest 85 per cent (3.99 million Hectare) is forest and wild area for collection of minor forest produces (Table 2).
- The total area under organic certification is 4.72 million Hectare.
- India produced around 1.24 million MT of certified organic products which includes all varieties of food products namely sugarcane, cotton, oil Seeds, basmati rice, pulses, spices, tea, fruits, dry fruits, vegetables, coffee and their value added products.
- The production is not limited to the edible sector but also produces organic cotton fiber, functional food products etc.
- Among all the states, Madhya Pradesh has covered largest area under organic certification followed by Himachal Pradesh and Rajasthan.

Total area under certified organic cultivation	0.72 M ha
Forest and wild area for collection of minor forest produces	3.99 M ha
The total area under organic certification	4.7 M ha
Total production	1.24 million MT
Total quantity exported	177766 MT
Value of total export	1328.61 crores

(Source: APEDA. 2014)

Table 2. Status of Organic Farming in India

7. Future prospects

India has other comparative advantages for organic production:

- India is poised for faster growth with growing domestic market. Success of organic movement in India depends upon the growth of its own domestic markets.
- India has traditionally been a country of organic agriculture, but the growth of modern scientific, input intensive agriculture has pushed it to wall. But with the increasing awareness about the safety and quality of foods, long term sustainability of the system and accumulating evidences of being equally productive, the organic farming has emerged as an alternative system of farming which not only address the quality and sustainability concerns, but also ensures a debt free, profitable livelihood option.
- India is strong in high quality production of certain crops like tea, some spices, rice specialties, ayurvedic herbs etc.
- India has a rich heritage of agricultural traditions that are suitable for designing organic production systems.
- Sophisticated crop rotation or mixed cropping patterns, for example the famous agro-forestry systems of the Western Ghats, facilitate the management of pests, diseases and nutrient recycling.
- Botanical preparations, some of which originate from the ancient Veda scripts, provide a rich source for locally adapted pest and disease management techniques.

- The widespread cultivation of legume crops facilitates the supply of biologically fixed nitrogen.
- In several regions of India agriculture is not very intensive as regards the use of agro-chemicals.
- Especially in mountain areas and tribal areas, use of agro-chemicals is rather low, which facilitates conversion to organic production.
- On these marginal soils, organic production techniques have proved to achieve comparable or in some cases (especially in the humid tropics) even higher yields than conventional farming.
- Compared to input costs, labor is relatively cheap in India, thus favoring the conversion to less input-dependent, but more labor intensive production systems, provided they achieve sufficient yields.
- The NGO sector in India is very strong and has established close linkages to a large numbers of marginal farmers.
- Many NGOs are engaged in promotion of organic farming and provide training, extension services information and marketing services to farming communities.

8. Goals of organic agriculture

1. Employing long-term, ecological, systems-based organic management
2. Assuring long-term, biologically-based soil fertility
3. Avoiding/ minimizing synthetic inputs at all stages of the organic product chain and exposure of people and the environment to persistent, potentially harmful chemicals
4. Minimizing pollution and degradation of the production/ processing unit and surrounding environment from production/ processing activities
5. Excluding certain unproven, unnatural and harmful technologies from the system
6. Avoiding pollution from surrounding environment
7. Maintaining organic integrity throughout the supply chain
8. Providing organic identity in the supply chain

9. Benefits of Organic Agriculture

9.1. Ecological Sustainability

- Recycling nutrients instead of applying external inputs
- Preventing the chemical pollution of soil, water and air
- Promotion of biological diversity
- Improving soil fertility and the buildup of humus
- Preventing soil erosion and compaction
- Promoting the use of renewable energies

9.2. Social Sustainability

- Supporting sufficient production for subsistence and income earning for small farmers
- Providing safe and healthy food
- Supporting the adoption of good working conditions
- Building on local knowledge and traditions

9.3. Economic Sustainability

- Helping farmers achieve satisfactory and reliable yields
- Providing a lower reliance on and associated cost for external inputs
- Promoting crop diversification to improve income security
- Promoting product value addition through quality improvement and onfarm processing
- Promoting the adoption of efficient farming systems to improve overall profitability and competitiveness

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Course Name	Organic Farming
Lesson 2	Organic Production Requirements
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Objectives:

To know the requirements and recommendations of organic production.

1. Choice of Crops and Varieties

General Principle

- Species and varieties cultivated in organic agriculture systems are selected for adaptability to the local soil and climatic conditions and tolerance to pests and diseases.
- All seeds and plant material are certified organic.

Recommendations

- A wide range of crops and varieties should be grown to enhance the sustainability, self–reliance and biodiversity value of organic farms.
- Plant varieties should be selected to maintain genetic diversity. Varieties known to be suited to organic cultivation should be preferred.
- Operators should use organically bred varieties

2. Length of Conversion Period

General Principle

- A conversion period enables the establishment of an organic management system and builds soil fertility.

Recommendations

- The conversion period should be long enough to improve soil fertility significantly and to re-establish the balance of the ecosystem.
- The length of the conversion period should be adapted to:
  a) The past use of the land;
  b) The ecological context and its implications;
  c) The experience of the operator.

The length of the conversion period should be defined to provide for a period of at least 36 months from the last date of application of any prohibited material or practice

3. Diversity in Crop Production

General Principle

- Soil and soil management is the foundation of organic production. Organic growing systems are soil based, care for the soil and surrounding ecosystems and provide support for a diversity of species, while encouraging nutrient cycling and mitigating soil and nutrient losses.

Recommendations

- Diversity in crop production is achieved by a combination of:
  a) A diverse and versatile crop rotation that includes green manure, legumes and deep rooting plants;
  b) Appropriate coverage of the soil with diverse plant species for as much of the year as possible.

4. Soil Fertility and Fertilization

General Principle

- Organic farming returns microbial plant or animal material to the soil to increase or at least maintain its fertility and biological activity.

Recommendations

- Biodegradable material of microbial, plant or animal origin produced from organic practices should form the basis of the fertility program.
- Nutrient resources should be used in a sustainable and responsible manner.
- Nutrient losses from the farm to the natural environment should be minimized.
- Nutrients should be used in such a way and at appropriate times and places to optimize their effect.

- Accumulation of heavy metals and other pollutants should be prevented.
- Naturally occurring mineral fertilizers and brought-in fertilizers of biological origin permitted under these standards should be regarded as only one component of the nutrient system, and as a supplement to, and not a replacement for, nutrient recycling.
- Manures containing human feces and urine should not be used unless free of human pathogens.
- Careful attention to hygiene is required and it is recommended that they are not applied directly to vegetation for human consumption or to soil that will be used to grow annual plants within the next six months

5. Pest, Disease, Weed, and Growth Management

General Principles

- Organic farming systems apply biological and cultural means to prevent unacceptable losses from pests, diseases and weeds.
- They use crops and varieties that are well-adapted to the environment and a balanced fertility program to maintain fertile soils with high biological activity, locally adapted rotations, companion planting, green manures, and other recognized organic practices as described in these standards.
- Growth and development should take place in a natural manner.

Recommendations

- Pests, diseases and weeds should be managed by the knowledgeable application of one, or a combination, of the following measures:
  a) Choice of appropriate species and varieties;
  b) Appropriate rotation programs;
  c) Mechanical cultivation;
  d) Protection of natural enemies of pests through provision of favorable habitat, such as hedges, nesting sites and ecological buffer zones that maintain the original vegetation to house pest predators;

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e) Diversified eco-systems. These will vary between geographical locations. For example, buffer zones to counteract erosion, agro-forestry, rotating crops, intercropping, etc.;
f) Thermal weeding;
g) Seed bed preparation;
h) Natural enemies including release of predators and parasites;
i) Acceptable biodynamic preparations from stone meal, farmyard manure or plants;
j) Mulching and mowing;
k) Grazing of animals;
l) Mechanical controls such as traps, barriers, light and sound.

6. Avoiding Contamination

General Principle

- All relevant measures are taken to ensure that organic soil and food is protected from contamination.

Recommendations

- Operators should take reasonable measures to identify and avoid potential contamination.
- In case of risk, or reasonable suspicion of risk that contamination may occur, the standard setting organization should set limits for the maximum application levels of heavy metals and other pollutants.
- The standards should place emphasis on detection of contamination sources, improvement of the production system taking into account the procedures developed for HACCP, and the assessment of background contamination levels.
- Accumulation of heavy metals and other pollutants should be limited and the appropriate remedial measures implemented where possible.
- The standards should establish parameters for the acceptance/rejection of organic products based on analysis.

- The standards should establish a procedure on how to evaluate organic products in case of reasonable suspicion of pollution based on due expert consideration and the precautionary principle.
- Contamination that results from circumstances beyond the control of the operation does not necessarily alter the organic status of the operation.

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Course Name	Organic Farming
Lesson 3	Biological Intensive Nutrient Management (INM) - Organic Manures
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Objectives:

- To acquire knowledge about Biological Intensive Nutrient Management (INM) in organic farming.
- To understand the importance of organic manures.

1. Introduction

- In order to realize the potential of production systems on a sustained basis, efficient management of resources is crucial.
- A successful farming system relies on the management of organic matter to enhance physico-chemical and biological properties of the soil.
- The effects of soil organic matter are dynamic as it is a source of gradual release of essential plant nutrients; improves soil structure, its drainage, aeration and water holding capacity (WHC); improves soil buffer capacity; influence the solubility of minerals and serves as a source of energy for the development of micro-organisms.
- According to a conservative estimate, around 600 to 700 m t of agricultural waste is available in the country but it is not managed properly.
- We must convert waste into wealth by converting this biomass into energy, nutrient to starved soil and fuel to farmers.
- India produces about 1800 m t of animal dung per annum. Even if ⅔ of the dung is used for biogas generation, it is expected to yield about 440 m t/ annum of manure, which is equivalent to 2.90 m t N, 2.75 mt P_2O_5 and 1.89 m t K_2O.

2. Concept and Definition of INM

- The concept of biological INM is the continuous improvement of soil productivity on long-term basis through appropriate use of organic manures, green manures, BGA, biofertilizers and other biological derived materials and their scientific management for optimum growth, yield and quality of crops and intensive cropping systems in specific agroecological situations.

3. Definition of Biological INM

- It should relay on biological processes by adapting germplasm to adverse soil conditions, enhancing soil biological activity and optimizing nutrient, cycling to minimize external inputs and maximize the efficiency of their use.
- It can also be defined as “a system for approaching of soil nutrient management which maintain soil health, soil fertility, sustaining agricultural productivity and improving farmer’s profitability through effective, judicious and intensive use of biological based nutrient management resources”.
- The resources are biofertilizers, organic manures green manuring crop rotation, N-fixing organisms, mycorrhizae, PSM etc.

4. Organic Manures

- Term ‘manure’ was used originally for denoting materials like cattle manure and other bulky natural substances that were applied to land, with the object of increasing the production of crops.
- Therefore, manures are defined as the plant and animal wastes which are used as sources of plant nutrients.
- Urine is normally low in phosphorus and high in potash, whereas about equal parts of nitrogen may be excreted in faeces and urine of the cattle.
- Hence the manure in which the proportion of the urine was allowed to drain away would be relatively low in N and K.
- Poultry manure is very important for organic farming due to there will be no loss of urine, since both liquid & solid portions are excreted together.
- Fresh poultry manure creates local alkalinity, it may hamper the standing crop. Therefore, it is recommended to preserve the excreta at least for six months with suitable amendments and appropriate microbes.

5. Advantages of Manuring

- Manures supply plant nutrients including micro nutrients
- They improve soil physical properties

- Increase nutrient availability
- Provide food for soil micro organism
- Provide buffering action in soil reaction
- Improve soil tilth, aeration and WHC of the soil

On the basis of concentration of nutrients, manures can be grouped into two categories-

6. Bulky organic manures

- They contain small percentage of nutrients and they applied in large quantities like FYM, compost, green manure, biogas slurry, night soil, sewage and sludge, poultry manure, sheep & goat manure, animal waste, crop residue etc.

6.1 Farm Yard Manure (FYM)

- Most commonly used organic manure in India. It refers to the decomposed mixture of dung and urine of farm animals along with litter and left over materials from roughages or fodder fed to the animals.
- It contains 0.5% N, 0.2% P_2O_5 and 0.5% K_2O. Urine contains 1% N and 1.35% K_2O. Litter is the straw, peat, sawdust and dry leaves used as bedding material for farm animals and birds.
- The N present in urine is mostly in the form of urea which is subjected to volatilization losses.
- Chemical preservatives are used to reduce losses and enrich FYM e.g. gypsum, kainite and super phosphate.
- These preservatives absorb urine and prevent volatilization loss of urea and also add nutrients.

6.2. Compost

- Compost means ‘a product obtained by the controlled decomposition of organic wastes (composting), finally used as organic manure’.
- Composting is the process of reducing animal and vegetable refuse (except dung) to a quickly utilizable condition for improving and maintaining soil fertility.

- The final well decomposed manure having lower C: N ratio is termed as 'compost'. The recycling of organic materials by biological decomposition as manure is very important for organic farming as it kills weed seeds, pathogenic organisms, and dispose of agricultural / industrial wastes to produce a uniform, slow release organic fertilizer which stimulates soils life, improve soil structure and control insect-pests and diseases.
- Compost contains 0.5-0.15-0.5 N, P, K respectively.

6.3. Biogas Slurry

- Instead of directly using the animal dung for composting it can be used for production of biogas by feeding through Biogas Plants.
- It contains (1–1.8% N, 0.4–0.9% P_2O_5 and 0.6- 1% K_2O) due to low volatilization losses of ammonia.

6.4. Night Soil (Poudrette)

- Night soil is human excreta, both solid and liquid.
- It contains 5.5% N, 4% P_2O_5 and 2% K_2O. The dehydration of night soil, as such or after admixture with absorbing materials like soil, ash, charcoal and sawdust produces a poudrette that can be used easily as manure.
- Poudrette contains about 1.32% N, 2.8% P_2O_5 and 4.1% K_2O.

6.5. Sewage and Sludge

- The solid portion in the sewage (human excreta + water) is called sludge and liquid portion is sewage water.
- It can be recycled for crop fertilization, irrigation to the crop, aquaculture production, application to forest land, biogas production and land reclamation.
- It was estimated that total waste generated by 217 million people in urban areas is 39 mt/ year (2001).
- The total NPK content of this would be 2.5 lac tone of N, 2.6 lac tone of P and 2.6 lac tone of K.
- Both the components are separated and are given a preliminary fermentation and oxidation treatments to reduce bacterial contamination and offensive smell, otherwise soil quickly becomes "sewage sick" owing to

the mechanical clogging by colloidal matter in the sewage and the development of anaerobic organisms which not only reduce the nitrate already present in the soil but also produce alkalinity.

- These defects can be removed by thoroughly aerating the sewage in the settling tank by blowing air through it.
- The sludge that settles at the bottom in this process is called "activated sludge" (3.6% N, 2% P_2O_5 & 1% K_2O).

6.6. Sheep & Goat Manure

- The droppings of sheep and goat contain higher nutrients than FYM and compost.
- On an average, the manure contains 3% N, 1% P_2O_5 & 2%K_2O).

It is applied to the field in two ways-

i) Sweeping of sheep and goat sheds are placed in pits for decomposition and it is applied later to the field.

ii) Sheep penning- wherein sheep and goats are allowed to stay overnight in the field and urine and fecal matter is added to soil.

6.7. Poultry Manure

- Poultry manure can supply higher N and P to the soil than other bulky organic manures.
- The average nutrient content is 2.87% N, 2.93% P_2O_5 & 2.35% K_2O.

6.8. Green Manuring

- Green un-decomposed plant material used as manure is called green manure.
- By growing green manure crops (usually leguminous crops) are grown in the field and incorporating it in its green stage in the same field is called green manuring.
- It adds organic matter and nitrogen to the soil. On an average green manuring gives 60-80 kg N/ha.

7. Concentrated organic manures

- These have required in small quantities and contain higher nutrients as compared to bulky organic manures.
- The most commonly used are oil cakes, fish meal, meat meal, blood meal, horn & hoof meal, bird guano, raw bone meal etc, (Table 1) which act a good source of organic manures for organic farming system.

7.1. Oil Cakes

- Oil cakes are generally grouped into two groups, viz., and edible oil cakes suitable for feeding the cattle and other domestic animals and non-edible oil cakes exclusively used as manure due to their higher content of plant nutrients.
- It has been estimated that India produced about 2.5 million tons of oil cakes annually Non-edible oil cakes are used as manure especially for horticultural crops.
- Nutrient present in oil cakes, after mineralization, are made available to crops 7-10 days after application.
- Oil seed cakes need to be well powdered before application for even distribution and quicker decomposition.
- Neem cake acts as Nitrification Inhibitor.

Table 1. Average nutrient contents of different oil cakes.

Oil cakes	Per cent composition		
	N%	P%	K%
Edible oil cakes (feed for livestock)			
Safflower (decorticated)	7.9	2.2	1.9
Groundnut	7.3	1.5	1.3
Cotton seed (decorticated)	6.5	2.9	2.2
Non-edible oil cakes (not fed to livestock)			
Safflower (un-decorticated)	4.9	1.4	1.2
Cotton seed (un-decorticated)	3.9	1.8	1.6
Caster	4.3	1.8	1.3
Neem	5.2	1.0	1.4

(Source: Rana, 2011)

7.2. Fish Meal

- Sea food canning industries are present in almost all coastal states of India, Fishes which is not preferred for table purposes due to their small size, bonny nature and poor taste can be converted into very good organic manure.
- The fish is dried, powdered and filled in bags.
- It contains average nutrients are 4-10, 3-9 & 0.3-1.5 NPK.
- These manures are highly suitable for fruit orchards and plantation crops.

7.3. Meat Meal

- An adult animal can provide 35 to 45 kg of meat after slaughter or death.
- It contains 8-9% N and 7% P_2O_5.

7.4. Blood Meal

- Blood manure contain about 13-20%N, rich in Iron and its application gives a deep rich colour to foliage,.

7.5. Horn & Hoof Meal

- A healthy animal can give about 3 to 4 kg of horn and hoof.
- These materials are dried, powdered, bagged and marketed as manure.
- It contains 13% N.

7.6. Guano (Bird / Fish)

- The excreta and dead remains of the bird is called bird guano (11-14% N & 2-3% P_2O_5) and the refuse left over after the extraction of oil from the fish in factories, dried in cemented yards and used as manure is called as fish guano (7% N & 8% P_2O_5).

7.7. Raw Bone Meal

- An excellent source of organic phosphorus.It contains 3 to 4% N and 20 to 25% P_2O_5.

Course Name	Organic Farming
Lesson 4	Green manuring, Bio-fertilizers and Recycling of Organic Residues
Content Creator Name	DR S. Sheeba
University/College Name	Tamil Nadu Agricultural University, Coimbatore
Course Reviewer Name	DR J. C. Sharma
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Designed and developed under the aegis of NAHEP Component-2 Project "Investments In ICAR Leadership In Agricultural Higher Education"
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Objective

To acquire knowledge about green manures, bio-fertilizers and recycling of organic residues

1. Green manuring

Green manuring is the practice of enriching the soil by ploughing under or soil incorporation of any green manure crops while they are green or soon after they start flowering.

The practice of green manuring is most common in rice growing states like Andhra Pradesh, Uttar Pradesh, Karnataka, Punjab and Orissa which contribute 41, 16, 11, 6 and 5 per cent to the total area under green manuring in India, respectively.

- Estimates suggest that a 40- 50 days old green manure crop can supply up to 80-100 kg. N/ha.
- Some of the potential green manuring legumes are dhanicha, sunhemp, cowpea, mung, bean, guar and berseem etc.
- Dhanicha, sunhemp, mungbean and guar grown during *kharif* season as green manure crops have been reported to contribute 8-21 tones of green matter and 42-95 kg. Of N/ha.

Fig 1. Green manures

Broadly the practice of green manuring in India can be classified in two ways,

1.1. A) Green leaf manuring

- Where the application of green leaves and twigs of trees, shrubs and herbs collected from plants grown in wastelands, field bunds, degraded lands and nearby forest.
- They are turned down or mixed into the soil 15-30 days before sowing of the crops depending on the tenderness of the foliage or plant parts is known as green leaf manuring.

1.2. B) *In situ* green manuring

- *In situ* green manuring is also called as On–farm green manure or legume green manuring. In this system, the short duration legume crops are grown and buried in the same site when they attain the age of 60-80 days after sowing.
- Among the different GM crops, dhaincha and sunhemp have higher accumulation of major and micro nutrients on account of more biomass production and better nutrient composition compared to food legumes which are inferior due to low contents of nutrients coupled with less dry matter production.

1.3. Techniques of green manuring in the field

The maximum benefit from the green manure crop cannot be obtained without knowing the:

1) Right time of growing.
2) Right time of incorporating in the soil.
3) Time required for decomposition

S. no.	Plant	Botanical name	Nutrient content (%) on air dry basis		
			N	P	K
	Green manure crop				
1.	Sunnhemp	*Crotolaria juncea*	2.30	0.50	1.80
2.	Dhaincha	*Sesbania aculata*	3.50	0.60	1.20
3.	Sesbania	*Sesbania speciosa*	2.71	0.53	2.21
4.	Cowpea	*Vigna sinensis*	1.70	0.28	1.25
5.	Mungbean	*Vigna radiate*	2.21	0.26	1.26
	Green leaf manure				
6.	Gliricidia	*Gliricidia sepium*	2.76	0.28	4.60
7.	Pongamia	*Pongamia pinnata*	3.31	0.44	2.39
8.	Neem	*Azadiracta indica*	2.83	0.28	0.35
9.	Gulmohar	*Delonix regia*	2.76	0.46	0.50
10.	Peltophorum	*Peltophorum ferrugenum*	2.63	0.37	0.50
	Weeds				
11.	Parthenium	*Parthenium hysterophorus*	2.68	0.68	1.45
12.	Water hyacinth	*Eichhornia crassipes*	3.01	0.90	0.15
13.	Trianthema	*Trianthema partulacastrum*	0.64	0.43	1.30
14.	Ipomoea	*Ipomoea*	2.01	0.33	0.40
15.	Calotropis	*Calotropis gigantean*	2.06	0.54	0.31
16.	Cassia	*Cassia fistula*	1.60	0.24	0.20

Table 1. NPK content of green manure crops and weeds on dry basis

2. Biofertilizers

A biofertilizer is a substance which contains living microorganisms, when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. Biofertilizers are natural fertilizers that are microbial inoculants of bacteria, algae and fungi. They help build up the soil micro-flora and there by the soil health.

2.1. Types of Biofertilizers

Fig 2. Types of Bio-fertilizers

2.1.1. Bacteria

- **Symbiotic nitrogen fixers.**

  Rhizobium, Azospirillum spp

- **Free living nitrogen fixers.**

  Azotobacter, Klebsiella etc,.

2.1.2. Algal biofertilizers

BGA in association with *Azolla*

Anabena, Nostoc, Ocillatoria

2.1.3. Phosphate solubilising bacteria

Pseudomonas, Bacillus megaterium

2.1.4. Fungal biofertilizer

VAM

2.2. Bacterial biofertilizers

- The live cells of bacteria used as a biofertilizers
- These microbes contains unique gene called as Nif-Gene which make them capable of fixing nitrogen.
- The nitrogen fixing bacteria work under two conditions,

1. Symbiotically
2. Free living bacteria (non-symbiotic).

The symbiotic bacteria make an association with crop plants through forming nodules in their roots.

The free living bacteria do not form any association but live freely and fix atmospheric nitrogen.

2.3. Bio - fertilizers application methods

There are three ways of using these N-fixing/P.S.M. bacteria.

1. Seed treatment
2. Root dipping
3. Soil applications

2.3.1 Seed Treatment

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- ✓ Seed treatment is a most common method adopted for all types of inoculant. The seed treatment is effective and economic.
- ✓ Important things has the seeds must be coated first with *Rhizobium* or *Azotobacter* or *Azospirillum* when each seeds get a layer of above bacteria then the P.S.M. inoculant has to be treated on outer layer of the seeds.

2.3.2 Root dipping

- ✓ Application of *Azospirillum* with the paddy/vegetable plants this method is needed.
- ✓ The required quantity of *Azospirillum* has to be mixed with 5-10 ltr of water at one corner of the field and all the plants have to keep for minimum ½ an hour before sowing.

2.3.3. Soil application

- ✓ P.S.M. has to be used as a soil application use 2 kgs of P.S.M. per acre. Mix P.S.M. with 400 to 600 kgs of cowdung along with ½ bag of rock phosphate if available.

2.4 Precautions

- ❖ Store bio-fertilizer packets in cool and dry place away from direct sunlight and heat.
- ❖ Use right combination of bio-fertilizers
- ❖ Rhizobium is crop specific, so use in specified crop
- ❖ Do not mix with chemicals

2.5 Advantage of biofertilizers

- Renewable source of nutrients
- Sustain soil health
- Replace 25-30% chemical fertilizers
- Increase the grain yields by 10-40%.
- Improve texture, structure and water holding capacity of soil
- Stimulates plant growth by secreting growth hormones.
- Solubilize and mobilize nutrients
- Eco-friendly, non-pollutants and cost effective method

2.6 Disadvantages

- Bio-fertilizers require special care for long-term storage because they are alive.

- If other microorganisms contaminate the carrier medium or if growers use the wrong strain, they are not as effective.
- Bio-fertilizers lose their effectiveness if the soil is too hot or dry.

3. Recycling of organic residues:

- A variety of organic residues include crop residues in the form of straw, husk, forest litter; animal wastes like dung urine, bones etc., guano, city or household residues, oil cakes, bye products of food and sugar industries, pond silt, marine wastes, sea weeds and human habitation wastes.
- There are two major components of crop residues available, i. e. harvest refuse (straw, stubbles, haulm of different crops) and process wastes (nut shell, oilcakes and cobs of maize, bajra and sorghum).
- Crop residues are defined as 'the non-economic plant parts that are left in the field after harvest and remains that are generated from packing sheds or that are discarded during crop processing'.

3.1. Benefits:

The benefits of proper organic residue recycling are-

- Supply essential plant nutrients,
- Improve soil properties,
- Protect the soil from erosion hazards,
- Reducing residue accumulation at the sites they produced,
- Providing employment as well as income to many,
- Enhancing environmental qualities

Reference

- Palaniappan, S. P., & Annadurai, K. (1999). *Organic Farming Theory and Practice. Scientific Publishers (India) Jodhpur*.
- Sharma, A. K. (2002). *A hand book of organic farming, ed. AK Sharma, Agrobios, India*, 148-215.

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Course Name	Organic Farming
Lesson 6	Vermi-Composting
Content Creator Name	DR S. Sheeba
University/College Name	Tamil Nadu Agricultural University, Coimbatore
Course Reviewer Name	DR J. C. Sharma
University/College Name	Dr. Yaswant Singh Parmar University of Horticulture & Forestry, Nauni- Solan

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Objectives:

To understand the process of vermin-composting

To know the importance of vermin-compost in orgnic farming.

1. **Definition:**

- The process of composting organic wastes through domesticated earthworms under controlled conditions is vermin-composting.
- Earthworms have tremendous ability to compost all biodegradable materials.
- Waste subjected to earthworm consumption decomposes 2 to 5 times faster than in conventional composting.
- During composting the wastes are deodorized, pathogenic micro-organisms are destroyed and 40 to 60 % volume reductions in organic wastes take place.
- It is estimated that the earthworms feed about 4 to 5 times their own weight of material daily.
- Earthworms bear both male and female reproductive organs.
- However, two worms are needed for successful copulation.
- The self fertilization does not occur generally in the earthworms. Fertilization takes place in the egg case or cocoon.
- Earthworm species such as *Eisenia foetida, Eudrilus eugeniae, lumbricus rubellus, L. mauritee and perionix excavatus* (Fig 1) have been recommended for vermiculture technology.
- Vermi-compost is the compost which is prepared by earthworms.
- It is a mixture of worm casting (faecal excretions) organic materials including humus, live earthworms, their cocoons and other micro organisms (Fig 2).

Fig 1. Different species of earthworms

Fig 1a. African earthworm (*Eudrillus euginiae)*	Fig 1b. Tiger worm or red wrinkle (*Eisenia foetida*)	Fig 1c. Asian worms (*Perinonyx exavatus)*



2. Vermiculture :

- It is the process of rearing and breeding of earthworms in controlled condition and presently it is known as earthworm biotechnology.
- It is estimated that 1800 worms which is an ideal population for one sq. meter can feed on 80 tonnes of humus per year.
- Faecal matter or excretions of earthworms is known as vermin cast.
- Vermiwash is a liquid fertilizer collected after the passage of water through a column of worm activation, which is useful for foliar spray.
- It may be diluted with water before use. It can also be diluted with 10% urine of cow.
- The average nutrient content of vermi-compost is about 0.5 to 0.9- 0.1 to 0.2- 0.67 % N, P, K respectively.

Fig 2. Vermicompost

3. Vermiwash

- Liquid manure: It is a transparent pale yellow colored fluid collected after the passage of water through a column of worm action or it a collection of excretory products and mucus secretions of earthworm along with nutrients from the soil organic molecules.
- It is very useful as a foliar spray to enhance the plant growth and yield and to check development of diseases.

4. Benefits of vermi-compost

1. When added to clay soil loosens the soil and provides the passage for the entry of air.

2. The mucus associated with it being hygroscopic, absorbs water and prevents water logging and improves water holding capacity.

3. In the vermin-compost, some of the secretions of worms and the associated microbes act as growth promoter along with other nutrients.

4. It improves physical, chemical and biological properties of soil in the long run on repeated application

5. How does earthworm facilitate vermin-composting?

- Materials consumed by earthworms undergo physical breakdown in the gizzard resulting in particles of size <2µ, thereby giving an enhanced surface area for microbial processing.
- This finally ground material is exposed to various enzymes such as protease, lipase, amylase, cellulase and chitinase secreted in lumen by the gut wall and associated microbes, which facilitates breaking down the complex biomolecules into simple compounds.
- Only 5-10% of the ingested material is absorbed into the tissues of worms for their growth and rest is excreted as cast.

5.1. Vermi-composting Process

- It is a process of decomposition of organic matters into humic rich manure by the action of earthworms.
- Partly degraded cow dung, sheep dung, elephant dung, pressmud, cane trashes, city solid wastes, poultry farm wastes and other domestic wastes are brought to vermin-composting unit.
- There, it is formed as windrows of 1-2 feet height.
- The windrows are provided with Green house shade in order to prevent from sunlight.
- Water is sprayed on the windrows by Drip irrigation or manual system to maintain the optimum moisture of 50-55%. Selected species of Earthworm is inoculated on the windrows.
- This process takes place to complete in 60-90 days.

6. Application of vermin-compost for different crops (Table 1)

- Mode of vermin-compost application depends upon the type of crop grown in the field/nursery.
- It is applied in the tree basin for fruit crops.
- It should be added in the pot mixture for potted ornamental plants and for raising seedlings.
- Vermi-compost should be used as a component of integrated nutrient management system for better crop production.

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Fig 3. Vermicompost Unit

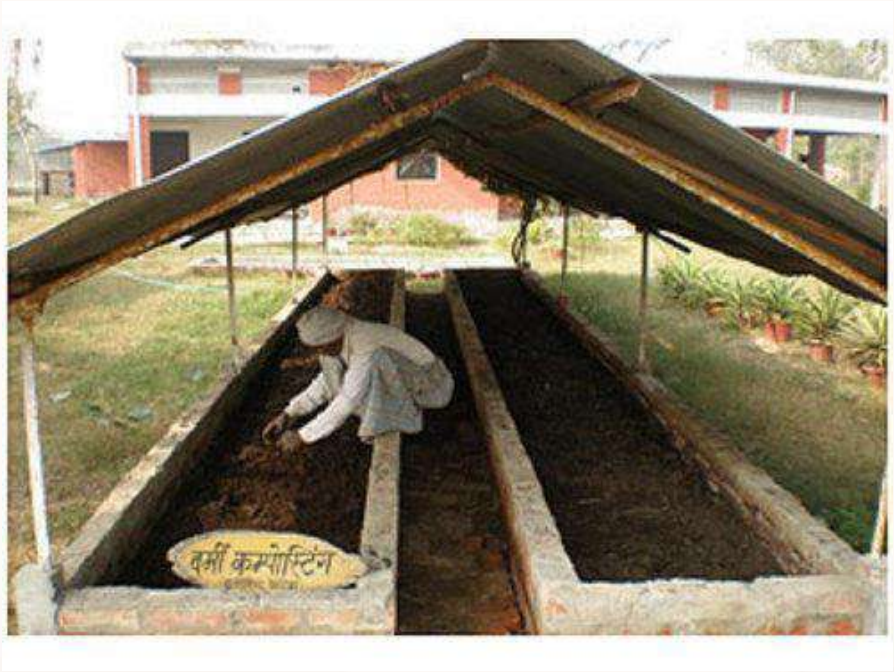

Table 1. Recommended quantity and time of application of vermicompost

Crop	Quantity to apply per acre	Time to apply
Rice	1 tonne	After transplanting
Sugarcane	$1^1/_2$ tonnes	Last ploughing
Cotton	1 tonne	Last ploughing
Chilli	1 tonne	Last ploughing
Groundnut	$^1/_2$ tonne	Last ploughing
Sunflower	$1^1/_2$ tonnes	Last ploughing
Maize	1 tonne	Last ploughing
Turmeric	1 tonne	Last ploughing
Grape	1 tonne	June-July
Citrus, pomegranate, ber, guava	2 kg per tree	At planting time and before flowering in 1-2 year old trees
Mango, coconut	2 kg per tree 5 kg per tree 10 kg per tree 20 kg per tree	At planting time 1-5 year old trees 6-9 year old trees Trees older than 10 years
Onion, garlic, tomato, potato, bhendi, brinjal, cabbage, cauliflower	1-$1^1/_2$ tonnes	Last ploughing
Teak, red sandal-wood, mangium	3 kg per tree	At planting time

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Course Name	Organic Farming
Lesson 6	Soil Improvement and Amendments
Content Creator Name	DR S. Sheeba
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Objectives:

To acquire knowledge about different soil amendments and soil improvement techniques.

1. Introduction

- A soil conditioner, also called a soil amendment, is a material added to soil to improve plant growth and health.
- The type of conditioner added depends on the current soil composition, climate and the type of plant.

1.1. Characteristics of soil conditioners

- Soil conditioners are natural and earthy.
- Absorb water rapidly.
- Compost is "Synthetic manure made from decomposing materials, fertilizer and soil.

1.2. Function of soil conditioners

- They help to improve the amount of minerals in the soil.
- Leaves work by attracting earthworms which create a healthy soil
- Soil improved by
  1. Physical
  2. Chemical
  3. Biological

1.3. Importance of soil conditioners

- Soil conditioners can be used to rebuild soils which have been damaged by improper management, to make poor soils more usable, and to maintain soils in peak condition.
- A wide variety of products can be used to manage soil quality, with most being readily available from nurseries and garden supply stores.
- People can also generate their own soil conditioner with materials from home.
- Soils tend to become compacted over time, which is bad for plants, and soil conditioners can add more loft and texture to keep the soil loose.

2. Soil physical conditions and soil conditioners

- Poor soil physical condition can restrict water intake into the soil and subsequent movement, plant root development, and aeration of the soil.

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- These goals can be accomplished in part through the use of good management techniques.

3. Vital role of soil conditioners

- ✓ Improved soil structure and aeration
- ✓ Increased water-holding capacity.
- ✓ Increased availability of water to plants
- ✓ Reduced compaction and hardpan conditions.
- ✓ Improved tile drainage effectiveness
- ✓ Alkali soil reclamation
- ✓ Release of "locked" nutrients
- ✓ Better root development
- ✓ Higher yields and quality

3.1. Examples of soil conditioners

1. Peat
2. Straw
3. Coir
4. Manure
5. Compost
6. Vermiculite etc.,

4. Types and use of soil conditioners/amendments

1. Organic soil conditioners
2. Inorganic (Synthetic) soil conditioners

Fig 1. Organic soil conditioner

4.1. Organic Soil Conditioners

- Soil organic matter serves as a reservoir for nutrients;
  - ✓ Improves soil structure,

- ✓ Drainage,
- ✓ Aeration,
- ✓ Cation exchange capacity,
- ✓ Buffering capacity, and water-holding capacity; and provides a source of food for microorganisms.

4.1.1. Green manure

- ➢ GM is a crop that is grown mainly to add nutrients and organic matter to the soil, this kind of crop is used in rotation with other crops, which is ploughed under to serve the same purposes as animal manure.
- ➢ The roots of some green manure grow deep into the soil and bring up nutrients that are not present in shallow rooted crops.
- ➢ Leguminous crops are especially favored as green manures because they add nitrogen to the soil.

Fig 2. Green manure crops

4.1.2. Green manuring

- ➢ Supply Organic Matter
- ➢ The organic residues from green manure also help to provide the stability of soil structure needed for optimum plant growth.
- ➢ Humus formed from green manure increases the absorptive capacity of soil, promotes aeration, drainage and granulation, which help the plant growth.

4.1.3. Addition of Nitrogen

- The green manuring crop supplies additional nitrogen to organic matter, if it is a legume crop, which has the ability to fix nitrogen from the air with the help of its root nodule bacteria (e.g. Rhizobium).
- Green manuring crops act as cover crop.
- They protect the soil from erosion and nutrient loss by taking up soluble nutrients which might otherwise have been lost in drainage water or due to erosion.

4.1.4. Compost

- Composting is comes naturally to plant materials.
- They return to the earth to supply nutrients for the next cycle of seeds.
- Kitchen scraps can be recycled and yard waste composting them.

4.1.5. Importance of composting

- ✓ Improve the soil quality to reap their benefits and vitality by releasing the rich nutrients in the compost into the soil
- ✓ Recycle valuable nutrients and reduce the use of artificial fertilizers

Fig 3. Compost

4.1.6. Peat

- Consists of plant remains; it improves soil structure

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Fig 4. Peat

4.1.7. Crop Residues

- Crop residues contain substantial quantities of plant nutrients. Recycling of plant nutrients
- Soil moisture temperature regimes, enhancement of soil structure, erosion control

Fig 5. Crop residues

- Leaves make dark, rich compost that add nutrients to your soil and help keep your plants strong and disease free.

4.1.8. Coconut shell mulch

- The mulching made from the grinding up of coconut shells.
- It is extremely long lasting since it comes from a tropical plant and decomposes very slowly;

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Fig 6. Coconut shell mulch

- It has a very strong but pleasant odor which is suppose to keep bugs and animals (dogs and cats) away from the plants it is mulching.

4.1.9. Other Organic Fertilizers

- Include bird and bat droppings, blood meal, bone meal, and fish meal.
- Bone meal is an excellent source of the element phosphorus.
- But blood meal, bone meal, and fish meal is seldom used on farms as fertilizers, because it is too expensive.

4.2. Types of Inorganic soil conditioners

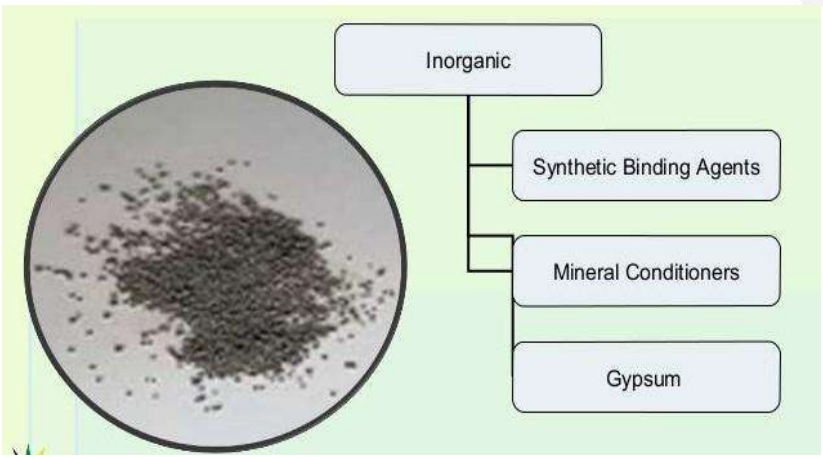

Fig 7. Inorganic soil conditioners

4.2.1. Synthetic Binding Agents

- New polymers applied at much lower rates have been promoted as soil conditioners.
- The compounds are very high
  1. molecular weight,
  2. long-chain polymeric,
  3. organic compounds,

4.2.2. Mineral Conditioners

- Gypsum is a mineral with the chemical composition $CaSO4 * 2H2O$.
- It occurs in nature as soft crystalline rock and varies in purity.

4.2.3. Gypsum

- Lowers bulk compactness of soil
- Prevents water run-off and eroding
- Converts Salty Soils
- An economical method to resolve salty soils.
- Gypsum helps the efficiency use of water for the crops. In periods of drought, this is exceedingly important.
- Helps moist soils to be tilled easier

Reference:

Sharma, A. K. (2002). *A hand book of organic farming, ed. AK Sharma, Agrobios, India*, 148-215.

Course Name	Organic Farming
Lesson 7	Integrated Pest and Diseases Management
Content Creator Name	DR S. Sheeba
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Objective:

1. To acquire knowledge regarding integrated pest management
2. To gain knowledge regarding integrated disease management

1. Integrated Pest Management (IPM):

Integrated Pest Management (IPM) is a system that, in the context of prevailing environment and population dynamics of the pest species, utilizes all appropriate techniques and methods in as compatible a manner as possible, and maintains pest populations at levels below those causing economic injury.

2. Bio-intensive Integrated Pest Management in Organic Farming:

Bio-intensive integrated pest management (BIPM) could be defined as: "a systems approach to pest management based on an understanding of pest ecology. It begins with steps to accurately diagnose the nature and source of pest problems, and then relies on a range of preventive tactics and biological controls to keep pest populations within acceptable limits" (Benbrook, 1996).

2.1 Bird perches: Bird perches are resting places for predatory birds to rest and to look for preys, such as insect pests of cotton, peanuts, and cowpeas.

Bio-intensive pest management practices:

1. Deep ploughing to expose hibernating stages of insects to hot summer temperatures.
2. Soil solarization technique for control of soil borne pathogens.
3. Seed treatment with permitted preparations and biopesticides.
4. Using semi-chemicals like pheromone attractants and trapping pests.
5. Augmentative releases of parasitoids and predators such as trichogramma, chrysoperla and coccinellids
6. Improving soil health to resist soil pathogens especially root diseases and promote plant growth through use of cover crops, green manures etc.
7. Growing crop varieties that are naturally resistant to diseases and pests.

3. **Biological control:**

Management of pests and diseasecausing agents utilizing, parasitoids, predators and microbial agents *like* viruses, bacteria and fungi is termed as biological control.

3.1 bio pesticides:

Use of micro-organisms for pest control involves their culture in artificial media and later introduction of larger amounts of inoculums in to the field at appropriate time.

3.2 Botanicals:

Some weeds like lantana, notchi, tulsi, adathodaetc act as natural repellant to many pests.

3.3 Biofungicides:

Biofungicides are the products containing benifical living organisms, often selected from natural environments that are used for pest management. These are formulated as powders for seed treatments, and as suspensions for root drenches and foliar sprays.

4. Components of organic pest management

The following are the components of organic method of pest management,

1. Ecology based pest management and habitat diversification
2. Use of resistant varieties
3. Wide hybridization.
4. Physical methods of pest management.
5. Mechanical methods of pest management.
6. Use of plant products/botanicals
7. Use of insect pheromones (sex attractants as traps)

8. Biological control of pests

5. HABITAT DIVERSIFICATION: Approaches by which the pest population can be brought down

5.1 Intercropping system:

In intercropping, due to chemical repellency, masking, feeding inhibition by odours from non-host plants leads to the decreased colonization and reproduction in pests. . Effect of intercropping system on pest levels was given in table 1.

5.2 Trap cropping:

Crops that are grown to attract insects or other organisms like nemathodes to protect target crops from pest attack. This is called trap cropping. List of successful examples of trap crops was given in table 2.

5.3 Planting dates and crop duration:

Planting dates should be adjusted that the susceptible stage of the crop synchronizes with the most inactive period or lowest pest population(Table 3).

5.4 Planting density:

Plant nutrient status, interplant spacing, canopy structure etc, affect insect behavior in searching for food, shelter and oviposition site. It also affects population of natural enemies.

5.5 Destruction of alternate host plants:

Many insects use a wide range of cultivated plants especially weeds as alternate hosts for off season carry-over of population. So their destruction is essential.

This can be done by thinning and topping, pruning and defoliation and summer ploughing are some of the cultural methods used.

5.6 Water management:

This step is crucial because, the plant growth is directly depended on the amount of water available.

5.7 Crop rotation:

Monocultures and overlapping crop seasons are more prone to severe outbreak of pest and diseases.

Growing rice after groundnut in garden land in puddled condition eliminates white grub.

5.8 Organic manure:

Application of press mud in groundnut @12.5 t/ha had a better influence on leaf minor with a lower leaflet damage.

The application of organic manure lowered the rice gall midge incidence.

5.9 Use of pest resistant or tolerant varieties:

Several resistant varieties of crops have been evolved against major pests, through intensive breeding programmes. Development of varieties with multiple resistances is essential.

5.10 Sanitation:

It includes destruction of breeding refuges and over wintering of pests.

Seed material, farm and manure etc. carrying insect eggs or its stages of development should be carefully screened before their use.

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5.11Wide hybridization:

It refers to crossing a wild species with a cultivated species which helps in enriching the gene pool of domesticated crops and raising agricultural product.

Table 1. Effect of intercropping system on pest levels

Sl. No,	Crop		Pest reduced
	Sole crop	Intercrop	
1.	Sorghum	Red Gram	Ear head bug
2.	Sorghum	Cowpea	Stem borer in sorghum
3.	Pigeon pea	Sorghum	*Leaf hopper*
4.	Green gram	Sorghum	*Leaf hopper*
5.	Groundnut	Sorghum	*Leaf hopper*
6.	Pigeon pea	Sorghum	*gram caterpillar*
7.	Chickpea	Wheat, Mustard or Safflower	*gram caterpillar*
8.	Sugarcane	Greengram,	Early shoot borer

Table 2. List of successful examples of trap crops

Sl. No.	Main Crop	Trap crop	Pests controlled
1.	Tobacco/ Cotton/ Groundnut	Castor	Tobacco caterpillar
2.	Maize	Sorghum	Shoot fly, Stem borer
3.	Cotton	Onion / Garlic	Thrips in cotton

Table 3. Role of planting dates on pest population and damage

Sl. No	Host	Insect	Response
1.	Rice	Leaf folder	Early planted rice (upto 3rd week of June) suppressed

2.	Rice	BP1-1 (Brown Plant Hopper)	Planting in end of may In Kharif and Early in Rabi escapes attack in AP

Table 4. Effect of plant density on pest population

SI. No.	Crop	Spacing/	Insect	Response
1.	Rice	Dense planting	Leaf folder, BPH	High incidence
2.	Chickpea	Dense plant population	*H. armigera*	High incidence
3.	Chickpea	Less plant population	Aphid	High incidence
4.	Sugarcane	Higher seed rate	Top shoot borer	Low incidence

Table 5. Alternate hosts to be removed to reduce damage by pests

S. No	Crop	Pest	Alternate host to be removed
1.	Groundnut	Thrips	*Achyranthus aspera*
2.	Rice	Gallmidge	Wild rice (O.nivara)
3.	Rice	GLH (Green leaf hopper)	*Leersiaheximdra Echinochloacolonum Ecrusgalli*
4.	Rice	WBPH (White Backed Plant	*Chieresbarbata*
5.	Sorghum	Earhead nudge	Grassy weeds

Table 6. Effect of irrigation on pest population/damage

Sl. No	Crop	Insect	Response
1.	Rice	Mealy bug	Continuous imponding of 5cm water reduced incidence
2.	Rice	Caseworm and BPH	Draining of water to field capacity reduces incidence
3.	Fruit tree nursery	Termite	Copious irrigation reduces incidence
4.	Groundnut	Aphids	Copious irrigation increased incidence

Physical method of pest control

The following are some examples of the use of physical methods of insect control

- Use of activated clay at one per cent or vegetable oil at one per cent has been found to effectively control damage by *Callosobruchus chinensis* in stored pulses.
- Solar heat treatment of sorghum seeds for 60 seconds using solar drier kills rice weevil and red flour beetle without affecting germination of seeds.

Mechanical method of control

- Mechanical destruction:
  1. Hand picking of caterpillars
  2. Shaking plants to dislodge caseworm in rice

- Mechanical exclusion:
  1. Trenching-for larvae of red hairy caterpillar
  2. Rat proof structure in storage godowns

Course Name	Organic Farming
Lesson 8	Weed Management
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Designed and developed under the aegis of NAHEP Component-2 Project "Investments In ICAR Leadership In Agricultural Higher Education"
Division of Computer Applications, ICAR-Indian Agricultural Statistics Research Institute

Objectives

1. To know the basic definition of weed given by different authors
2. To gain knowledge regarding methods of weed management

Weed

- Weeds are the plants, which grow where they are not wanted (Jethro Tull, 1731).
- "A plant growing where it is not desired" (Buchholtz, 1967).
- In 1989 the Society's definition was changed to define a weed as "any plant that is objectionable or interferes with the activities or welfare of man".

Weed Management

- The procedure by which the harmful effect of weed may be maintained to the minimum level in a place.
- Weed management is a system by which the infestation of weeds of a farm or an area is kept to lower than the economic injury level without deteriorating the environment.

- ✓ Increased use of herbicides has resulted many problems. The environment safety has been doubted with increased pollution hazards.
- ✓ That apart, weed species are developing resistance to chemical toxicants.
- ✓ In India, continuous use of isoproturan in wheat crop has resulted in the development of resistance in *Phalaris minor*.
- ✓ More over there is also problem of resurgence of weeds.
- ✓ In organic farming weeds can be managed by the following methods;

1. **Preventive methods:**

- Preventive method of weed control include use of weed free crop seeds, weed free manure, clear equipments and elimination of weed infestation in and around irrigation channels and cultivated fields.

2. **Cultural methods:**

- Smother crops are highly competitive with the weed species infesting an area for light, nutrients and moisture.
- The crops such as barley, millet, sorghum, alfalfa, clover, cowpea, sesbania, sunflower etc. Other cultural methods are sowing of cover crops, crop rotation, line sowing, maintaining optimum plant population, drip irrigation etc. which reduces weed problems.

3. **Mechanical methods:**

- This method includes practices like hand weeding, hoeing, mowing, flooding, mulching, burning and tilling the soil for the reduction of weeds.

4. **Soil solarization:**

- This is an eco-friendly technology used to kill weed seeds in soil. It involves mulching of soil with clear plastic films so as to trap the solar heat in the surface soil.
- The resultant temperature increase would be lethal to soil pathogens, nematodes and weeds. This method can be use where air temperature goes up to 45℃ during summer months.
- It is efficient where bright sun light is available for about 4-6 weeks.

5. **Biological methods**

- This method involves utilization of natural enemies for the control of certain weeds.
- This can be achieved by direct or indirect action of biological control agents. In direct action, firstly the bio control agent bores into plant, weakens its structure which leading to its collapse and consumes as food and destroys the vital plant parts.
- In indirect action the bio control agent reserves the competitive ability of weed over other plants and enhances the condition favorable for plant pathogens.

5.1 Insects:

- For bio-control of weeds, the insect selected should specifically attack on the targeted weed without harming the other plants

Table 1. List of bio-agents of different weed species

S.N.	Weed species	Bio-agent	Remarks
1.	Prickly pear cactus	*Cactoblastis cactorurn*	By leaf feeding beetle
2.	Water hyacinth	*Neochetina bruchi Alternaria eichhornia*	By leaf eating weevil & fungus
3.	Parasiticweed *Orobanche* sp.	*Fusarium oxysporum* and fly *(Sipha maidis)*	Fungus & Insects both are used
4.	*Cyperus rotundus*	*Bactra minima* and *Athespacuta cyperi*	By leaf eating insect
5.	*Partheniu m hysteropho rus*	*Zygograma bicolorata and Smicronyx lutulentus*	By leaf eating insect

(Source: Telkar *et al.,* 2015)

5.2 Plant pathogens

- The active ingredient in a bio-herbicide is a living organism, mostly a microorganism.
- An herbicide made of mycelia fragments or spore of fungi is called mycoherbicide.

- This technique holds promise because reduced quantities of spores are needed, when seedlings are small and emerging.

Table 2. List of weed controlled by fungi

Mycoherbicide	Fungus	Weed controlled
De vine	*Phytophthora palmivora*	Milk weed vine
Velgo	*Colletotrichum coccodes*	Velvet leaf
Collego	*Collego gloeosphoroides f. sp. Aeschynomene*	Northern joint vetch

(Source: Telkar *et al.,* 2015)

6. Allelopathy:

- Inter-weed-competition determined by allelopathy can be manipulated in the natural control of weeds.
- Natural compounds released by some plants inhibit or prevent the growth of nearby plants.
- Marigold flowering plant is found to suppress the growth of parthenium. Thistle exudation inhibits the growth of oats.
- Wheat, oats & peas suppress the growth of *Chenopodium album*.
- The crop residues from alfalfa, sunflower, wheat, corn and soybean are toxic to weeds

Reference:

- Telkar, S. G., Gurjar, G. N., Dey, J. K., Kant, K., & Solanki, S. P. S. (2015). Biological weed control for sustainable agriculture. *International Journal of Economic Plants*, *2*(4), 181-183.

Course Name	Organic Farming
Lesson 9	Quality Considerations, Certification, Labelling and Accreditation Process
Content Creator Name	DR S. Sheeba
University/College Name	Tamil Nadu Agricultural University, Coimbatore
Course Reviewer Name	DR J. C. Sharma
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Designed and developed under the aegis of NAHEP Component-2 Project "Investments In ICAR Leadership In Agricultural Higher Education"
Division of Computer Applications, ICAR-Indian Agricultural Statistics Research Institute

Objectives:

To understand the process of certification, labelling and accreditation of Organic products.

Organic Certification:

- It is a certification process for producers of organic food and other organic agricultural products.
- Certification requirements vary involve a set of production standards for growing, storage, processing, packaging and shipping that include:
    - Avoidance of synthetic chemical inputs and genetically modified organisms.
    - Use of farmland that has been free from chemicals for a number of years.
    - Keeping detailed written production and sales records.
    - Maintaining strict physical separation of organic products from non-certified products.
    - Undergoing periodic on-site inspections.

Purpose of certification

It is intended to assure quality and prevent fraud. Certification is essentially aimed at regulating and facilitating the sale of organic products to consumers.

The certification process

The certification process is as follows:

- **Study** the organic standards.
- **Compliance** - farm facilities and production methods must comply with the standards, which may involve modifying facilities, sourcing and changing suppliers, etc.
- **Documentation**- extensive paperwork is required, detailed farm history and current set-up, and usually including results of soil and water tests.
- **Planning**- a written annual production plan must be submitted, detailing everything from seed to sale.
- **Inspection**- annual on-farm inspections are required.

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- **Fee** – A fee is to be paid by the grower to the certification body for annual survellence and for facilitatining a mark which is acceptable in the market as symbol of quality.
- **Record-keeping**- written, day-to-day farming and marketing records, covering all activities, must be available for inspection at any time.

Certification system in India

In India, there are two accreditation systems for authorizing Certification and Inspection agencies for organic certification:

- National Programme on organic Production (NPOP) promoted by Ministry of Commerce is the core programme which governs and defines the standards and implementing procedures.
- National Accreditation Body (NAB) is the apex decision making body. Certification and Inspection agencies accredited by NAB are authorized to undertake certification process.

National Programme on Organic Production

- National Program on Organic Production (NPOP) was launched during 2001 under the Foreign Trade & Development Act (FTDR Act).

Operational Structure:

- National Steering Committee for National Programme for Organic Production, is the apex policy making body and operates the entire programme through National Accreditation Body (NAB), Technical Committee (TC) and Evaluation Committee (EC).
- Agricultural and Processed Food Products Export Development Authority (APEDA)is the secretariat and implementation office for NPOP for export while Agriculture Marketing Advisor, Directorate of Marketing and Inspection, Department of Agriculture and Cooperation is the secretariat and implementation office for NPOP for domestic certification.

National Standards for Organic Production (NSOP)

National Standards for Organic Production are grouped under following six categories:

- 1) Conversion
- 2) Crop production
- 3) Animal husbandry
- 4) Food processing and handling
- 5) Labeling
- 6) Storage and transport

Standard requirements for crop production, food processing and handling are listed below:

1. **Conversion Requirements**
   - The time between the start of organic management and cultivation of crops or animal husbandry is known as the conversion period.
   - All standard requirements should be met during conversion period.
2. **Crop Production**

2.1Choice of crops and varieties –

- All seeds and planting materials should be certified organic.
- Use of genetically engineered seeds, pollen, transgenic plants is not allowed.

2.2Duration of conversion period –

- The minimum conversion period for plant products, produced annually is 12 months prior to the start of the production cycle.
- For perennial plants (excluding pastures and meadows) the conversion period is 18 months from the date of starting organic management.

2.3 Fertilization policy-

- Biodegradable material of plant or animal origin produced on organic farms should form the basis of the fertilization policy.

2.4 Pest disease and weed management including growth regulators –

- Botanical pesticides prepared at farm from local plants, animals and microorganisms are allowed.
- Use of genetically engineered organisms or products is prohibited.

2.5 Soil and Water conservation –

- Soil and water resources should be handled in a sustainable manner to avoid erosion, salination, and the pollution of surface and ground water.

3 Collection of non-cultivated material of plant origin and honey –

Wild harvested products shall only be certified organic, if derived from a stable and sustainable growth environment and the harvesting shall not exceed the sustainable yield of the ecosystem and should not threaten the existence of plant or animal species.

3. **Food processing and handling:** Organic products shall be protected from co-mingling with nonorganic products, and shall be adequately identified through the whole process.
   - Controlled atmosphere, cooling, freezing, drying and humidity regulation.

Pest and disease control –

Methods of pest control are:

- Mechanical, physical and biological methods
- Permitted pesticidal substances as per the standards and
- Other substances used in traps.

Irradiation is prohibited.

5. Packaging

- Material used for packaging shall be ecofriendly.
- Recycling and reusable systems should be used.

6. Labelling

- When the full standard requirements are met, the product can be sold as “Organic”.

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- On proper certification by certification agency “India Organic” logo can also be used on the product.
- In the US, federal organic legislation defines three levels of organics:
  -Products made entirely with certified organic ingredients and methods can be labelled "100% organic ".
  -Products with 95% organic ingredients can use the word “organic ".
  -A third category, containing a minimum of 70% organic ingredients, can be labelled "made with organic ingredients".

7. Storage and transport

Organic products must be protected from co-mingling with non-organic products and must be protected all times from contact with the materials and substances not permitted for use in organic farming.

Organic Certification Mark

Organic Logo

- A trademark – “India Organic” will be granted on the basis of compliance with the National Standards for Organic Production (NSOP). This trademark is owned by the Government of India.
- Only such exporters, manufacturers and processors whose products are duly certified by the accredited inspection and certification agencies, will be granted the license to use of the logo which would be governed by a set of regulations.

Specifications

The Indian Organic Logo must comprise of the colour specifications listed below: -

Concept of Organic Logo

- Symbolizing the rhythm of cosmic and earth forces represented by the blue and brown waves of force and energy, ‘India Organic’ logo celebrates the essence of nature.

- The colours used have a special significance in the logo concept. The cosmic force in blue symbolizes universal purity.
- Richness of soil, nourished with natural ingredients in organic farming, is symbolized by the earth forces in golden brown.
- The plant in green uses the colour of nature and natural products untouched by chemicals.
- The blue background is symbolic of earth's environment that is congenial for life to thrive in and is also free of pollution and harmful chemicals.

Regulatory mechanism for production of organic products in India

Govt. of India and State Governments are initiating the following steps:

1. Formation of organic farmers group
2. Registration of farmer's group with district authorities
3. Documentation of individual farms/farmer's records
4. Service providers
5. Accreditation agencies
6. Certification and inspection agencies
7. Periodic Inspection of Organic farms

Certification Procedure in brief

- Application is made to the certification agency in the prescribed format with necessary farm and process details
- Screening of application by certification agency and if necessary further details/clarification sought
- Cost estimate comprising of certification charge, inspection charge, travel cost, reporting cost, laboratory charges etc. is sent for acceptance
- Acceptance of cost by the grower/producer
- Signing of agreement between grower/producer and certification agency

- Certification agency seeks cropping/production/cultivation /processing plan and supply a copy of the standards to the grower/producer to follow
- Certification agency raises an invoice and asks the producer to release 50% of the certification cost in advance
- Grower/producer pays the fee
- Inspection schedule is worked out
- Inspection is carried out at one or more than one occasion
- If required unannounced inspection can also be done. In case of doubt the inspection team can also draw plant/soil/raw material/input/product sample for laboratory analysis.
- Inspection report/(s) submitted to the certification committee
- Certification agency asks for final payment
- Final payment is made
- Certification is granted
- Grower/producer releases the stock for sale with Certification Mark (India Organic Logo)

Accreditation

Accreditation is a process in which certification of competency, authority, or credibility is presented.

Guideline of Organic Standard for food process

- Handling/processing of organic products should be optimized to maintain quality
- Pollution sources should be identified
- Flavouring extracts preferably be organic
- Product shall be protected with non- organic product
- Organic & non- organic product shall not be stored & transported together.
- Special condition of storage permitted (controlled atmosphere, cooling, freezing, Drying)
- Humidity regulation ethylene gas for ripening permitted
- Biodegradable packaging materials shall be used

- Packaging through product like benzooxazolyl, methoxymethyl flourine etc. prohibited

Reference:

- Gehlot, D. (2005). *Organic farming: standards, accreditation, certification and inspection*. Agrobios (India).

Course Name	Organic Farming
Lesson 10	Organic Farming- Marketing, Exports
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Division of Computer Applications, ICAR-Indian Agricultural Statistics Research Institute

Objectives:

1. To acquire knowledge regarding marketing and exports of organic farming.
2. To gain knowledge about the opportunities and challenges of organic farming.

1. Global Market

- Organic agriculture now accounts for just 1.1% of global agricultural hectares.
- One hundred and seventy nine countries currently report organic agriculture statistics. However the "big five" (Australia, Argentina, USA, Spain, and China) account for 62% of the total while the remaining 174 countries account for 38% of the global total.
- Consumer demand for organic products is concentrated in North America and Europe; these two regions comprise 97% of global revenues.
- Asia, Latin America and Australasia are important producers and exporters of organic foods.
- The financial crises have had a negative impact on the global market for organic products; however, preliminary research finds that growth continued in 2009 despite the poor economic climate.

2. Indian domestic market and export

- Organic Food Consumption in India is on the Rise.
- Though 50% of the organic food production in India is targeted towards exports, there are many who look towards organic food for domestic consumption.
- Though organic food is priced over 25 percent more than conventional food in India, many people are willing to pay this higher premium due to the perceived health benefits of organic food. The increase in organic food consumption in India is evident from the fact that many organic food stores are spurring up in India.

- Organic food exports from India are increasing with more farmers shifting to organic farming. With the domestic consumption being low, the prime market for Indian organic food industry lies in the US and Europe.
- India has now become a leading supplier of organic herbs, organic spices, organic basmati rice, etc.
- The increasing demand for organic food products in the developed countries and the extensive support by the Indian government coupled with its focus on agri-exports are the drivers for the Indian organic food industry.
- Organic food products in India are priced about 20-30% higher than non-organic food products. This is a very high premium for most of the Indian population where the per capita income is merely US $800.
- The domestic market is not sufficient to consume the entire organic food produced in the country.
- As a result, export of organic food is the prime aim of organic farmers as well as the government.

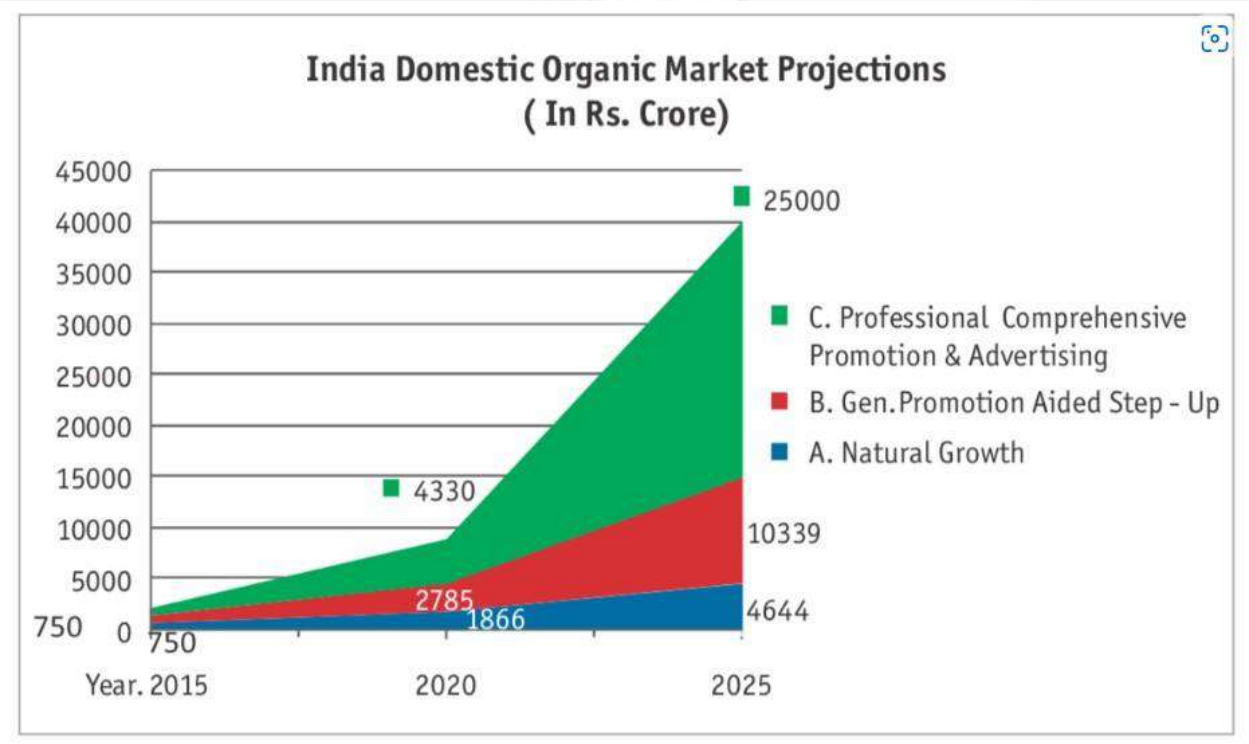

Fig 1. India Domestic Organic Market Projections

(Source: Indian Organic sector, vision 2025)

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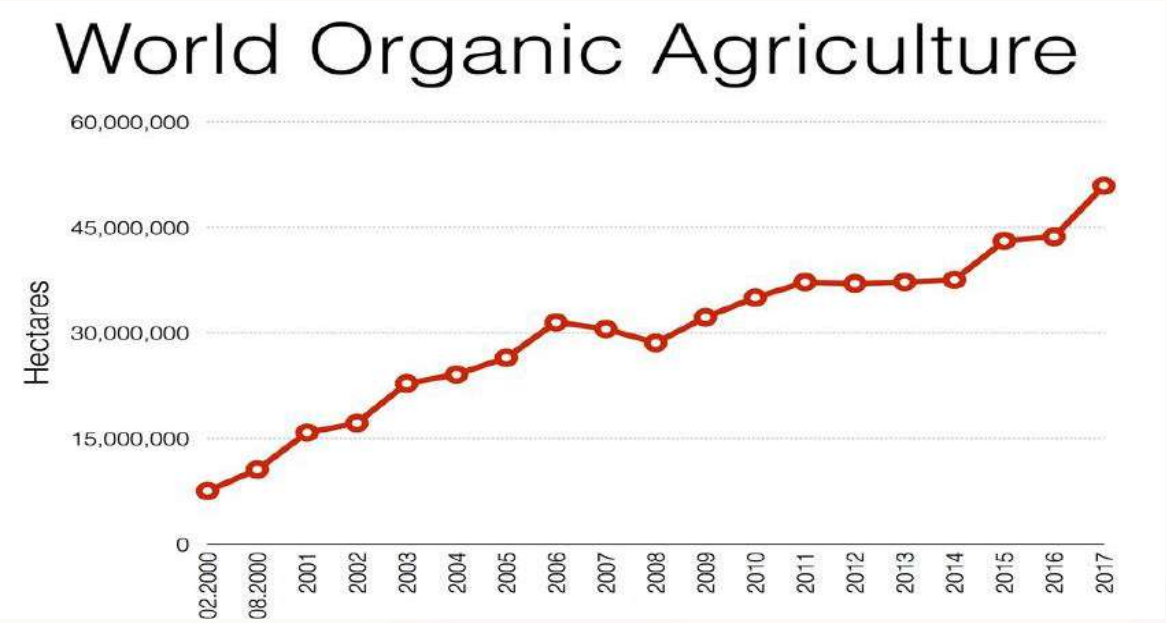

Fig 2. World Orgnic Agriculture

(Paull, 2017)

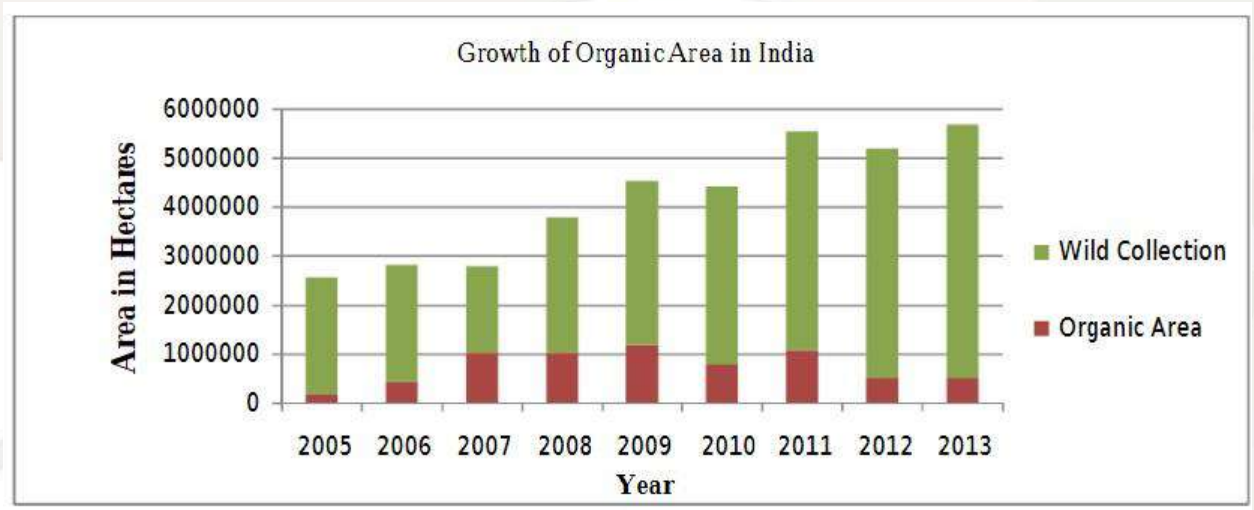

Fig 3

(Source: FIBL-AMI organic data network survey 2000-2015)

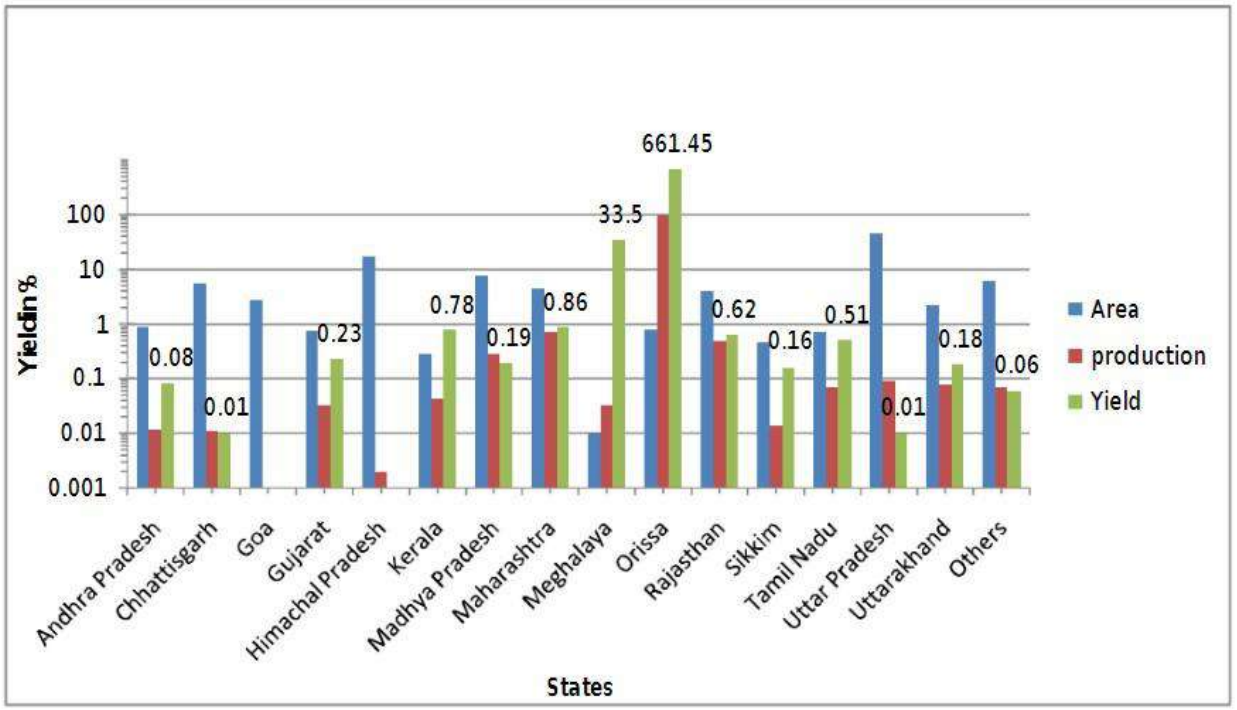

Fig 4. State wise production of organic products

(Source: National Project on Organic Farming Annual Report 2012-2016)

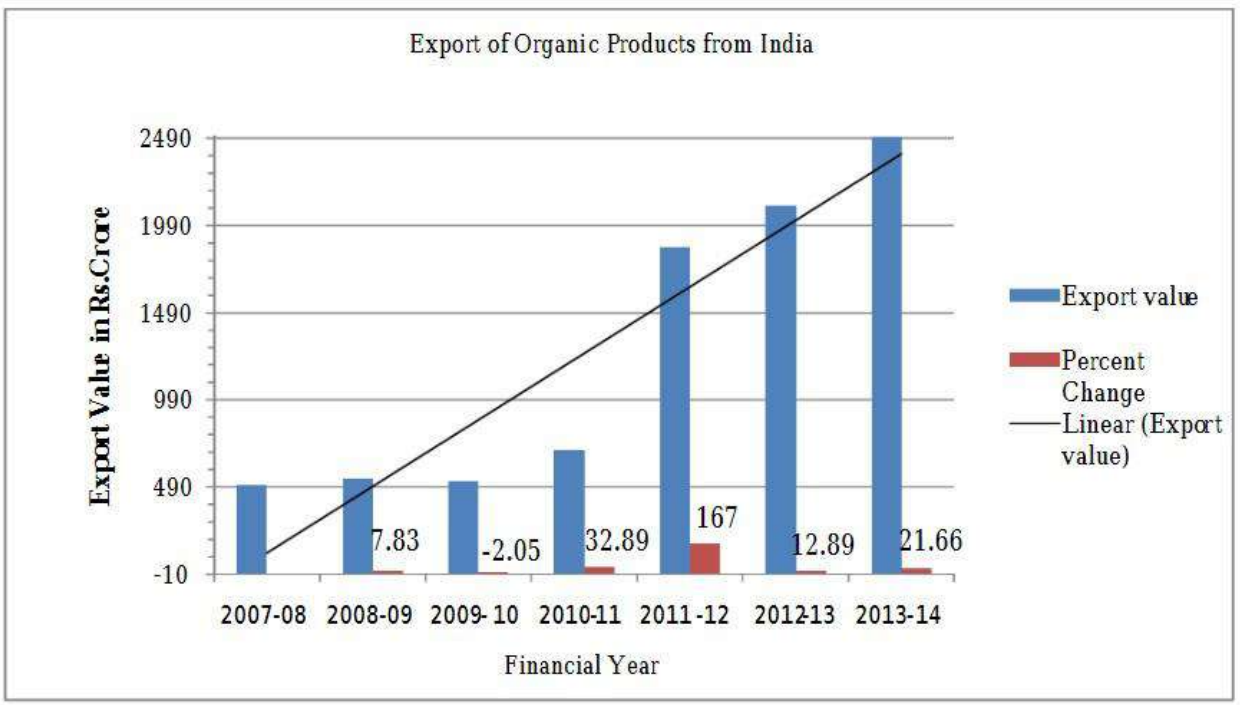

Fig 5

(Source: National centre for organic agriculture annual report 2013-2014)

3. Opportunities and Challenges of Organic Farming:

3.1. Opportunities

- In recent years, awareness of health and environment among consumers has increased the demand of organic produce.
- Indian agriculture needs not only to increase but also to maintain the production of food grains.
- In India chemical fertilizers are applied only in 30% of the cultivated area which is irrigated and the remaining land is under rain-fed agriculture with almost no fertilizer application which accounts for about 40% of the food grain production of the country.
- The potential areas and crops with low or no use of chemicals could be explored and brought under organic agriculture.
- The rain-fed, tribal, Northeast and hilly regions of India were traditional farming on eco-friendly lines is more or less practiced could be considered. The introduction of organic farming in these areas will immediately lead to increased food production.
- The simple technologies with low input use developed for dry farming can be transferred to the farms for organic farming.
- About 600-700 million tones of biomass is available to be converted into manure. This could increase the nutrient value from 0.3-0.4% to 1-2%.
- By March, 2010, India has brought more than 4.48 million ha under organic certification process. Indian organic industry is estimated at US$ 116.09 million and is entirely export oriented. According to APEDA about 585970 tonnes of organic products worth Rs 301 million are being exported from India.
- Exceptional growth rates have tightened the supply in themarket and this is creating opportunity for the organic food exporters. Growing awareness, increasing market demand,increasing inclination of farmers to go organic and growing institutional support have resulted in more than 200% growth in certified area during the last 2 years.
- India has the potential to become a major organicproducing country given the international demand for our farm products, different agro-climatic regions for cultivation of a number of crops, the size of the domestic market and above all the long tradition of environment friendly farming and living.

3.2. Challenges

- Maintaining sustainability in the global economy and balancing organic principles with commercial imperatives.
- Maintaining flexible organic standards and certificationprocesses to address issues such as:
    a. nature conservation and regeneration;
    b. equitable, affordable and flexible access to certification services;
    c. responsible labour relations and land tenure arrangements;
    d. animal welfare;
    e. new inputs such as 'natural' biocides, soil amendments and GMOs;
    f. Incomplete or unscientific basis for including/excluding materials from organic standards.
- Pursuing international harmonization of standards andcertification.
- Developing locally applicable agronomic solutions toproduction constraints, such as weeds, animal health and soil fertility.
- Expanding research activities in many disciplines (particularly beyond Europe and North America) and foster the integration of knowledge.
- Preserving food quality while trying to increase productivity.
- Educating and training at all levels to build capacity, infrastructure and networks.
- Inadequacies in regulatory and marketing structures (e.g. Labelling).
- Excessive consumer prices and inconsistent quality and availability.
- Establishing and maintaining credibility and professionalism.